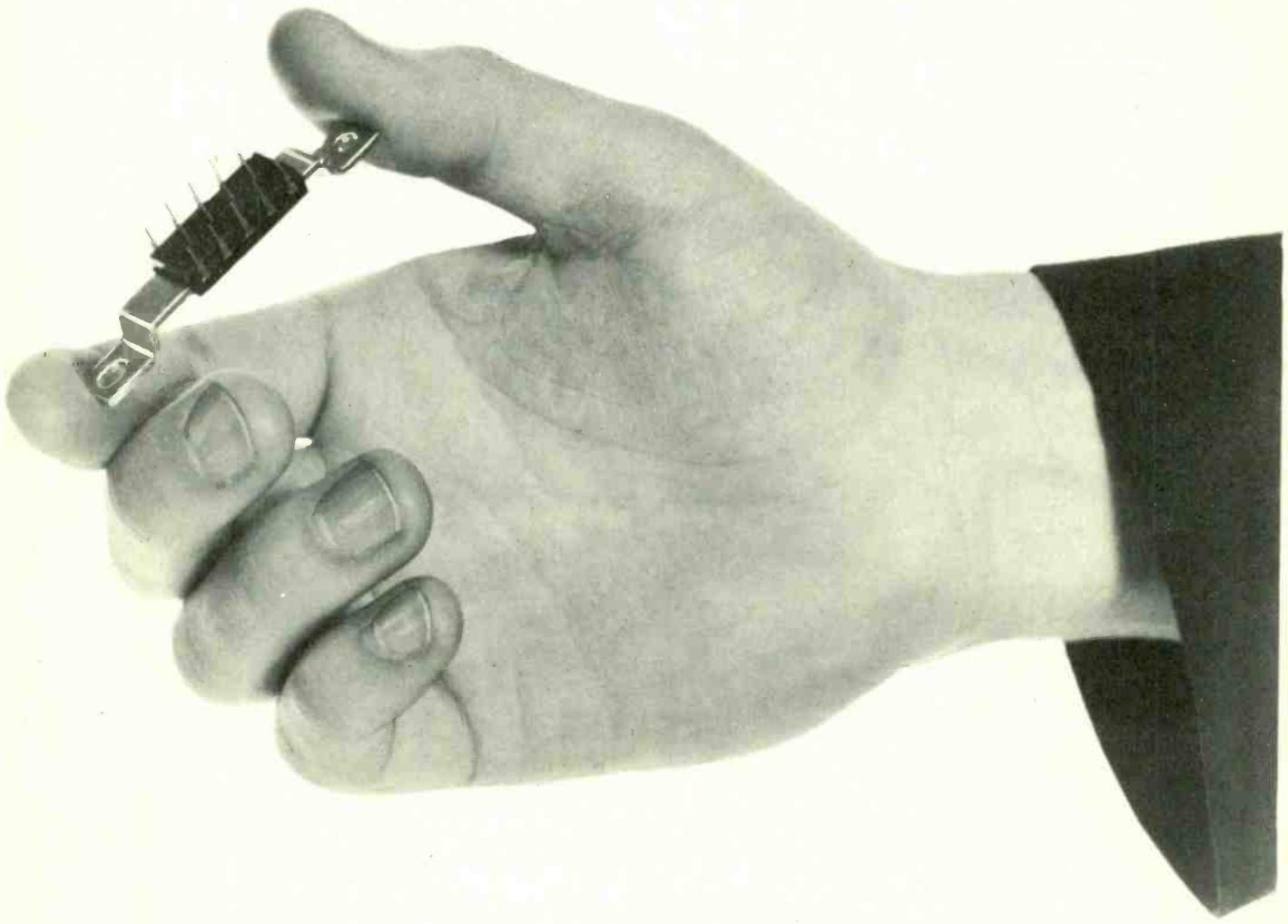
Wireless World

April 1970 3s 6d

Stabilized power supply unit
Digital remote control

2 Watt and 3 Watt Professional IC Audio Amplifiers now available



These Plessey general purpose integrated circuit audio amplifiers are being used by a number of major equipment manufacturers throughout the country.

Through large scale production Plessey can now make these devices available to home constructors at reasonable prices.

Each circuit incorporates a preamplifier and a class A-B power amplifier stage and needs only a minimum of external components.

Take a look at these specifications opposite!

These really outstanding Plessey IC audio amplifiers are immediately available off-the-shelf from our distributors listed below. Data application brochures (Price 1s. 9d. each) which include PC board layouts for mono and stereo amplifiers are obtainable from:

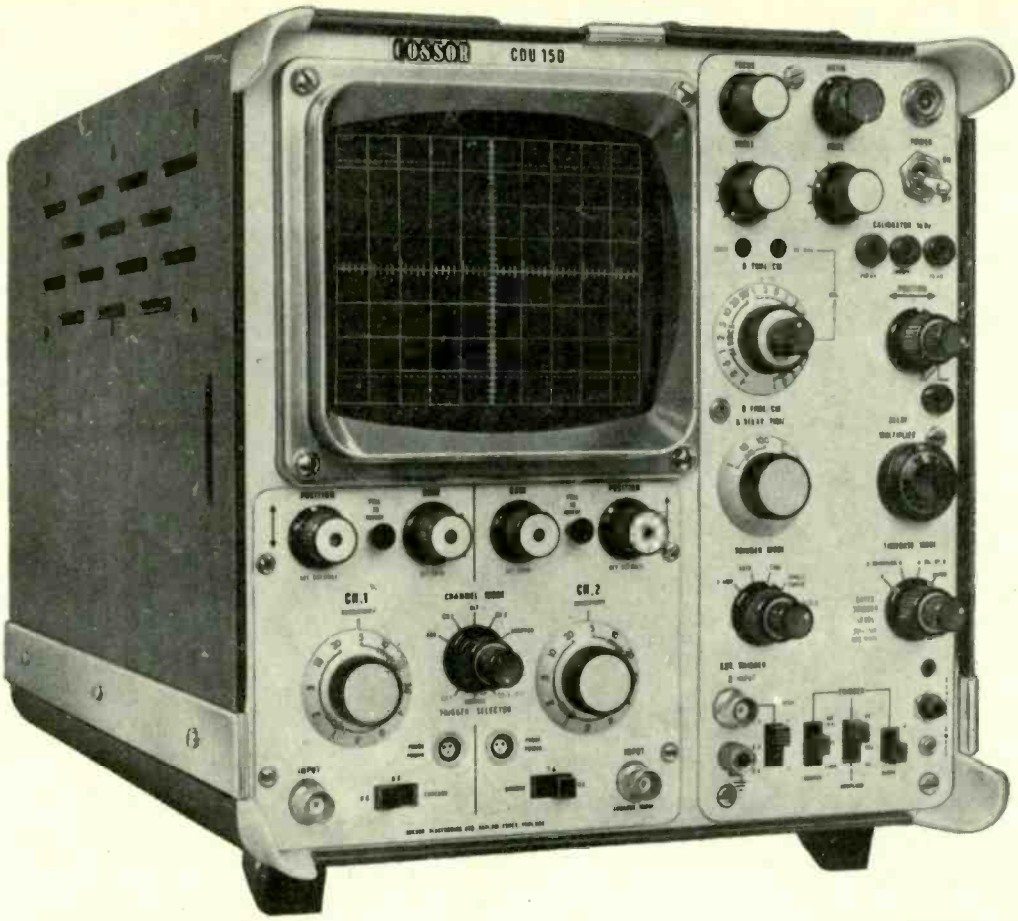
Farnell Electronic Components Ltd
Canal Rd, Leeds LS 12 2TU
Tel: Leeds 636311 Telex: 55147

Characteristic	SL402A	SL403A
Output power r.m.s.	2W	3W
Input impedance		
Preamplifier	20 M Ω	20 M Ω
Main amplifier	100 M Ω	100 M Ω
Distortion		
Preamplifier	0.1%	0.1%
Main amplifier	0.3%	0.3%
Frequency response		
Lower—3dB point	20 Hz	20 Hz
Upper—3dB point	30 kHz	30 kHz
Operating voltage	+14 V	+18 V
Min. operating load	7.5 Ω	7.5 Ω

SDS (Portsmouth) Ltd
Hillsea Industrial Estate, Hillsea, Portsmouth, Hants.
Tel: Portsmouth (0705) 62332 or 62180 Telex: 86114

PLESSEY microelectronics
Cheney Manor Swindon Wiltshire England Telephone: Swindon (0793) 6251. Telex: 44375

WW—006 FOR FURTHER DETAILS



Check this list— see how much scope you get from Cossor

- ☐ **CDU 110** 20 MHz Dual Channel 5 mV/cm Sweep Speeds to 40 nS/cm Sweep Delay **£360**
- ☐ **CDU 120** 50 MHz 5 mV/cm 25 MHz 1 mV/cm Dual Channel Sweep Delay **£640**
- ☐ **CDU 130** 15 MHz 5 mV/div. Mains/Internal Batteries 16.5 lb. including battery **£230**
- ☐ **CDU 150** 35 MHz Dual Channel 5 mV/cm Sweep Speeds to 20 nS/cm Sweep Delay **£480**

COSSOR — first in scopes

Please write or phone for further details:
COSSOR ELECTRONICS LIMITED, Instrument Division, The Pinnacles, Harlow, Essex. Telex: 81228 Telephone: Harlow 26862
WW—007 FOR FURTHER DETAILS

Experience:

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

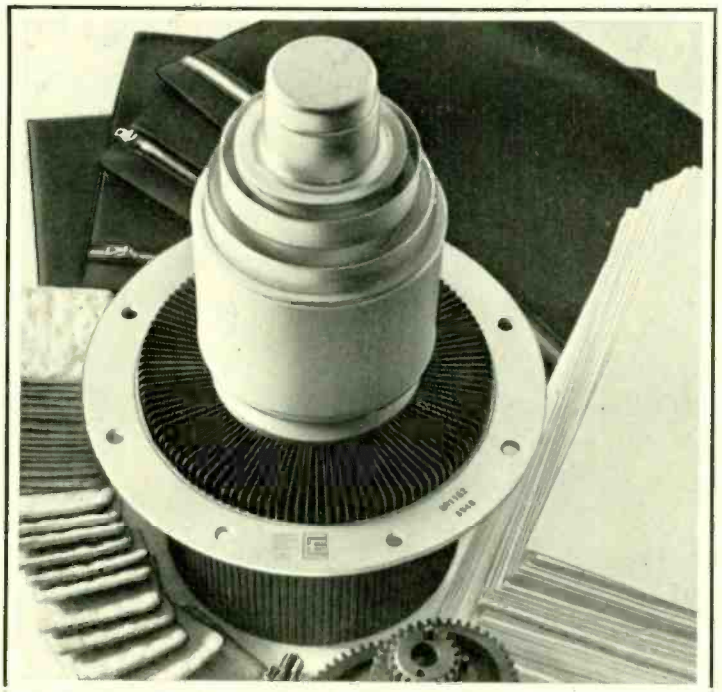
EEV make power triodes for industrial heating applications from 1kW up to 250kW. They are all conservatively rated and realistically designed to give good length of life. Whatever your application —for drying paper, baking biscuits, welding plastic, treating metal—r.f. heating the EEV way is economical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

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

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

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

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



To: English Electric Valve Co Ltd, Chelmsford, Essex, England.

Please send full data on power triodes for industrial heating.
Please recommend triodes for an equipment with these ratings.

Output power (kW) *Anode voltage max. (kV)* *Frequency (MHz)*

Name & Position

Company

Address

Telephone exchange or STD code

Number Extension

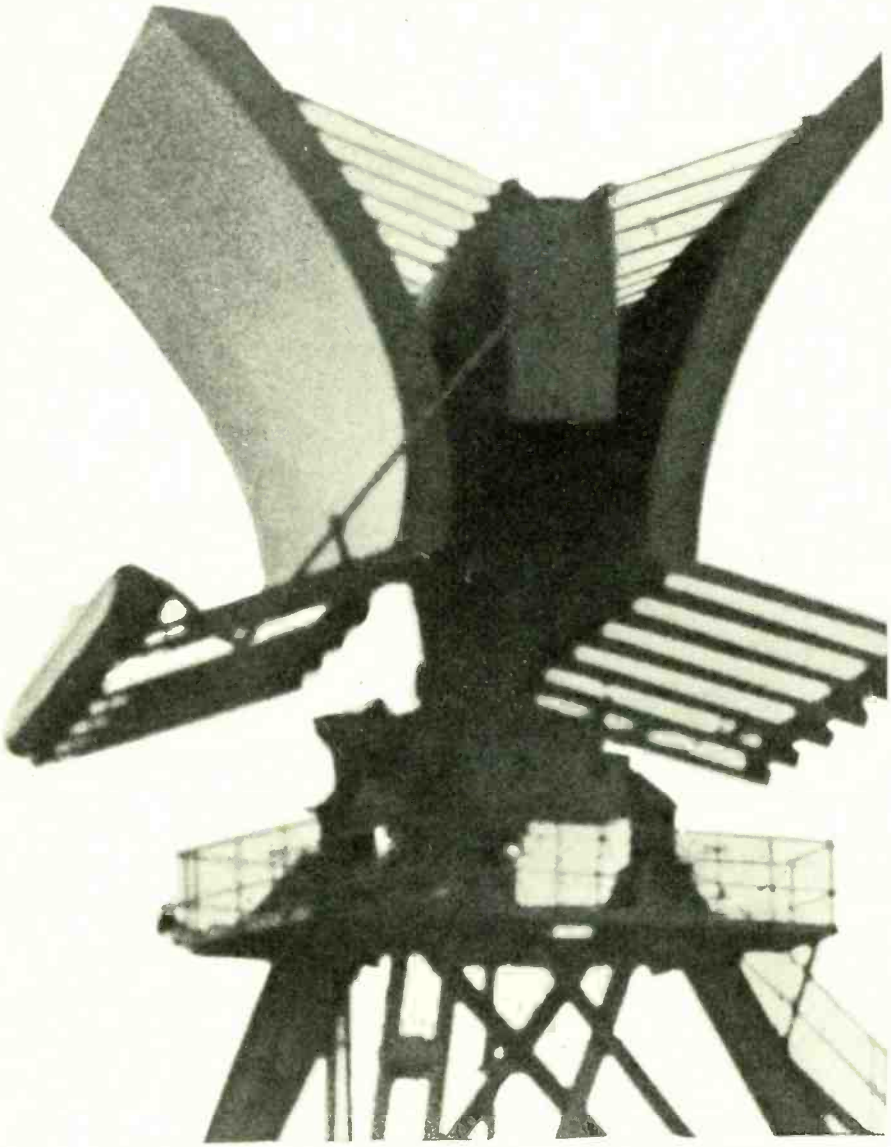
WW—008 FOR FURTHER DETAILS

The great EEV radar display

These radar components represent just part of our total radar capability, and they indicate the size of our investment in radar. We know radar from thyratrons to magnetrons, from duplexers to klystrons. And we have the resources to back this immense fund of knowledge. EEV's advanced tube technology is at your service. If a device to suit your equipment is not already in our catalogue, we would consider making one specially for you.

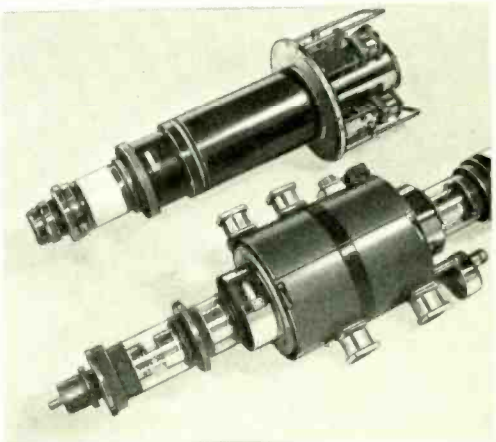
So that we can send you the latest, up-to-date information, please return the coupon opposite.

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

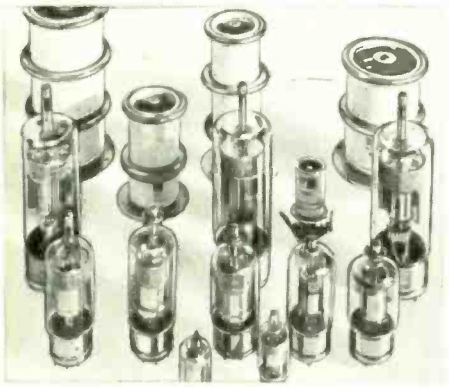


1. Magnetrons

2. High power klystrons

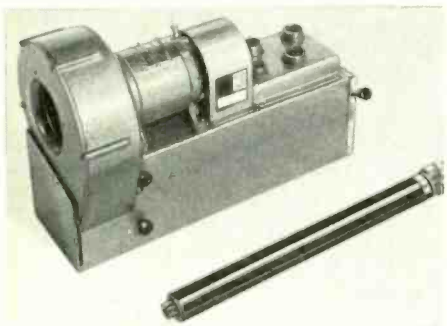


3. High-power travelling-wave tubes

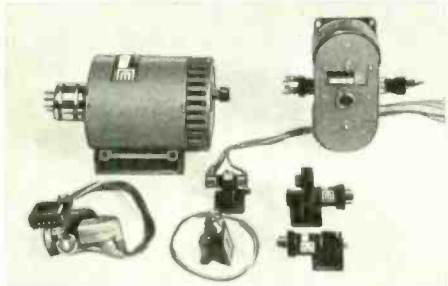


4. Hydrogen thyratrons

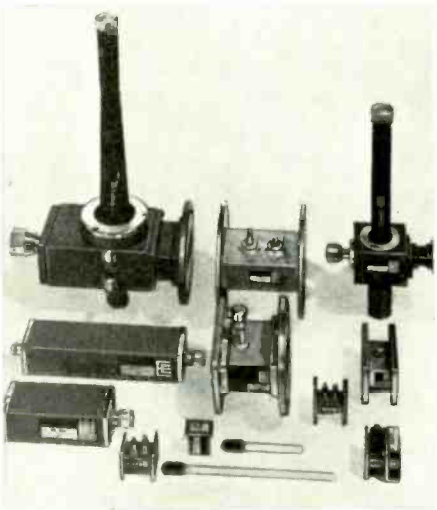
5. Pulse tetrodes



6. Low-power travelling-wave tubes



7. Low power klystrons and backward wave oscillators



8. Duplexer devices

9. Voltage stabilisers

10. Storage tubes

QUAD 50 is a single channel 50 Watt amplifier designed for Broadcast, Recording and other applications in the Audio industry, completely proof against misuse and giving the highest quality of reproduction.

INPUTS – 0·5 Vrms unbalanced with provision for an optional plug-in transformer for bridging 600 ohms lines.
OUTPUTS – isolated providing 50 watts into almost any impedance from 4 to 200 ohms.
DIMENSIONS – 12¾" x 6¼" x 4½"

Complete the coupon and post today.

Please send me full details of the QUAD 50 Amplifier

NAME .....

POSITION .....

COMPANY .....

ADDRESS .....

.....

(BLOCK CAPITALS)

ACOUSTICAL MANUFACTURING CO. LTD.,
HUNTINGDON. Telephone: Huntingdon (0480) 2561/2

WW

QUAD
for the closest approach to the original sound

WW—012 FOR FURTHER DETAILS

World Travellers pose for their passports

The Teonex family is big – 2,000 odd members, exclusive of semi-conductor relatives!
Like every family, they come in many shapes and sizes. Slim or fat, tall or squat, bigger or smaller, and in many ages: very young to very old.

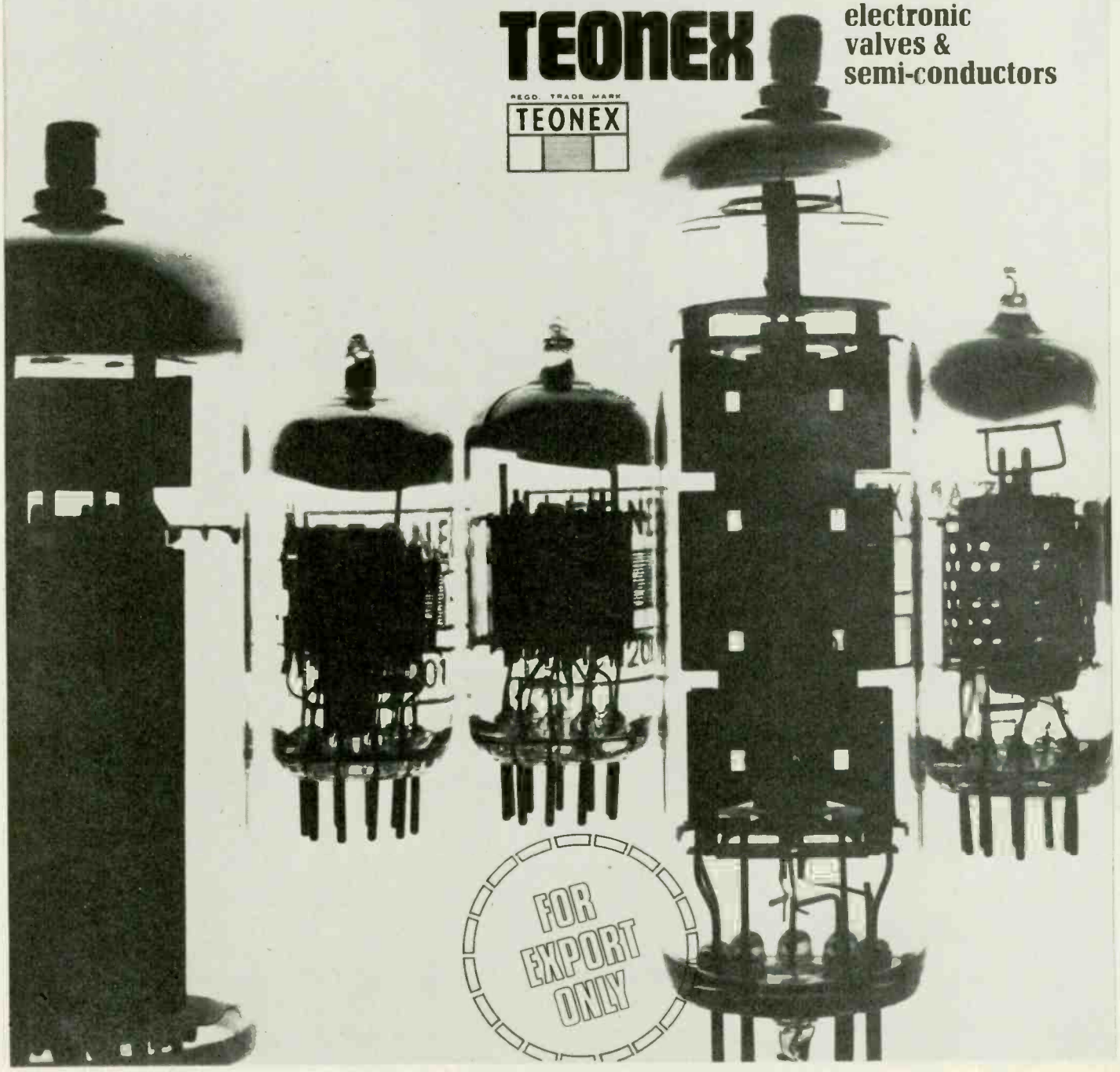
But there are two common characteristics. They are very reliable and they all have to travel.

Nearly 60 countries now welcome Teonex, on Government and private contract. The family album is as comprehensive as you can get and most members are available from stock.

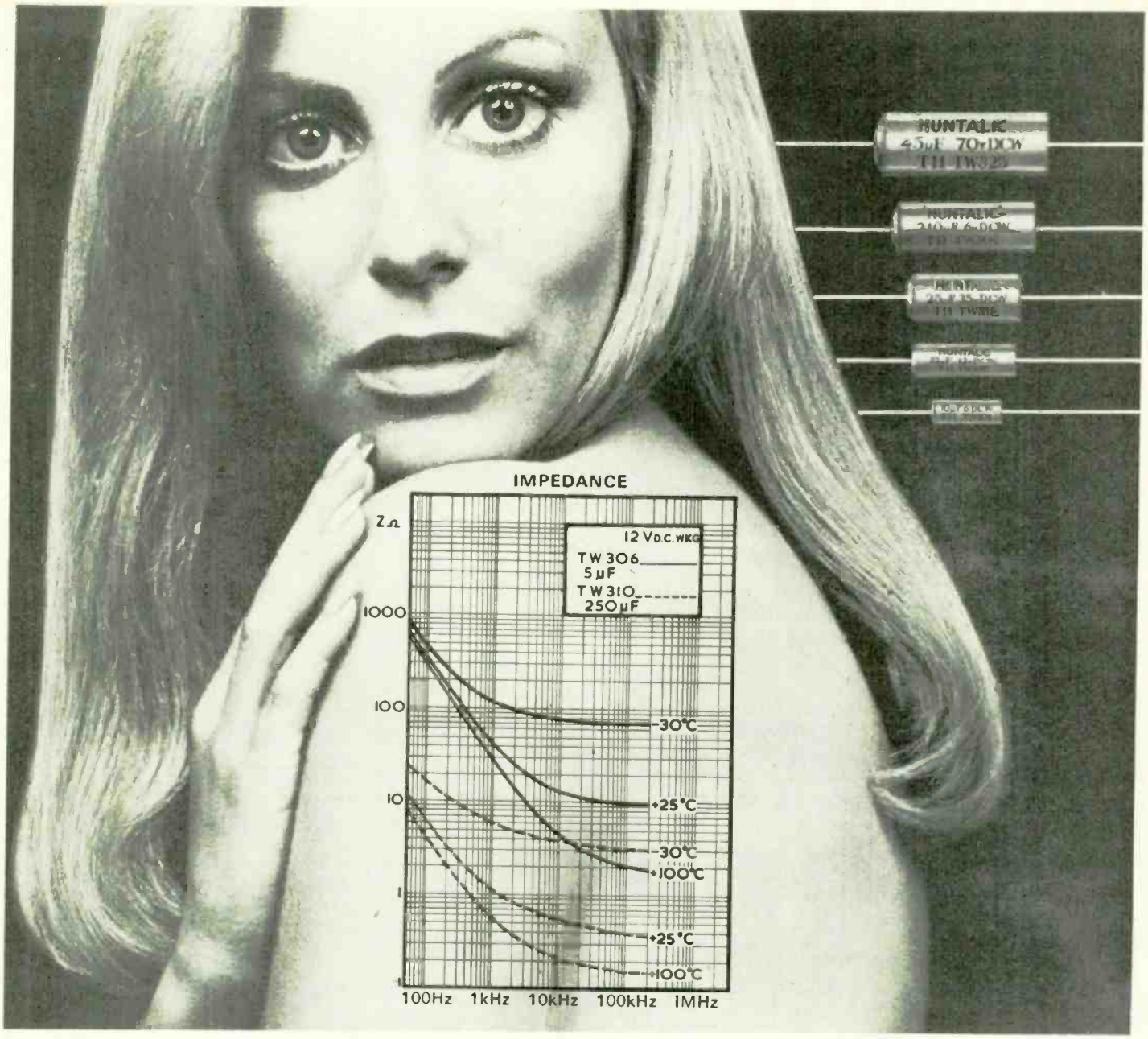
For technical specifications and price lists please write to Teonex Limited
2a Westbourne Grove Mews · London W.11 · England
Cables: Tosuply London W.11

TEONEX electronic valves & semi-conductors

REGD. TRADE MARK
TEONEX



WW—013 FOR FURTHER DETAILS



We know a thing or two about Tantalum Capacitors – and here are the curves to prove it!

Erie T11 tantalums use every cubic millimetre, every gramme of weight, to give you more capacitance. Porous sintered slugs and high-conductivity electrolyte combine to give you high CV's per unit volume; in 5 case sizes; in values from 1 to 500 µF; and in ratings from 6 to 70 Volts d.c.

Designed to operate at temperatures between –55 and +100°C, Tee-elevens eliminate corrosion risks by using completely neutral electrolyte ... and they are sealed in double cases. Leakage current characteristics are lower than accepted specifications. But see the curves yourself. They're fascinating. Supply your name and address; we'll rush the leaflet to you.

ERIE ELECTRONICS LIMITED

ERIE ELECTRONICS LTD.
Gt. Yarmouth, Norfolk.
Telephone: 0493 4911
Telex: 97421

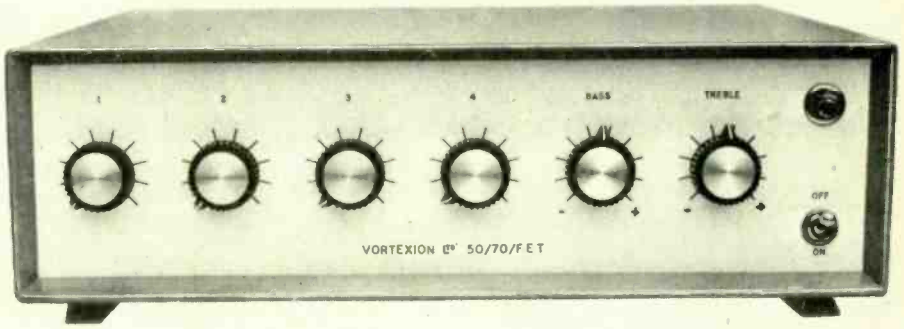
ERIE TANTALUM ELECTROLYTIC CAPACITORS

WW—014 FOR FURTHER DETAILS

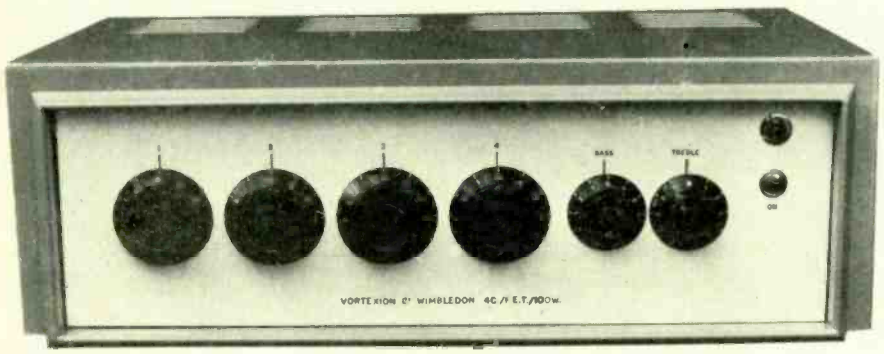
Vortexion

This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable—100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 3-30/60Ω balanced line microphones, and a high impedance line or gram. input followed by bass and treble controls. 100 volt balanced line output.

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



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



THE 100 WATT MIXER AMPLIFIER with specification as above is here combined with a 4 channel F.E.T. mixer, 3 mic. 1 gram with tone controls and mounted in a standard robust stove enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25% and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rack panel form.

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

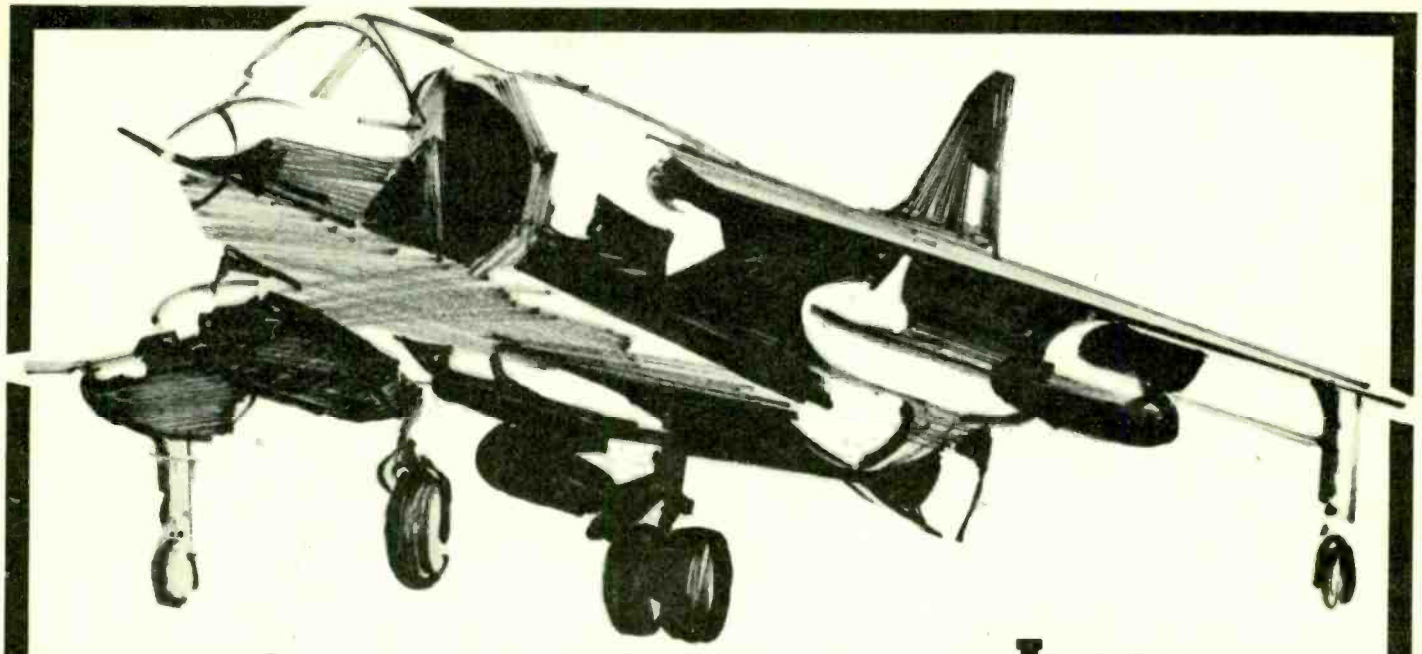
200 WATT AMPLIFIER. Can deliver its full audio power at any frequency in the range of 30 c/s–20 Kc/s ± 1 dB. Less than 0.2% distortion at 1 Kc/s. Can be used to drive mechanical devices for which power is over 120 watt on continuous sine wave. Input 1 mW 600 ohms. Output 100–120 V or 200–240 V. Additional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

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

see us at
SONEX'70
Skyway Hotel
Bath Rd, Hayes, Middx.
April 24th — 26th 1970
Fri & Sat: 11am — 9pm
Sun: 11am — 6pm

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—015 FOR FURTHER DETAILS



What's so special about the Jump Jet?

The answer—*everything*.

It took years of intensive research and development to perfect every little part that goes to make the Hawker Harrier.

And these specially developed components include Gardners Transformers.

Many people seem to think that Gardners only provide 'off-the-shelf' equipment. It isn't true—80% of our production is for special components.

We design and develop highly specialised transformers for Defence projects, Radar, Sonar, electronics, control systems and similar sophisticated equipments.

Of course, we don't expect everyone to be making things like aircraft that don't need runways.

They wouldn't be special anymore.

Incidentally, Gardners manufacture the largest standard range of transformers in Europe. So even our un-specials are special!

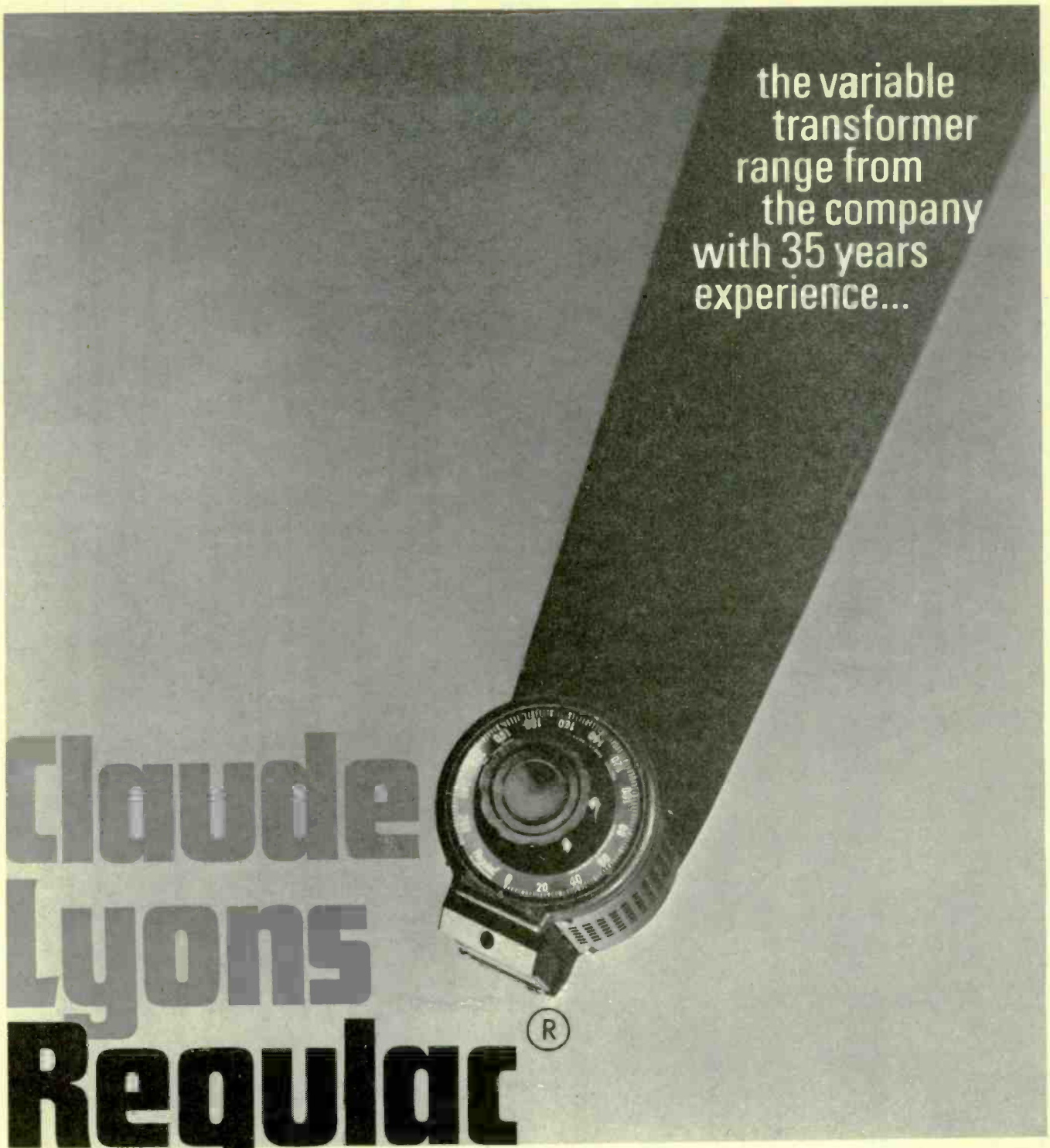
Comprehensive publications available on request include.

Microphone and Line Matching Transformers GT22.
Microminiature Transformers GT12.
Audio Transformers GT4.
Inverters GT21.
Saturable Reactors GT1.
Low Voltage, Isolating and Audio Transformers GT17.
Transformers for Tube Type Circuits GT24.

Gardners

GARDNERS TRANSFORMERS LIMITED,
Christchurch, Hampshire BH23 3PN.
Tel: Christchurch 2284. (STD 0201 5 2284)
Telex 41276 GARDNERS XCH.

WW—016 FOR FURTHER DETAILS



® Registered trade mark of Claude Lyons Limited

With every Claude Lyons Regulac comes the benefit of 35 years' experience in variable transformers. Regulacs come in hundreds of models from small single units for laboratory or instrument use to large ganged assemblies for high-power 3-phase operation at outputs from 210VA to 28·8 kVA and above.

The range includes portable, dual-output and oil-immersed models plus many high-frequency and special types – and is constantly being extended.

Regulacs provide smooth, continuous adjustment of voltage output from zero to line voltage and above, either hand-operated or motor-driven. No device is more useful, versatile and reliable for the control of AC voltage.

For full details write to Publicity Department, Hoddesdon
Claude Lyons Limited
Hoddesdon, Herts. *Hoddesdon 67161 Telex 22724*
76 Old Hall St., Liverpool L3 9PX. *051-227 1761 Telex 62181*

CL71

WW—017 FOR FURTHER DETAILS

Uncamouflaged stereo.

All too many stereo makers tend to gloss over their inadequacies with high-sounding rhetoric, hiding poor performance behind purple prose.

Sansui, Japan's foremost audio-only specialist, offers you stereo without camouflage. Complete, and all out in the open. We let features and figures do the talking for us, not empty phrases.

One of our most powerful and most popular systems, for example, offers:

The 180 watt 5000A receiver, with a 15 to 30,000Hz power bandwidth figure and distortion of 0.8% or less. IC and FET circuitry, trouble-free output terminals, two AC outlets, MPX separation adjustor, and a ground terminal that permits a better than 65dB S/N ratio.

The 70 watt SP-2000 speaker system. You can hardly call those hand-carved "Kumiko" fretwork grilles "camouflage," when behind them are six perfectly positioned speakers, with a 12dB/oct. crossover network and 3-position level controls. Superb stereo reproduction throughout a wide 30 to 20,000Hz frequency response range.

Add the professional 2-speed manual turntable SR-3030BC, and 2-way 4-speaker SS-20 headphone set and you're ready for an eye-opening surprise in undisguised stereo.

If you've had enough of camouflage compromises and excess verbiage, we think you'll find us refreshingly frank. Because at Sansui, the only word that really counts is quality.

Sansui

England: BRUSH CLEVITE COMPANY LIMITED Thornhill, Southampton S09 1QX Tel: Southampton 45166 / Ireland: RADIO CENTRE 122A, St. Stephen's Green, Dublin 2 / West Germany: COMPO HI-FI G.M.B.H. 6 Frankfurt am Main, Reuterweg 65 / Switzerland & Liechtenstein: EGLI, FISCHER & CO. LTD. ZURICH 8022 Zurich, Gotthardstr. 6, Claridenhof / France: HENRI COTTE & CIE 77, Rue J.-R. Thorelle, 77, 92-Bourg-la-Reine / Luxembourg: MICHAEL SHEN, EUROTEX 12, Route de Thionville / Austria: THE VIENNA HIGH FIDELITY & STEREO CO. 1070 Wien, Burggasse 114 / Belgium: MATELECTRIC S.P.R.L. Bouleverd Léopold II, 1080 Brussels / Netherlands: TEMPOFOON BRITISH IMPORT COMPANY N.V. Tilburg, Kapitein Hatterasstraat 8, Postbus 540 / South Africa: GLENS (PTY) LTD. P.O. Box 6406 Johannesburg / Southern Yemen: BHICAJEE COWASJEE LTD. Steamer Point, Aden / SANSUI ELECTRIC CO., LTD. FRANKFURT OFFICE 6 Frankfurt am Main, Reuterweg 93, West Germany / SANSUI ELECTRIC CO., LTD. 14-1, 2-chome, Izumi, Suginami-ku, Tokyo, Japan

WW—019 FOR FURTHER DETAILS

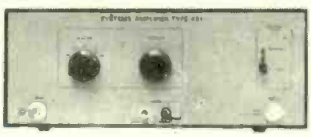
BROOKDEAL AMPLIFIERS: a limited guide to their unlimited uses.

Signal source	450	451	431	432
ac bridge (Hi-Z)	✓	✓		✓
ac bridge (Lo-Z)	✓		✓	
accelerometer (piezoelectric)	✓	✓		✓
accelerometer (moving coil)	✓		✓	
biological sensors				✓
CdS photocell	✓	✓		
condenser microphone	✓			✓
Cu doped Ge photodetector	✓		✓	
electron multiplier	✓	✓		
Faraday cup	✓	✓		
Golay cell	✓	✓		
Hall-effect sample	✓	✓		
hydrophone	✓		✓	
hot carrier diode	✓		✓	
In Sb photocell (room temp)			✓	
In Sb photocell (cooled)	✓	✓		
inductive ratio divider	✓		✓	
ion detector	✓	✓		
magnetometer coils	✓		✓	
microwave point-contact diode	✓			
moving coil microphone	✓		✓	
PbS photocell	✓	✓		
photodiode	✓	✓		
photomultiplier	✓	✓		
photovoltaic cell	✓	✓		
phototransistor	✓	✓		
plasma probes	✓	✓		
Pt wire detector			✓	
resistance thermometer	✓		✓	
scintillation detector	✓	✓		
thermistor	✓		✓	
thermocouple			✓	
thermopile			✓	
vibrating capacitor	✓	✓		

This list includes present and envisaged applications of these amplifiers. For more information and specific applications assistance contact Geoffrey Gamble at 0344 23931/5.

Low-noise Amplifier Type 450

Frequency Range	1Hz – 300kHz
Gain	100dB – 18dB
Noise Figure (1kΩ – 10MΩ)	< 2dB above 0·5kHz
Non Linearity	< 0·05%
Input Impedance	50MΩ, 20pF

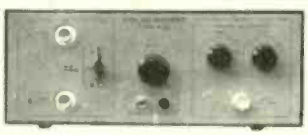


Systems Amplifier Type 451

Frequency Range	1Hz – 1MHz
Gain	80dB – 28dB
Non Linearity (< 100kHz)	< 0·05%
Input Impedance	10MΩ, 25pF
Output Impedance	600Ω

Nanovolt Preamplifier Type 431

Frequency Range	1Hz – 100kHz
Gain	60dB
Equivalent input noise voltage	400pV/√Hz
Non Linearity	< 0·1%
Power	Four PP7 batteries



High IZI Amplifier Type 432

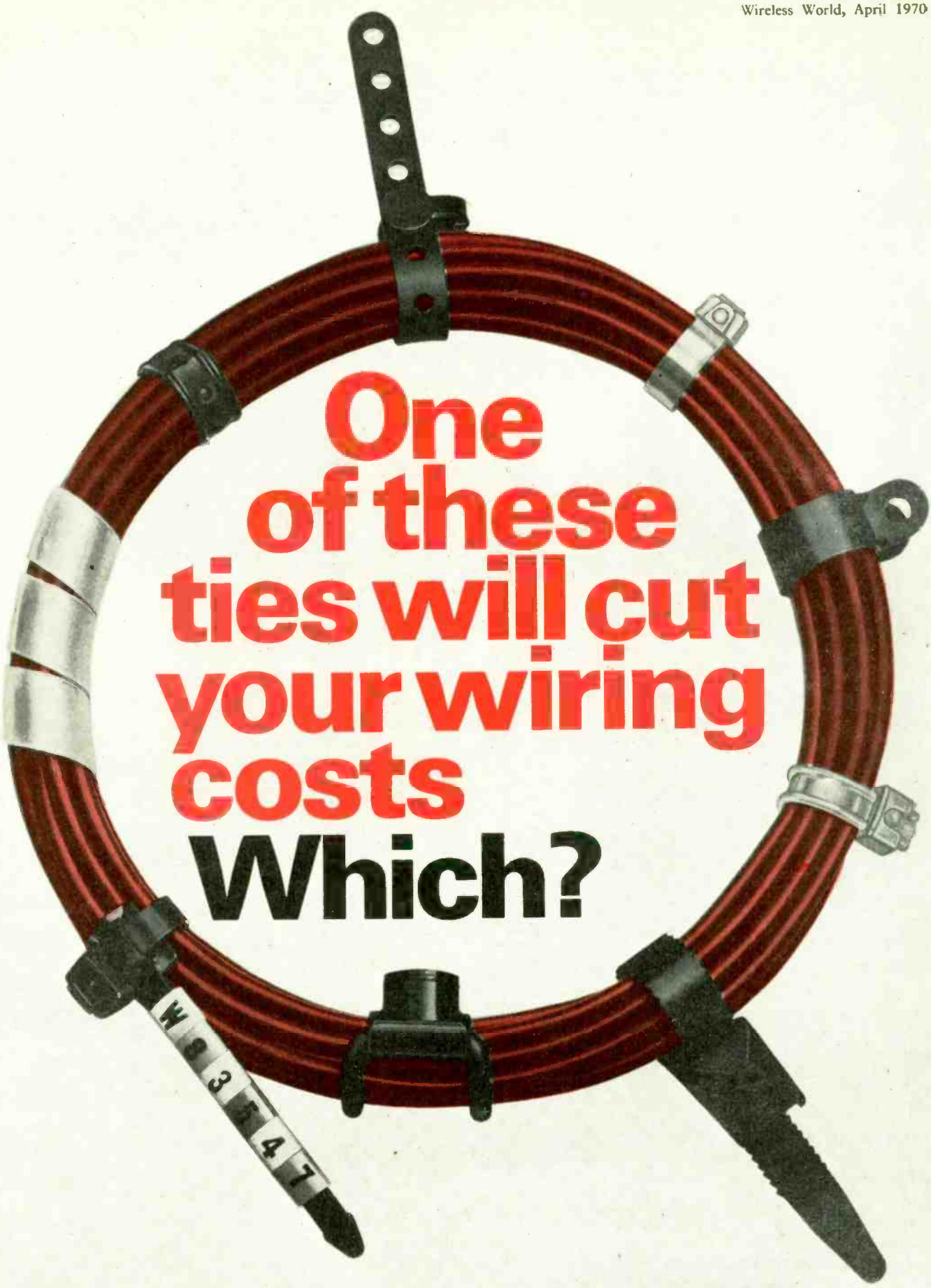
Frequency Range	1Hz – 1MHz
Gain	20, 40, 60dB
Input Impedance	100MΩ, ~ 0·1pF
Common Mode Rejection	> 100dB below 1kHz
Noise Figure (@ 1kHz)	0·5dB at 1MΩ

If the signal source you are working with isn't listed above, this doesn't mean to say that we can't supply the amplifier you need. It's just that space is limited here. However, in the range 1Hz to 1MHz, we can noise-match most signal sources. Send for full information.

Brookdeal

Brookdeal Electronics Limited,
Market Street, Bracknell, Berks. Tel: 0344 23931

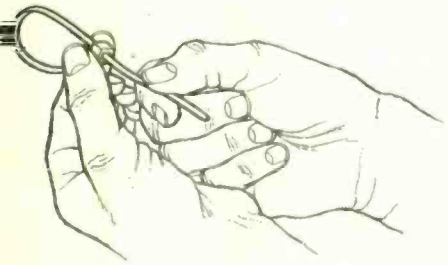
WW—020 FOR FURTHER DETAILS



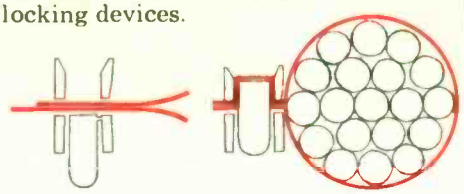
Whatever cable tie you're using at the moment, Hellermann can almost certainly put a better one on your production line to cut your wiring costs. And with good reason.

Hellermann have the world's largest range of ties, clips, saddles, and binding systems. Each is purpose designed – one is certain to be exactly right for your purpose . . . whether for the semi-skilled operator, or the fully-trained engineer.

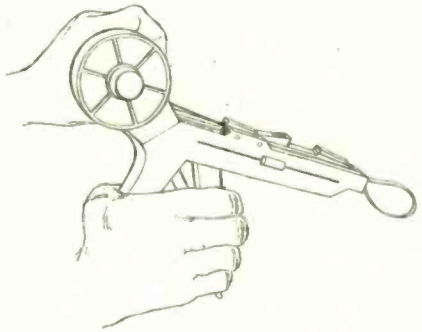
And you'll find Hellermann ideas not only practical – but most often ingenious too.



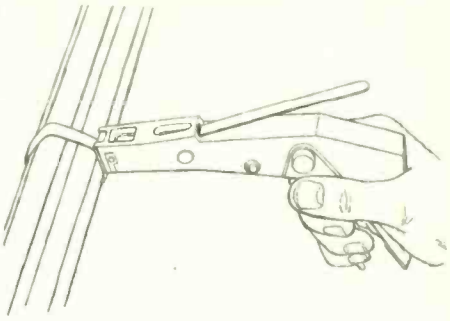
For example, there's Insulok MS – one piece cable ties for quick, simple, hand or tool fixing without pins or metal locking devices.



More Hellermann ingenuity . . . an exclusive extrusion system that prevents strapping pulling out even under extreme vibration. The principle is utilised in two Hellermann tying systems.



The first is called Tyton – an 'off-the-reel' system that binds 50% faster than any other comparable system. The second is Kabelrap – a heavy duty version using 'one-piece' ties.



These are just three of more than a dozen Hellermann systems.

So you can see, Hellermann are deeply involved in all aspects of cable tying.

Job for job – pound for pound – Hellermann will give you increased output, simplified production, minimised tie wastage, quick and easy wiring amendment and, as an added bonus, better looking cable bundles.

The only problem: which Hellermann tie suits you best.

ask Hellermann

TO HELP YOU

Hellermann would like to present you with one of these Hellermann Demonstration Sets. Have a look at the ties – see how they're used . . . and check the literature for the benefits that each system has to offer. Hellermann experts are available to advise you on *exactly* the right, cost-saving tie for *you*.

Please send me a Hellermann Demonstration Set and a copy of your Ties Selection Guide.

NAME_____

COMPANY _____

ADDRESS_____

_____

_____

_____ WW4/70

WORLD LEADERS IN CABLE ACCESSORIES

HELLERMANN ELECTRIC

Division of Bowthorpe-Hellermann Ltd

Gatwick Road, Crawley, Sussex. Tel: Crawley 28888

A member of the Bowthorpe Holdings Group of Companies.

WW—021 FOR FURTHER DETAILS

Radio Microphones mean an end to trailing cables!!

*
See us at the Clubs' & Licensed Trade Exhibition Prince's Exhibition Hall, Birmingham 11-15 May STAND No. 42

STAND No. 30 at Musical Ride New Century Hall Manchester 28-30 May

RESLO-AUDAC RADIO MICROPHONE GIVES REAL FREEDOM OF MOVEMENT

Here's the safe answer to the old problem of trailing cables. The Reslo-Audac Radio Microphone allows completely unhampered movement. Ideal for clubs, cabaret, theatres, bingo halls and many other applications. Illustration shows integrated microphone transmitter unit, no larger than a normal microphone.

Star Names using Reslo-Audac system include Des O'Connor, Ronnie Corbett, Mirelle Mathieu, Terri Stevens, Peter Gordeno.

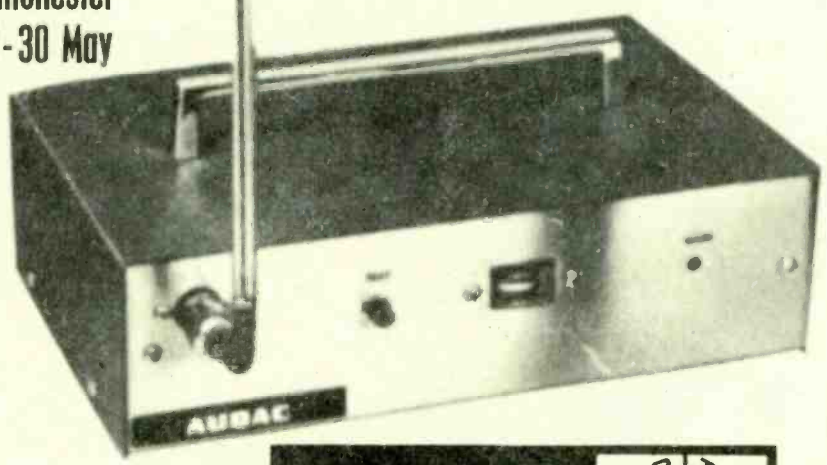
Star Places include the London Palladium, Victoria Palace, Churchills Club, Talk of the Town (London), The Carousel (London), Palace Theatre and many other places.

Types Available

1. Integrated microphone transmitter
2. Separate transmitter packs
3. Choice of receiving units, including the new loudspeaker/amplifier unit

Reslo-Audac radio microphone has to be heard to be believed. Ask for a demonstration!

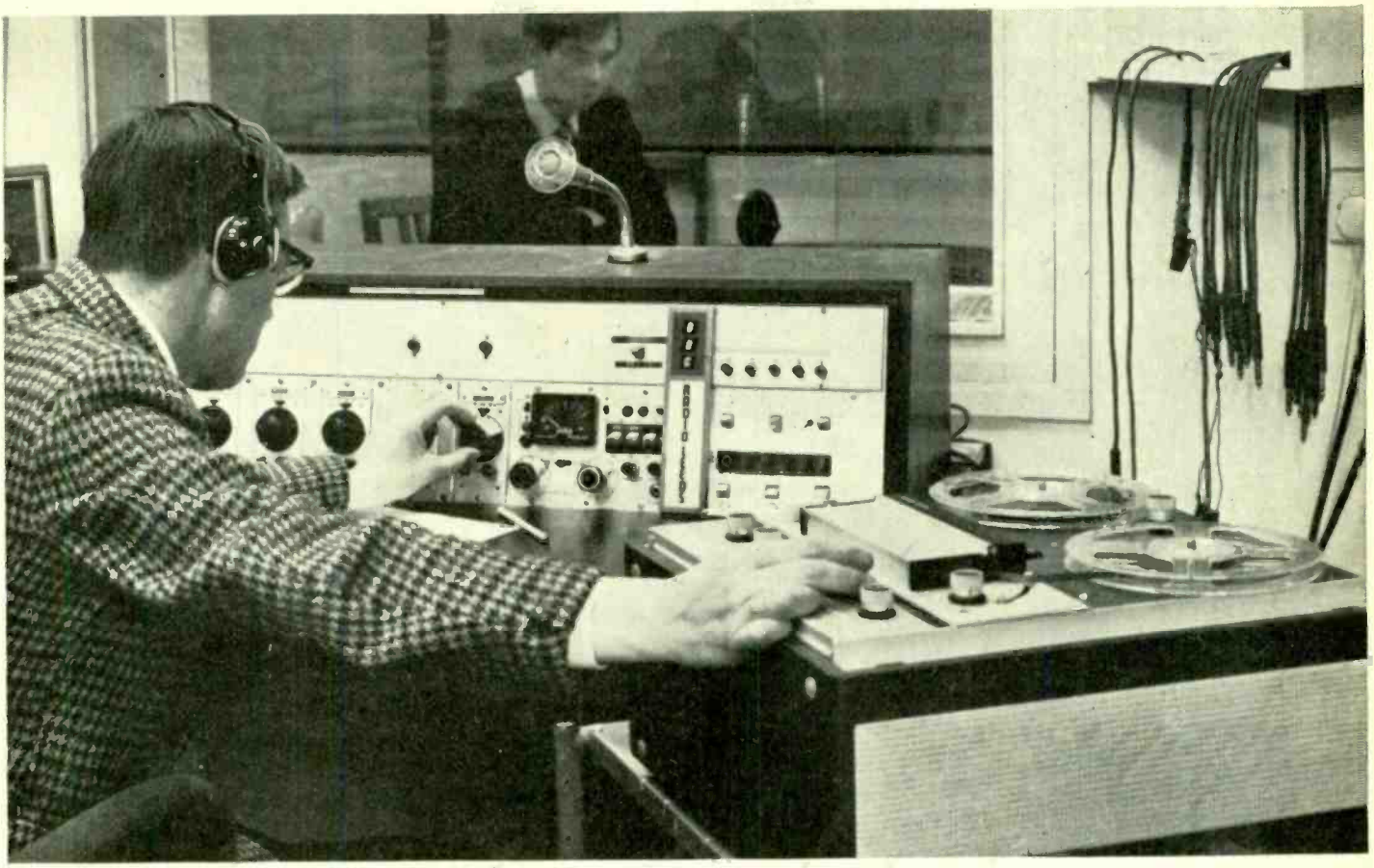
Full technical services available.



Reslo DERRITRON GROUP

RÉSLO MIKES
ROMFORD
ESSEX

WW—022 FOR FURTHER DETAILS



Radio Leeds: Where a tape recorder must be good and reliable you'll find a Ferrograph.

In a radio station, the tape recorder is in constant use. Technical performance is all-important; absolute dependability and split-second control are essential. So Radio Leeds uses the Ferrograph Series 7 tape recorder.

Ferrograph Series 7 recorders are British-made, available in Mono and Stereo, with and without end amplifiers, in two versions: in elegant hardwood case, or in grey vinyl case. All solid state, three speed, two inputs per channel with independent mixing, all incorporate a range of facilities unparalleled in any other recorder. Retail prices are from £175 incl. P.T.

Follow the professionals; choose the recorder you know will serve you best at home or in your work: Ferrograph—it makes sound sense. See your nearest stockist or send the coupon for details and address of nearest Ferrograph specialist or ring 01-589 4485.

Ferrograph

A member of the Wilmot Breeden Group

To the Ferrograph Co Ltd,
Mercury House, 195 Knightsbridge,
London, S.W.7.

Please send me a free brochure on the Ferrograph Series 7 ☐
or the Ferrograph Manual for which I enclose £1. ☐

Name _____

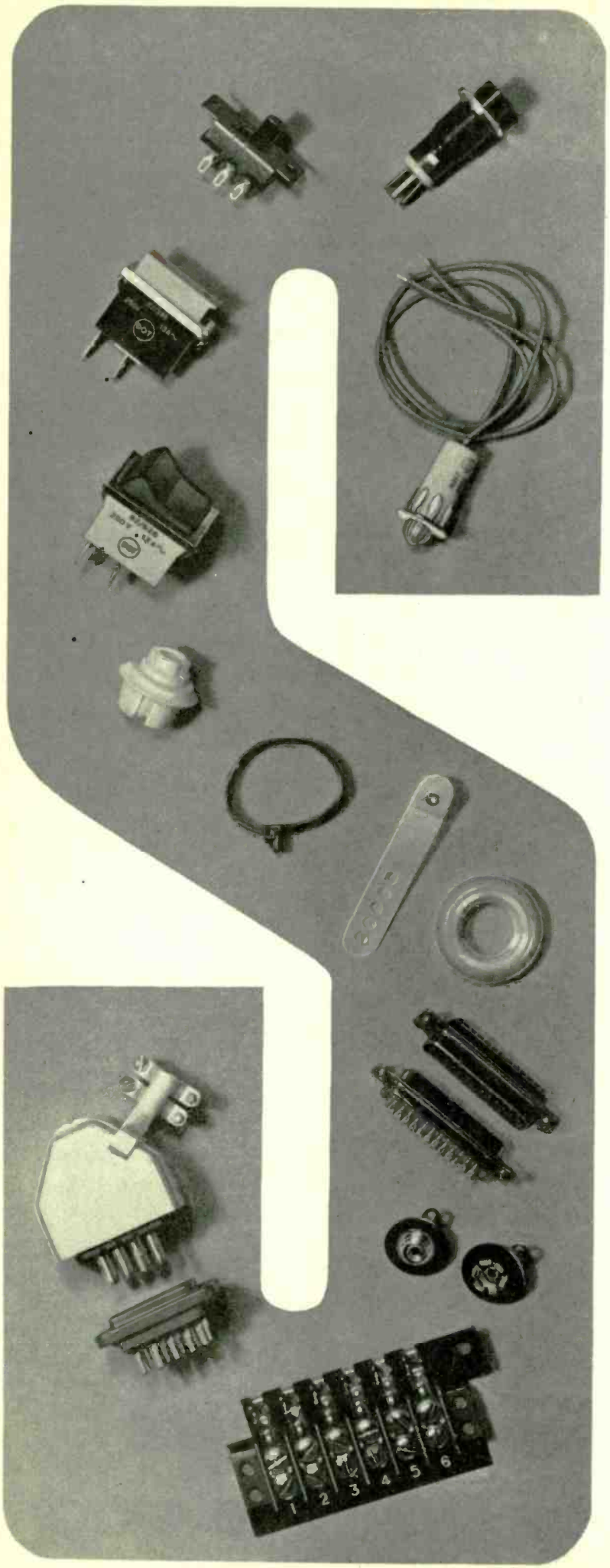
Address _____

_____

_____

WW

WW—023 FOR FURTHER DETAILS



SINGLE SOURCE SENSE

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

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

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

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

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

Send for yours now, stating which catalogue you require.

Make United-Carr Supplies your

SINGLE SOURCE

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

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

Cinch DOT FT STOCKISTS

UNITED-CARR SUPPLIES

WW—024 FOR FURTHER DETAILS

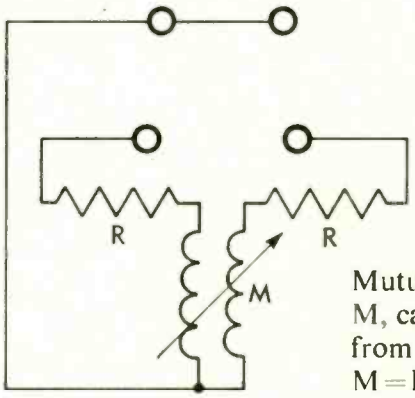
Some notes on Bridge Measurement by WAYNE KERR

Number 9
Four-Terminal Applications

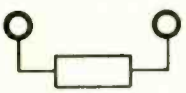
In this issue we are illustrating the principal applications of four-terminal technique made available by the Transformer Ratio Arm Bridge.

The diagrams show six different measurement arrangements using four connection points to the bridge. The two upper terminals marked 'N' in the first diagram are the neutral connections, the two lower terminals representing connections to the bridge voltage and current transformers.

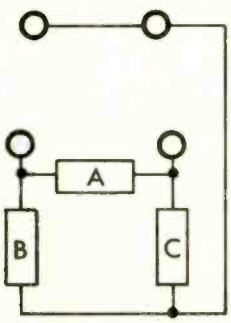
These diagrams are necessarily in summary form and, if further explanation is required, reference should be made to the first two issues of these notes.



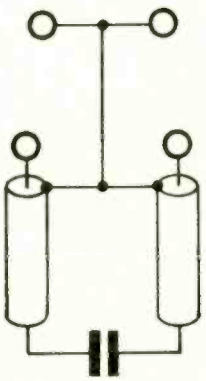
Mutual Inductance, M, can be derived from bridge C reading: $M = R^2.C$.



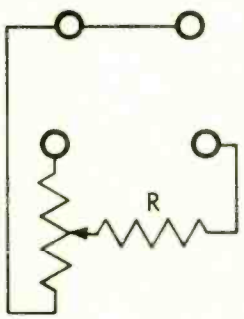
2-terminal connection for normal component measurements.



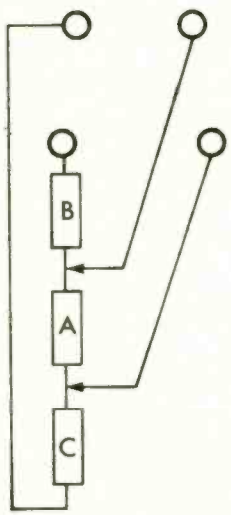
3-terminal connection. Bridge reads A, ignores B & C. Ideal for in-situ checks.



Small capacitors (and all other types of component) can be measured at the end of long test leads. The effect of the neutral connections is to prevent the cable capacitances appearing in shunt with the component under test.



Potentiometer ratios can be related to angular rotation. Bridge reads $R \times (1/\text{ratio})$.



4-terminal connections minimise lead and contact resistance errors. Bridge measures A, ignoring B & C.

The cartridge recorder that gives you **all the professional features**

CT80

concept

Advanced — with outstanding professional technics in design and manufacture

design

Solenoid operation — with motor size, number of amplifiers and facilities unequalled

componentry

No compromise — with all devices to the highest telecommunication standards

construction

Modular — with the latest technics and materials for heavy duty operation

facilities

Complete — with every feature demanded by the industry, and more

finish

Attractive, robust, up-to-the-minute — with extremely functional front panel

application

For professional broadcasters — who appreciate the refinements and reliability of modern design and engineering

Ask for complete CT80 specifications and operating features!

PLESSEY
Electronics

Sales and Service — Rola Recording Products Department — Garrard Engineering Limited Newcastle Street Swindon Wiltshire Telephone Swindon 5381 Telex 44271 or the manufacturer Plessey Electronics Pty Limited Equipment Unit 91 Murphy Street Richmond Australia 3121 Telex 30383 Cables ROLA Melbourne

AV22

WW—026 FOR FURTHER DETAILS

People keep talking about...

Solid State

Microcircuits

Integrated circuits

Semiconductors

?

Integrated circuits

Microcircuits

Semiconductors

State Solid

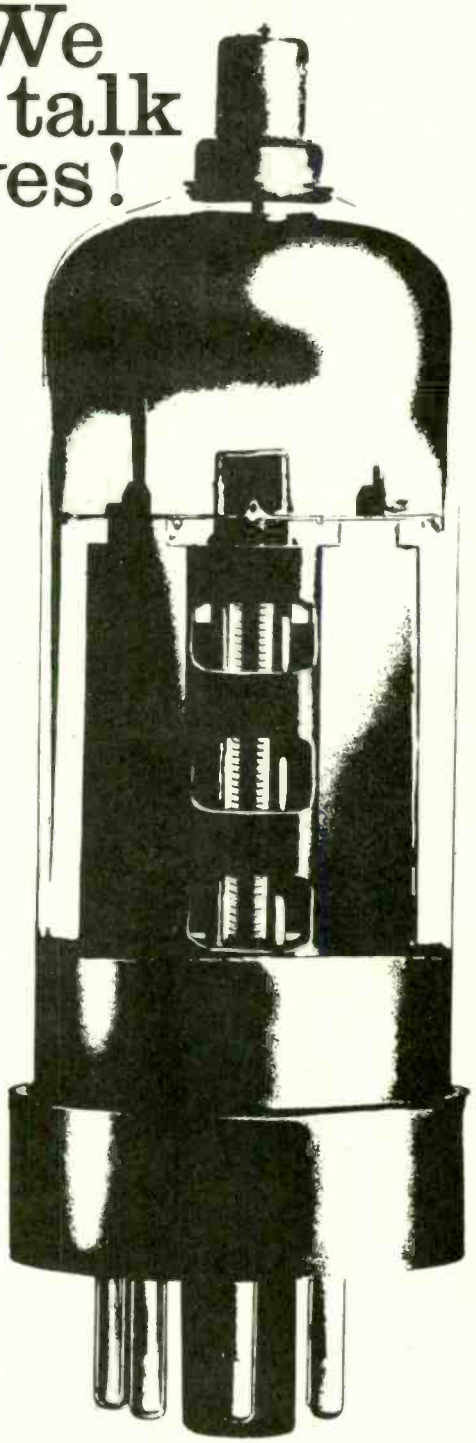
Solid State

etc

etc etc

etc

We talk valves!



We can't, and don't,
disregard current advancements
in sophisticated electronics
We can, and do,
cater to an undiminishing requirement
for replacement valves from all quarters of
Industry, Education and Research.
This requirement has been built up over
many years past.
So has Pinnacle

Pinnacle

Pinnacle Electronics Limited
Achilles Street, New Cross, London, S.E.14.
Phone: All departments 01-692 7285
Direct orders: 01-692 7714

WW—029 FOR FURTHER DETAILS

No sulphur-sickness here

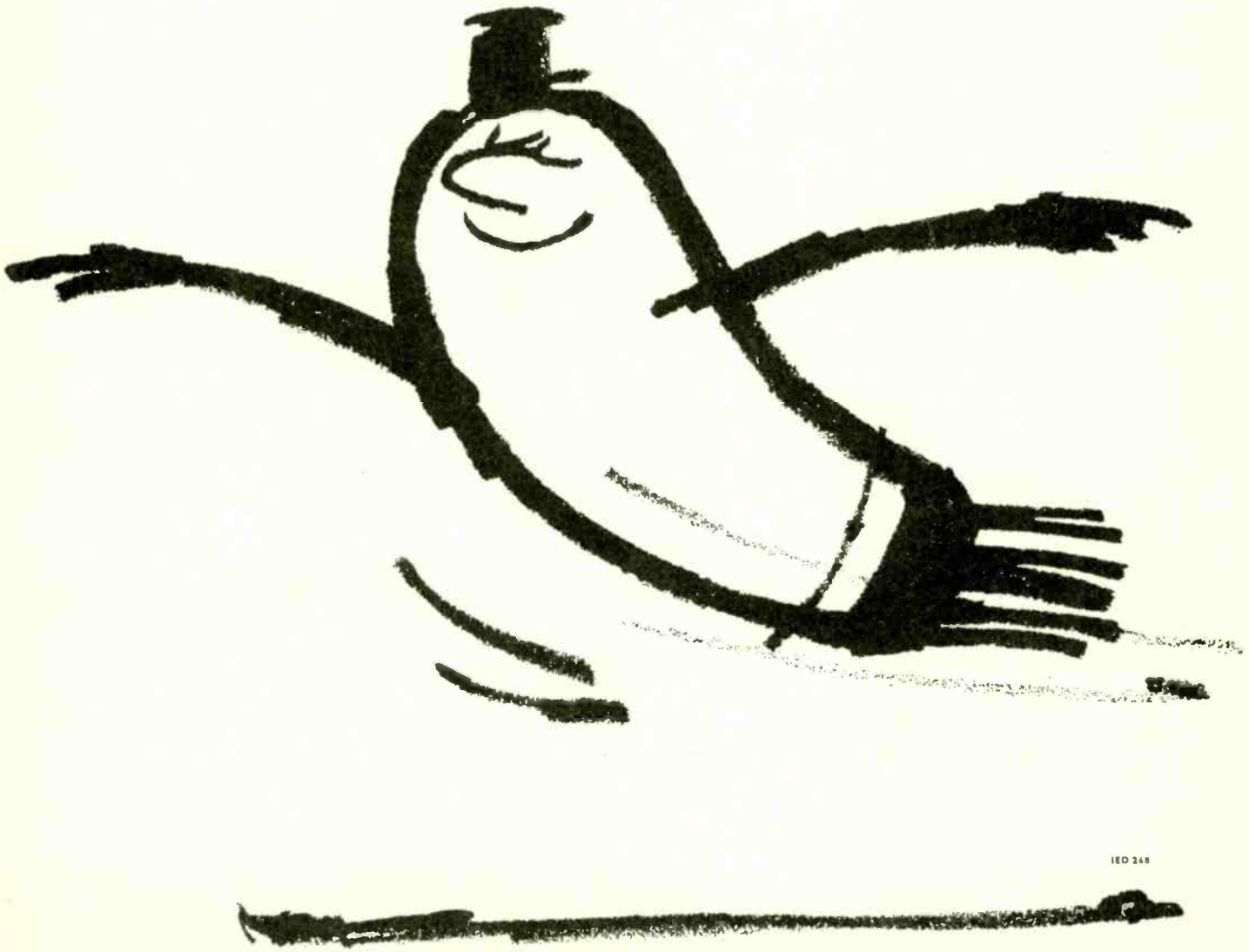
Factory chimneys turn out sulphur, and sulphur makes industrial receiving valves sick and unreliable. At Mullard we don't tolerate sick valves, so we set about eliminating the sulphur menace. Investigations – including putting a model of the factory in a wind tunnel – led finally to a new specification for fuel oil. Now before we use any fuel oil it's checked for sulphur content. We go to any lengths to ensure our special valves are healthy and reliable.

The time we spend on environmental control cuts your equipment down-time...another reason it pays to ask your supplier for Mullard.

Mullard

Mullard Limited Industrial Electronics Division
Mullard House Torrington Place London WC1 01-580 6633

New Buyers Guide
There's a new wallchart on Mullard special quality receiving valves. It gives comprehensive equivalents information, and it's free from any Mullard Industrial Distributor – or use the reader enquiry service.



IED 268

WW—032 FOR FURTHER DETAILS

Mullard industrial distributor service

Birmingham: Central 5060
Gothic Electrical Supplies Ltd., Gothic House, Henrietta Street, Birmingham 19.

Birmingham: Aston Cross 4301
Hawnt & Company Ltd., 112/114 Pritchett Street, Birmingham 6.

Bristol 294313
Wireless Electric Ltd., 'Wirelect House', 122/123 St. Thomas Street, Bristol 1.

Crawley 28700
SASCO, Gatwick Road, Crawley, Sussex.

Glasgow: Govan 3347/3991
Harper Robertson Electronics Ltd., 82 Loanbank Quadrant, Glasgow SW1.

Leeds 636311
Farnell Electronic Components Ltd., Canal Road, Leeds LS12 2TU.

London: Elgar 7722
Cables & Components Ltd., Park Avenue, London N.W.10.

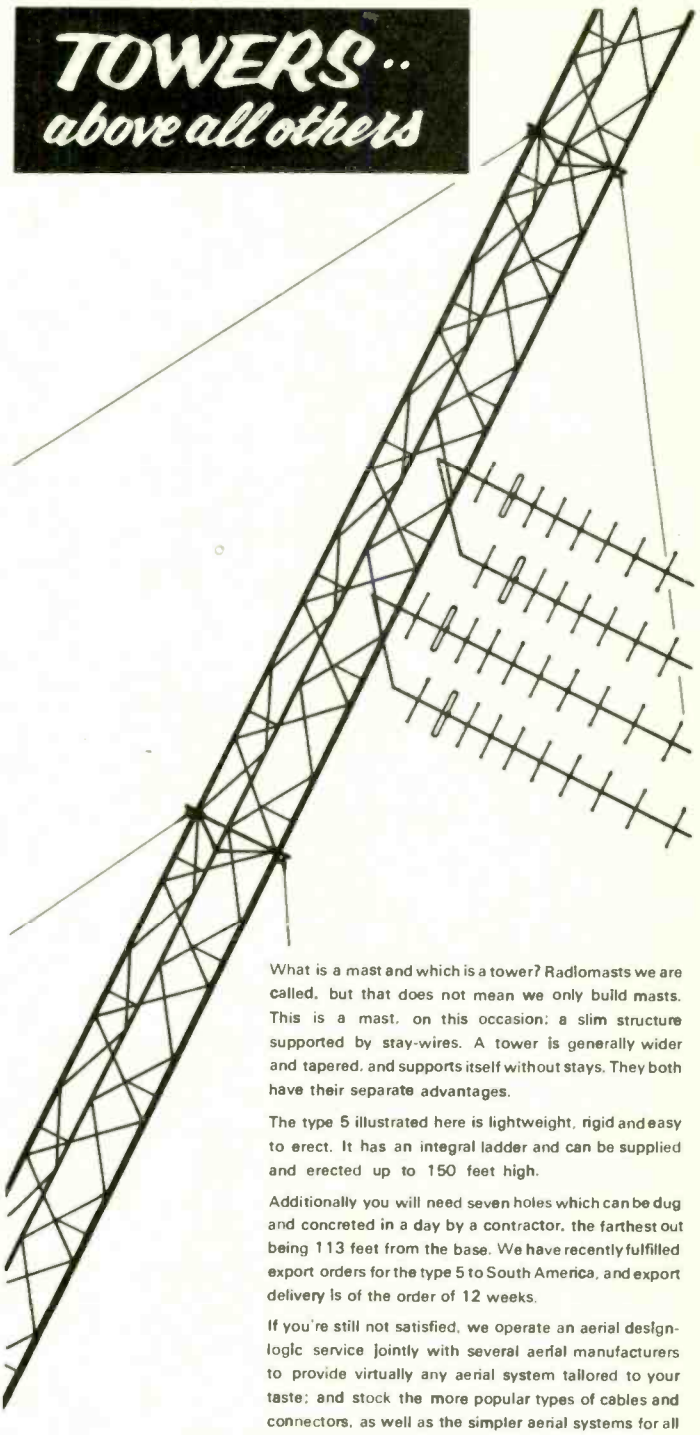
London: New Cross 9731
Edmundsons Electronics Ltd., 60-74 Market Parade, Rye Lane, London S.E.15.

Leicester: Leicester 768561
Townsend-Coates Ltd., Coleman Road, Leicester.

Rochdale 47411
Swift-Hardmans, P.O. Box 23, Hardale House, Baillie Street, Rochdale.

Sheffield 27161
Needham Engineering Co. Ltd., P.O. Box 23, Townhead Street, Sheffield 1.

TOWERS.. above all others



What is a mast and which is a tower? Radiomasts we are called, but that does not mean we only build masts. This is a mast, on this occasion; a slim structure supported by stay-wires. A tower is generally wider and tapered, and supports itself without stays. They both have their separate advantages.

The type 5 illustrated here is lightweight, rigid and easy to erect. It has an integral ladder and can be supplied and erected up to 150 feet high.

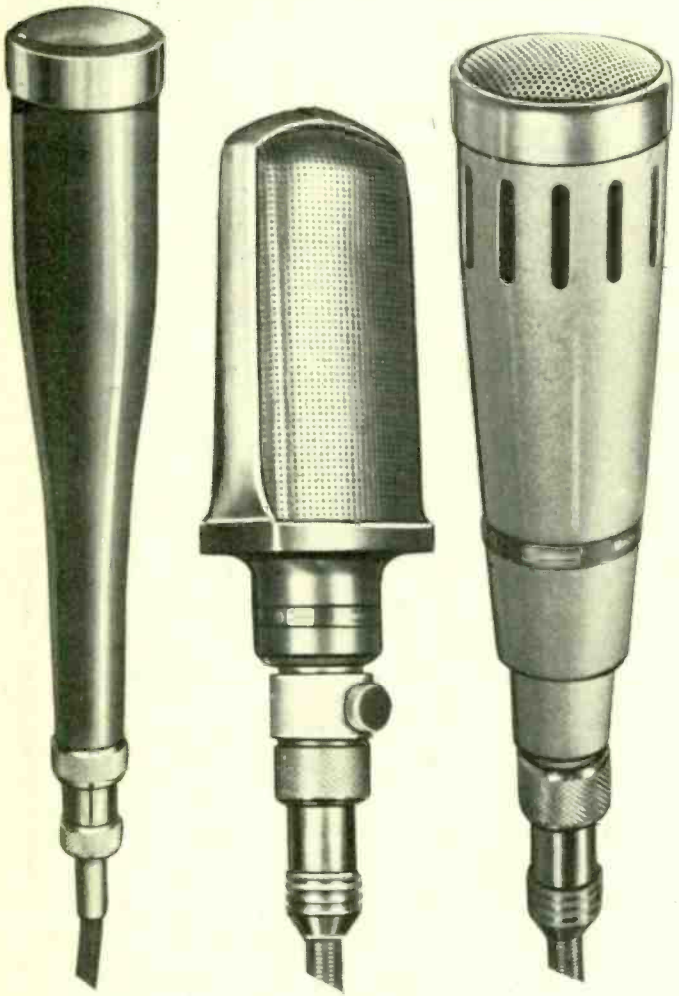
Additionally you will need seven holes which can be dug and concreted in a day by a contractor, the farthest out being 113 feet from the base. We have recently fulfilled export orders for the type 5 to South America, and export delivery is of the order of 12 weeks.

If you're still not satisfied, we operate an aerial design-logic service jointly with several aerial manufacturers to provide virtually any aerial system tailored to your taste; and stock the more popular types of cables and connectors, as well as the simpler aerial systems for all the commercial bands. If there's more you want—call us anytime.

RADIOMASTS LTD
19 CROSS STREET MOULTON
NORTHAMPTON
NN3 1RZ ☎ 0604 43728

WW—033 FOR FURTHER DETAILS

MICROPHONES & ACCESSORIES



DP4 GR1 GC1

Our range of microphones includes various types, dynamic and ribbon, omnidirectional and cardioid patterns, with or without switches, for hand or stand use. All microphones are manufactured in a special section of our works, under strictly controlled conditions with stringent test and inspection at every stage. Each and every microphone is individually tested both aurally and on Bruel & Kjoer visual and graphic recording test equipment for conformity to a prescribed performance. Accessories such as desk or floor stands, wind shields and parabolic reflectors are available.

We also manufacture high grade amplifiers, mixers and ambiophonic units, loudspeakers and associated equipment for P.A. work, disc recorder amplifiers and cutter heads.

Please send for fully descriptive literature:

Grampian

SOUND EQUIPMENT

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

(M.20) JACW/X/44

WW—034 FOR FURTHER DETAILS

Adamin

MODEL 15

MICRO SOLDERING INSTRUMENT

as selected for the DESIGN CENTRE LONDON

- **EXTREME VERSATILITY**
  Range of 8 interchangeable bits, from $\frac{3}{64}$in. (.047in.) to $\frac{3}{16}$in., including long-life PERMATIPS.
- **ULTRA-SMALL SIZE**
  Length $7\frac{1}{8}$in. Weight $\frac{1}{2}$ oz.
  Max. handle dia. $\frac{7}{16}$in.
- **EXTRA-HIGH PERFORMANCE**
  Heating time 90 secs. Max. bit temp. 390°C. Loading 15 watts—equal normal 30/40-watt iron.
- **ALL VOLTAGES**
  The ADAMIN range includes five other models (5, 8, 12, 18 and 24 watts), Thermal Strippers (PVC and PTFE) and a De-Soldering Tool. Please ask for colour catalogue A/5.

LIGHT SOLDERING DEVELOPMENTS LTD

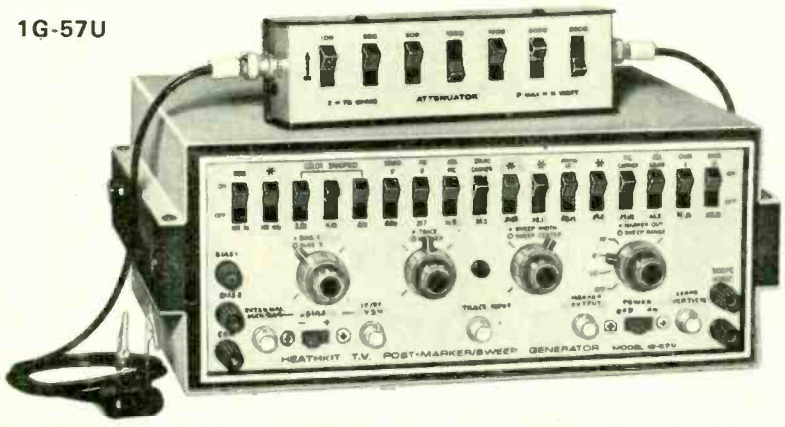
28 Sydenham Road, Croydon, CR9 2LL

Tel: 01-688 8589 & 4559

WW—035 FOR FURTHER DETAILS

Heathkit for Instrumentation

1G-57U



The Heathkit range of Electronic test instruments including the latest advances in Solid-State instrumentation has been especially prepared for the High Fidelity and Television Service Engineer as well as the Industrial and Laboratory Instrument User.

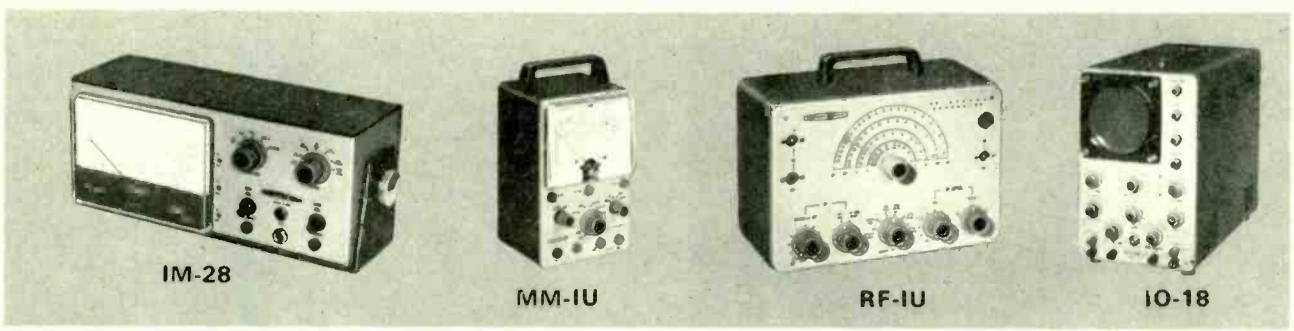
Whatever your requirements, be they Potentiometric Chart Recorders, Power Supplies or General Test Instruments, substantial savings against similar specifications of other Manufacturers can be made by using Heathkit Instrumentation.

LATEST SOLID-STATE POST-MARKER/SWEEP GENERATOR, 1G-57U is typical of the Heathkit ultra-functional instrumentation styling

1G-57U SPECIFICATION—Marker frequencies: 100 kHz. **Marker frequencies, crystal controlled:** 3.83, 4.43, 5.03 and 6.0 MHz, ±.01%, 10.7, 31.5, 33.5, 34.65, 35.5, 38.15, 39.5, 39.65, 41.5, 58.25 and 196.25 MHz ±.005%. **Modulation frequency:** 400 Hz. **Input impedance:** External Marker, External sweep and Attenuator—75 ohms. Demod in—220 K ohms. **Output impedance:** Marker Output, Sweep Output and Attenuator—75 ohms. Scope Vert.—22 K ohms. **Bias Voltage:** Positive or negative 15 volts D.C. at 10 milliamperes. **Type of marker:** Birdie. **Controls:** Bias control with pull-on/push-off switch; Marker/Trace—dual concentric; Sweep Width/Sweep Centre—dual concentric; Marker out—concentric with Sweep Range switch; and Phase. **Switches:** Rocker type—Reverse; Modulation On/Off. **Transistor—diode complement:** (19) 2N3692 transistors; (7) 2N3393 transistors; (1) 2N3416 transistor; (3) silicon diode rectifiers; (2) crystal diodes; (1) 13.6 volt zener diode; (1) 20 volt zener diode. **Sweep frequency ranges and output voltage:** LO Band—3.0 to 6.0 MHz ±1 dB at 0.5 volts rms (min.) fundamentals, and 10.7 MHz on harmonics. IF Band—31 to 42 MHz ±1 dB, at 0.5 volts/rms (min.) fundamentals, and 10.7 MHz on harmonics. RF Band—55 to 61 MHz ±1 dB at 0.5 volts/rms (min.) fundamentals and 192 to 198 MHz on harmonics. **Attenuator:** Total of 70 dB or attenuation in seven steps—1 dB, 3 dB, 6 dB, 10 dB, 10 dB, 20 dB and 20 dB. **Power requirements:** 105-125 or 210-250 volts, 50 Hz A.C. at 20 watts.

Kit K/1G-57U, £75. Carr. 8/-.

Ready-to-Use A/1G-57U, £90. Carr. 8/-;



RESTYLED TEST, SERVICE AND WORKSHOP INSTRUMENTS

The Heathkit range of instrumentation can adequately provide engineers with quality instruments at lowest cost, whatever your requirements, be they VVMs, Generators, Qscilloscopes, Transistor Testers or Power Supplies.

FOR THE HOME WORKSHOP

The householder and hobbyist can, by purchasing easy-to-build Heathkits, obtain low cost models for testing household appliances, automobile circuitry, electrical/electronic models.

SEND FOR THE 1970
FREE HEATHKIT CATALOGUE
and see for yourself the wide range of instruments, Hi-Fi, Amateur and Leisure products

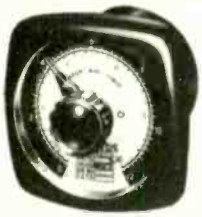
To: **DAYSTROM LTD**, Gloucester, GL2 6EE, England
○ Please send me full details of Heathkit models
□ Send me FREE CATALOGUE
NAME .....
ADDRESS .....
POST CODE ..... Ref. 294

HEATHKIT

Schlumberger Company
DAYSTROM LTD, Gloucester GL2 6EE, England.
Tel: Glos 29451. Telex: 43216

WW—036 FOR FURTHER DETAILS

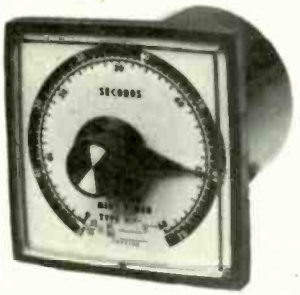
OMRON PROCESS TIMERS



SYS TIMER

- ★ SYNCHRONOUS MOTOR & CLUTCH
- ★ 10 MILLION OPERATIONS
- ★ Instantaneous & Timed out 3 AMP contacts
- ★ Repeat Accuracy ± ½%
- ★ Dial ranges 0-10 secs up to 0-28 hrs. May also be used as impulse start

£11 dependent on quantity



NSY TIMER

- ★ 2 sets 5 amp changeover output contacts
- ★ 5 Million operations
- ★ Repeat accuracy ±½%
- ★ Set time can be altered whilst in operation

Dial ranges from seconds to hours

Approx.
160/- each dependent on quantity.

STP TIMER

SYNCHRONOUS MOTOR & CLUTCH
Matchbox size frontal area
Automatic re-set

- ★ PLUG-IN OCTAL BASE
- ★ INSTANTANEOUS AND TIMED OUT 2 AMP CONTACTS
- ★ RANGES: 0-10 SECS TO 0-36 MINS

£5 dependent on quantity

TEMPERATURE CONTROLLER TYPE THP

- ★ THERMISTOR OPERATED
- ★ OCTAL BASE PLUG IN
- ★ COMPACT

Temperature ranges up to 280°c
Output contacts 4 amp
Repeat Accuracy 3% full scale
Complete with Thermistor

Approximately
£21 dependent on quantity.

OMRON PRECISION CONTROLS

OMRON APPROVALS: CSA. US Mil Spec. SEV.UL. IMMEDIATE DELIVERY OF LIMIT & MICRO SWITCHES, FLOATLESS LIQUID LEVEL CONTROLS, PROXIMITY SWITCHES

WORLD FAMOUS I·M·O (ELECTRONICS) LTD.

VARIABLE VOLTAGE CONTROLS

VARIABLE TRANSFORMERS

- ★ Output 0-260V
- ★ Input 230V 50/60CPS
- ★ Shrouded for Bench or Panel mounting

Inset shows latest pattern Brush gear ensuring smooth continuous adjustment.

£5.10.0 1 amp

2.5 amp £6.15.0 | 8 amp £14.10.0 | 12 amp £21.0.0
5 amp £9.15.0 | 10 amp £18.10.0 | 20 amp £37.0.0

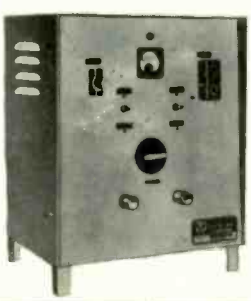
CONSTANT VOLTAGE TRANSFORMER.

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

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

£12.10.0 C&P 20/-

20 AMP LT SUPPLY UNIT



- ★ Input 240V
- ★ Output 20 amps at 24V and 12V fully adjustable
- ★ Size 16"x12"x20" high
- ★ Weight 50 lbs.

£35.0.0
40/- C & P (G.B.)

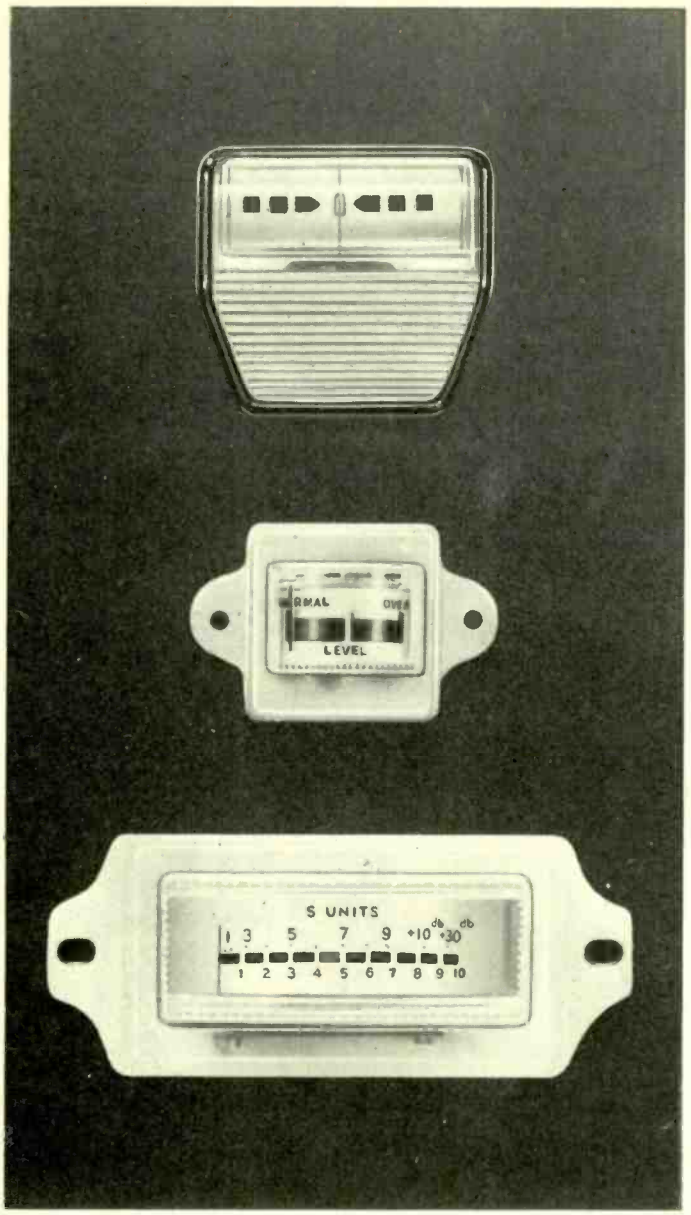
SOLID STATE VARIABLE VOLTAGE CONTROL

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

5 amp model
£8.7.6
10 amp model
£13.15.0

I.M.O. (PRECISION CONTROLS) LTD
(Dept WWX) 313 EDGWARE ROAD, LONDON, W.2. TEL. 01-723 2231

WW—039 FOR FURTHER DETAILS



LEVEL METERS...

For a wide range of applications in professional radio, recording, instrumentation, and domestic equipment. For further information contact, IMPECTRON LTD., 23-31, King Street, London, W.3, Telephone: 01-992 5388

IMPECTRON

WW—047 FOR FURTHER DETAILS

Valradio

DC TO AC TRANSVERTORS

(transistorised Invertors/Convertors)

Type B12/250T

PRICE £41-18-0

The "T" range of transvertors provide an AC output from static accumulators, mobile vehicles, boats, etc. These units are very economical for obtaining a stand-by AC supply or for operating equipment where no AC power supply is available. The 400/500 Hz output versions can and are frequently used as power tone generators for audio or visual fire alarms and other signalling systems in factories, ships, stores, schools, etc.
A typical model B12/250T input 12V accumulator, output 115V and 230V 250W 50Hz. Other models for input voltages of 12 to 250V DC and outputs of square or sine wave. The standard range covers 50 or 60 Hz but frequencies of up to 10KHz are available to order.
All units are fully transistorised.
Send for full information and technical details.

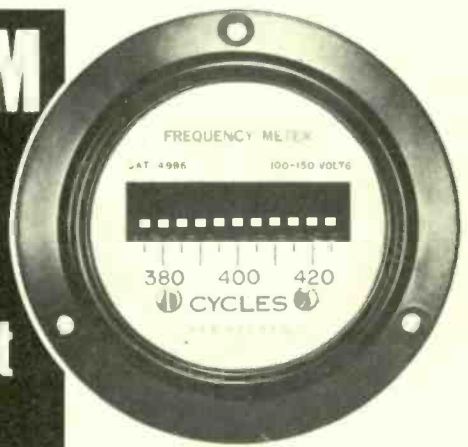
VALRADIO LTD.

Dept. WC6, BROWELLS LANE, FELTHAM, MIDDLESEX, ENGLAND

Telephone: 01-890 4242 or 4837

WW—048 FOR FURTHER DETAILS

FRAHM



resonant reed FREQUENCY METERS

used as standards in many industries

- Accurate to ±0.3% or ±0.1% as specified
- Not sensitive to voltage or temperature changes, within wide limits
- Unaffected by waveform errors, load, power factor or phase shift
- Operational on A.C., pulsating or interrupted D.C., and superimposed circuits
- Need only low input power
- Compact and self-contained
- Rugged and dependable

FRAHM Resonant Reed Frequency Meters are available in plastic and hermetically sealed cases to British and U.S. Government approved specification. Ranges 10–1700 Hz. Literature on these meters and Frahm Resonant Reed Tachometers available on request. Manufacture and Distribution of Electrical Measuring Instruments and Electronic Equipment. The largest stocks in the U.K. for off-the-shelf delivery.

ANDERS ELECTRONICS LIMITED

48/56 Bayham Place, Bayham Street, London NW1. Tel: 01–387 9092

Anders means meters

WW—049 FOR FURTHER DETAILS

Develop the art of good listening

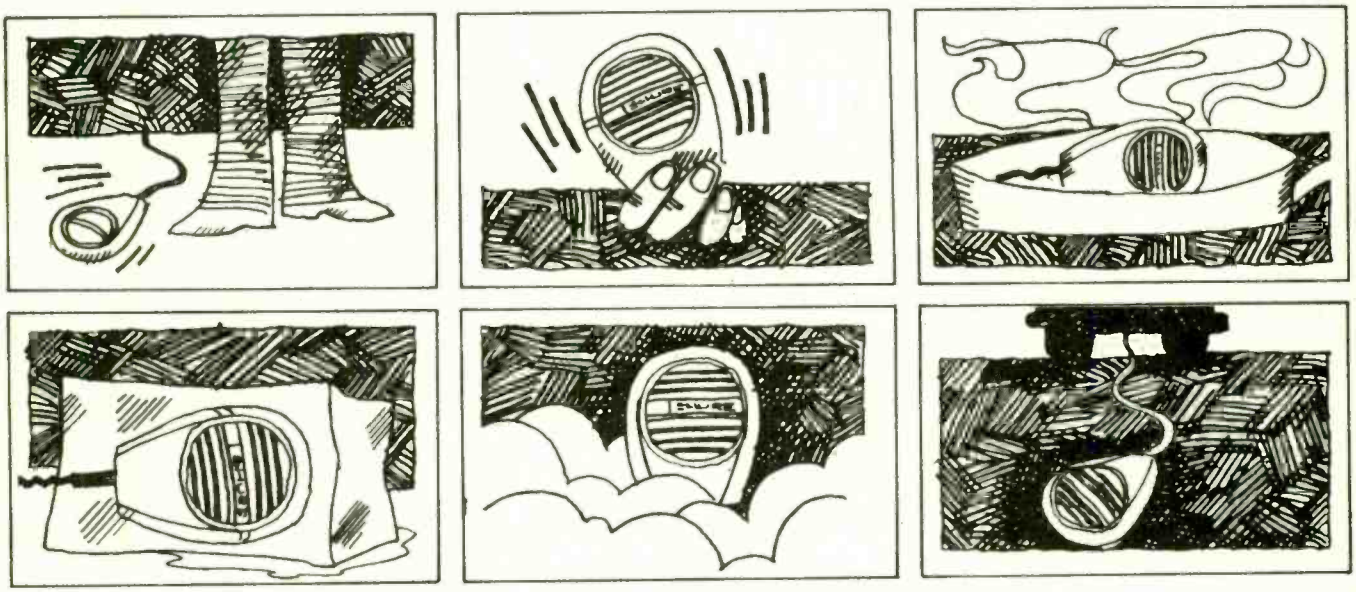
The best pick-up arm in the world. Write to SME Limited · Steyning · Sussex · England

SME

WW—050 FOR FURTHER DETAILS

Before we sell you a Shure microphone we try to ruin it

just to make sure that you never will



Microphones have to be rugged. Think of the punishment they take. That's why Shure Safety Communications Microphones get a tremendous going over before we dream of selling them.

We drop them. We vibrate them.
We fry them. We freeze them.
We steam them in Turkish baths.
We drag them behind fast moving cars.
We subject them to all kinds of torture.
Sand. Rain. Infra-red. Ultra-violet.
Acids. Alcohol. Salt spray. Wind.
Electrostatic fields. High altitude . . .

and still they work

This savage testing, backed by stringent quality control, ensures that every Shure communications microphone will give you reliable performance. And will go on doing so even under conditions where other microphones would pack up. Always use Shure, the microphones that never fail to get the message through.

Communications
Controlled magnetic hand microphone providing a clear, crisp, highly intelligible voice response. Rugged and dependable, ideal for outdoor-indoor P.A., and communications. Frequency response 200 to 4,000 cps. High impedance. High output.
Model 414.

Amateur Radio
Provides optimum radio communications performance from single sideband transmitters as well as AM and FM units. Response cuts off sharply below 300 cps and above 3,000 cps, ensuring maximum speech intelligibility and audio punch to cut through noise and interference.
Model 444.

For full details of Shure microphones, SEND IN THIS COUPON TODAY

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

I'd like to know more about Shure Microphones for

Communications ☐ Professional Recording ☐
Amateur Radio ☐ Professional Entertainers ☐

Please send me the facts :

NAME .....

ADDRESS .....

.....

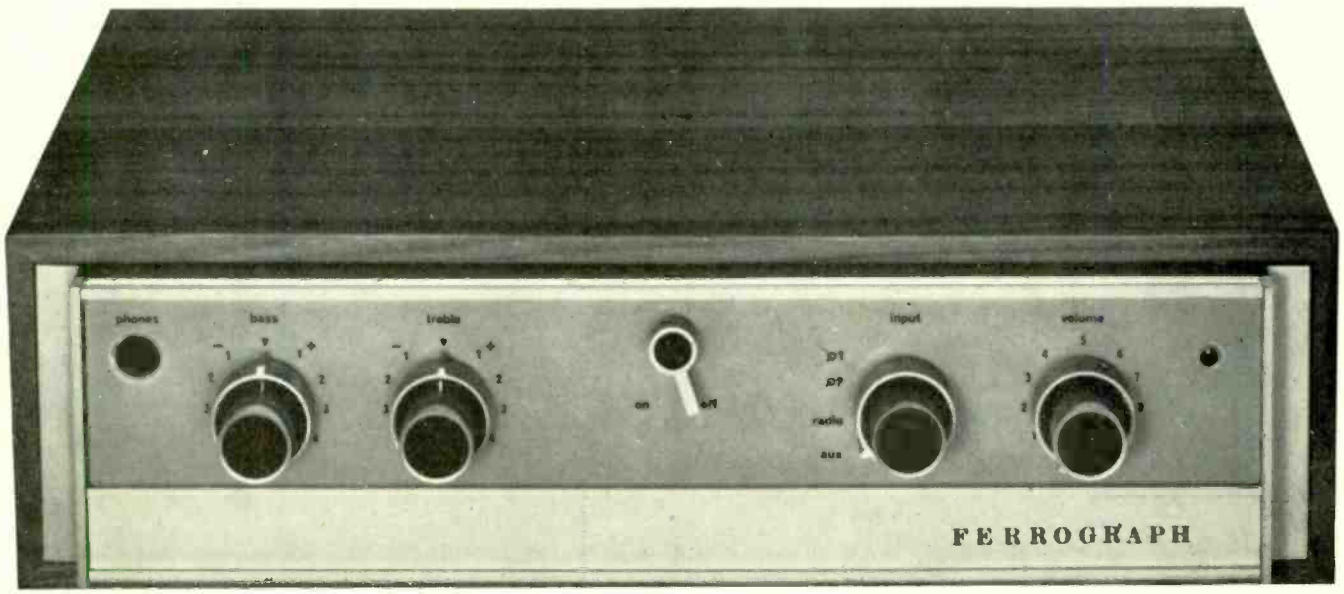
.....

SHURE

setting the world's standard in sound

WW4

WW—052 FOR FURTHER DETAILS



Ferrograph F307 stereo amplifier– the heart of great Hi-Fi

F307 is an integrated Stereo Amplifier, built in a tradition of excellence and extremely versatile in its capabilities.

It presents a clean uncluttered appearance, conforming very closely with the Series Seven Recorder in this regard. Only its main controls appear on the panel—all subsidiary controls being housed beneath a hinged extruded aluminium flap.

F307 delivers power output of 20 watts RMS per channel into a load of 8 ohms and has a total harmonic distortion of less than 0.25% at 1kHz at all levels up to its rated output.

Your Ferrograph dealer will be pleased to demonstrate F307 to you. When planning your Hi-Fi system, this is an Amplifier to which the most serious consideration must be given and its Manual makes informative and compelling reading.

FERROGRAPH

The Ferrograph Co. Ltd.
Mercury House, 195 Knightsbridge, London, S.W.7.
Telephone: 01-589 4485

To The Ferrograph Co. Ltd.
Mercury House, 195 Knightsbridge, London, S.W.7.
Please send me FREE details of the Ferrograph Stereo Amplifier F307 ☐
OR send me the F307 Manual for which I enclose 5s 6d post paid ☐

Name.....

Address.....

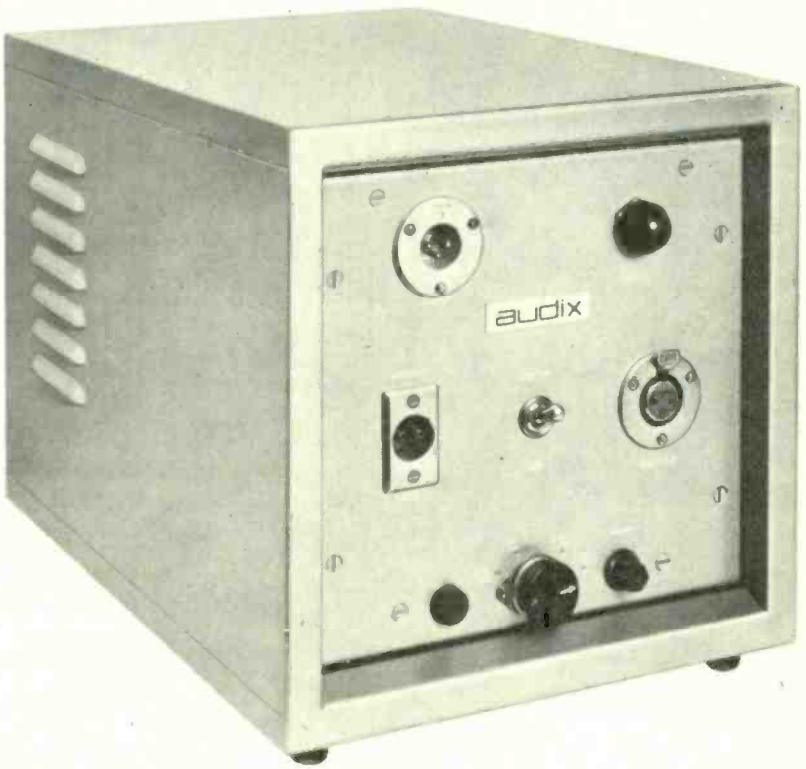
.....

WW

WW—055 FOR FURTHER DETAILS

audix

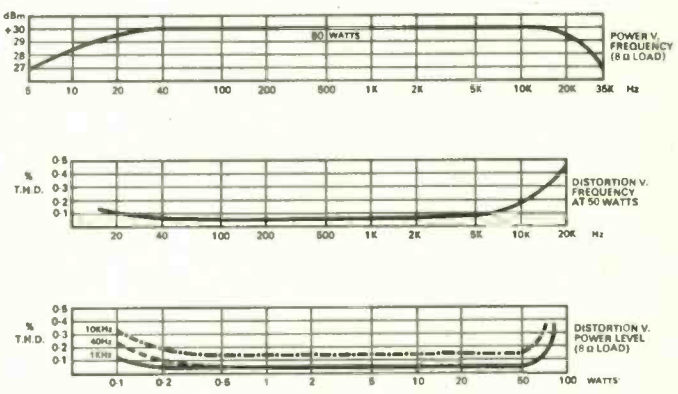
"Studio 80" amplifier



The "Studio 80" Power Amplifier has been produced to high performance standards for Studio and Laboratory applications.

Its proven characteristics puts it in a class beyond anything yet available in power, performance, and price, and is the ultimate in economic functional engineering design – Write for full details of guaranteed performance specification.

POWER OUTPUT:	Max 80W into 8 ohm.
POWER BANOWIOTH:	5 Hz to 35 KHz at 80 W.
FREQUENCY RESPONSE:	+ 0 dB, – .5 dB 20 Hz to 20 KHz.
TOTAL DISTORTION:	Less than 0.05 at 1 KHz.
SIGNAL TO NOISE RATIO:	Better than–95 dB below maximum output.
POWER SUPPLY:	100/120–200/250 A/C 50-60 Hz.



audix SOUND SYSTEMS

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

WW—057 FOR FURTHER DETAILS

Now you can get a fully equipped CCTV studio from GVS for as little as £3,000

No matter what your CCTV requirements are, General Video Systems have the answer – with their wonderful range of SHIBADEN equipment. The result of extensive Research and Development, SHIBADEN equipment has been designed to a modular concept which means that you can fit and furnish your own CCTV studio for as little as £3,000.

The widespread need for this type of package deal within industry, commerce and education fields are numerous. And each individual requirement can be met from the simplest operation to a full broadcast studio.

If you are about to invest in CCTV equipment or would like to discuss your requirements, let GVS "put you in the picture"

GVS

Contact Norman Simpson today at:

GENERAL VIDEO SYSTEMS LTD.

Main Distributors of SHIBADEN Equipment
61-63 Watford Way, Hendon, London NW4.
Telephone: 01-202 8056

WW—058 FOR FURTHER DETAILS

Valradio

25kv Transformer/Rectifier Unit

Type 350/25k3

A compact oil filled ringing transformer/rectifier unit, supplying 25Kv. at up to 350 micro amps, suitable for dust extractors, air purifiers, paint spraying or any application requiring a smoothed well regulated 25Kv. supply.
The transformer needs an HT supply of 350v. and a drive of 1000 Hz. pulsed. This unit is an electrical equivalent to the Mullard type 10840 used in many projection T/V receivers.
We shall be happy to quote you for other output voltages.
Size 4 in. (102 m/m) × 4 in. (102 m/m) × 4½ in. (114 m/m).
Send for details and circuits.
Recommended retail price £12 subject. Competitive price for quantities.

VALRADIO LTD.

Dept. WHT1, BROWELL'S LANE, FELTHAM, MIDDLESEX, ENGLAND

Telephone: 01-890 4242

WW—059 FOR FURTHER DETAILS

Nombrex accuracy!

in the palm of your hand

TRANSISTORISED–COMPACT–MODERN STYLING

Standard Model 29-S

- 150KHz-220 MHz on fundamentals
- Eight clear scales. Total length 40"
- Smooth vernier tuning—ratio 7½ : 1
- Magnifier cursor—precision tuning
- Overall accuracy, better than 1.5%
- Modulation, variable depth and frequency

Price £20-0-0

Xtal Check Model 29-X

- All the features of the Model 29-S AND
- Integral Crystal Oscillator providing calibration check points throughout all ranges. For adjustment of scale accuracy to ± 0.02%

Price £27-10-0

Illustrated: R. F. SIGNAL GENERATOR MODEL 29, Spin Wheel Tuning £1-0-0 extra

Trade & Export enquiries welcome. Send for full technical leaflets. Post and Packing 6/6 extra

NOMBREX (1969) LTD. EXMOUTH DEVON

Tel. 03-952 3515

WW—060 FOR FURTHER DETAILS

'With a Weircliffe Bulk Eraser you can clean a tape whistle-clean without even taking it from the can'

'Now he tells me'

Let's come clean. Weircliffe Bulk Erasers are, quite simply, the best you can buy.

Magnetic tape/film – up to a maximum of 16" diameter × 35 mm width or 14½" × 2" – can be instantaneously erased. Which means you can handle up to 250 tapes in an hour. And you can, we promise you, even clean a tape while it's still in its can.

What's more, nobody has yet produced a tape or recorded a signal – whether it's data, audio, pulsed or video – that can't be clearly erased to between 80dB and 90dB below saturation recording level. Weircliffe Bulk Erasers have a greater erase factor than any other known make.

Weircliffe Bulk Erasers have been tested and tested by tape manufacturers and technical institutes throughout the world. They're used by broadcasting authorities from Australia to Finland. They're approved and supplied by the major manufacturers of data recording equipment.

They're that good.

For more information, fill in coupon or 'phone Ken Chapman 01-568 922 Ext. 366.

Rank film equipment

Rank Film Equipment, Rank Audio Visual,
P.O. Box 70, Great West Road, Brentford, Middx.
Phone 01-568 9222. Cables: Rankaudio London Telex: 24408

Please send me more information ☐ Please arrange a demonstration ☐

Name _____ Position _____

Company/Address _____

_____

Date _____ Telephone _____

WW—061 FOR FURTHER DETAILS

IF YOU HAVE

A HOME RADIO CATALOGUE

Ordering components is easier and quicker with our new

Just a phone call away

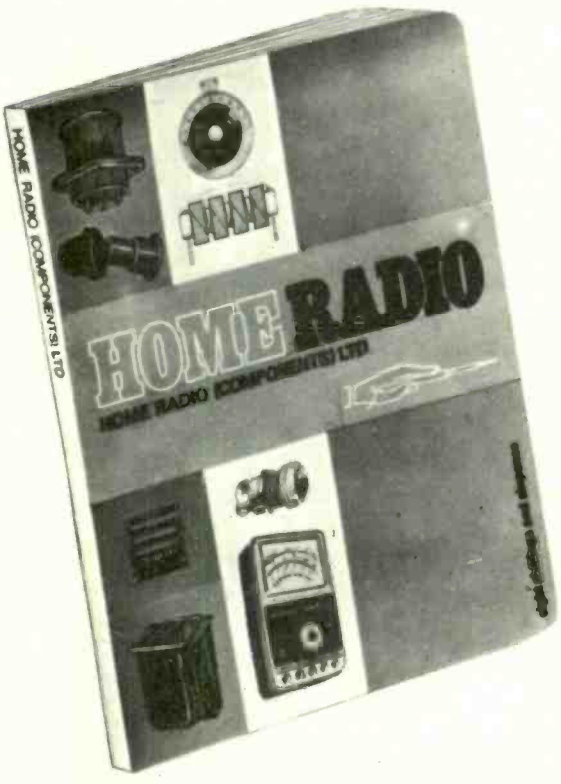
Credit Account Service

Our aim in life at Home Radio Components Ltd. is to make *your* life happier and less complicated! To this end we have recently introduced a **Credit Account Service,** one advantage of which is that you can order components by telephone *any time, any day.* If you phone out of shop hours a recording machine will take your message for us to deal with as soon as we open shop next day.

There are *other* advantages to the new Service—if you want to order by post we provide Order Forms and *Prepaid* Envelopes. You settle your account just once per month. We stipulate *no* minimum order value. Of course for ordering your components you first need our Catalogue, and after you have been in the Service 12 months we regularly send you an up-to-date catalogue—FREE!

For full details of our Credit Account Service just drop us a line or phone 01-648 8422.

IF YOU HAVEN'T...



Whether or not you want to use the Credit Account Service described above, you certainly need the **Home Radio Components Catalogue** if you construct or repair radio and electronic gadgets. The catalogue has 350 pages, lists 8,000 components and has over 1,500 illustrations. It contains six vouchers, each worth 1/- when used as indicated. *Post the coupon with 12/-* (8/6 plus 3/6 postage and packing) and we will send a catalogue by return of post. By the way, we supply *free* a 30-page Price Supplement and a Bookmark giving electronic abbreviations.

Write Name and Address in block capitals

Name .....

Address .....

.....

.....

HOME RADIO (Components) LTD., Dept WW, 234-240 London Road, Mitcham, Surrey CR4 3HD

WW—063 FOR FURTHER DETAILS

see you at SONEX '70

Come and hear Hi-Fi of the Seventies. See what the new decade promises the Hi-Fi enthusiast and music lover

SONEX is an important new series of annual Hi-Fi exhibitions. The best in Hi-Fi, the newest equipment, future trends in sound, sound demonstration, ideas for Hi-Fi in the home – a wealth of exhibits awaits the enthusiast.

Rooms with a view to listening. Special care has been taken in planning demonstration rooms. They help you evaluate equipment accurately. The hotel rooms are built much like your own at home and are a first class testing site for the equipment you will hear. Spatially and acoustically the setting is just right for the enthusiast and the music lover.

SONEX will be the highlight of your Hi-Fi year. Be sure to get your free ticket for the first of these great sound events from your Hi-Fi dealer.

April 24th-26th, 1970

Organised by British Audio Promotions Ltd. for the Federation of British Audio
Fri & Sat: 11 am-9 pm.
Sun: 11 am-6 pm.

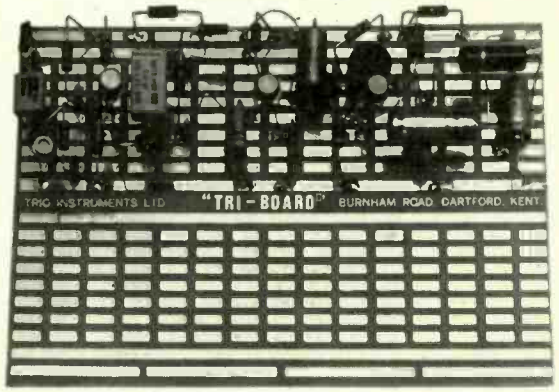
SKYWAY HOTEL
Bath Rd., Hayes, Middx.
(free car park)

Luxury coaches from Hounslow West tube station. Skyway bus between airport and hotel.

SONEX '70
Hear the Hi-Fi of the 70's

WW—064 FOR FURTHER DETAILS

'TRI-BOARD'



The ideal "Breadboard" material for rapid construction of electronic circuits at the design and prototype stages of development programmes.

TRI-BOARD is supplied in Fibreglass which is suitable for cold punching or cutting. Board size is $7\frac{1}{2}$" × $5\frac{3}{8}$" × $\frac{1}{16}$" thick with 1 oz. copper
A roller tinned finish is standard.

PRICE 15/- net per board.
Quantity discounts apply:

TRIO INSTRUMENTS LTD.,
BURNHAM ROAD,
DARTFORD, KENT. Telephone: Farningham 2082

WW—065 FOR FURTHER DETAILS

M. R. SUPPLIES (London) LTD.,

(Established 1935)

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

ROOM THERMOSTATS. Danfoss wall-mounted Thermostats. 40 deg. F.-80 deg. F., 380 v. A.C., 4 amps.; 240 v. A.C., 6 amps. Our nett price **£1/12/6** (des. 2/-).

MINIATURE RUNNING TIME METERS (Sangamo). We have great demands for this remarkable unit and now can supply immediately from stock. 200/250 v. 50 c. synchronous. Counting up to 9,999 hours, with 1/10th indicator. Only 1¼ ins. square, with cyclometer dial, depth 2 ins. Many industrial and domestic applications to indicate the running time of any electrical apparatus, easy to install, **63/-** (des. 1/6).

SYNCHRONOUS TIME SWITCHES. (Another one of our popular specialities) 200/240 v. 50 c., for accurate pre-set switching operations. Sangamo S.254, providing up to 3 on-off operations per 24 hours at any chosen times, with day-omitting device (use optional). Capacity 20-amps. Compactly housed 4 in. dia., 3½ in. deep. **£6/4/6** (des. 4/6).

ELECTRIC FANS (Papst), for extracting or blowing. The most exceptional offer we have yet made. 200/250 v. A.C. Induction motor—silent running. 2,800 r.p.m. duty 100 C.F.M. Only 4¼in. square and 2in. deep. Ideal for domestic or industrial use. Easy mounting. **£3/5/-** (des. 3/6).

SMALL GEARED MOTORS. In addition to our well-known range (List GM.169), we offer small open type S.P. Units 200/250 v. A.C., 1, 6, 12, 24, 60 r.p.m., approx. 5in. long, with 1in. shaft projection each side and enclosed gearbox. Suitable for display work and many industrial uses. Only **75/-** (des. 5/-).

MINIATURE COOLING FANS. 200/250 v. A.C. With open type induction motor (no interference). Overall 4in. × 3½in. × 2¼in. Fitted 6-bladed metal impeller. Ideal for projection lamp cooling, light duty extractors, etc., still only **31/6** (des. 5/-).

AIR BLOWERS. Highly efficient units fitted induction totally enclosed motor 230/260 v. 50 c. 1 ph. Model SD.26, 60 CFM (free air) to 11.5 CFM at .15 WG (size approx.) 6 × 6 × 7in. Outlets 2½in. square. **£8/10/-** (des. 5/-). Model SD27, 120 CFM (free air) to 40 CFM at 1.2 WG, 8 × 7 × 9in. outlet 2½in. sq.. **£11/15/6** (des. 5/-). Model SD28, 260 CFM (free air) to 127 CFM at 1.5 WG, 11 × 8 × 9in.. outlet 3in. sq., **£13/17/6** (des. U.K. 7/6).

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS (as mentioned and recommended in many national journals). 200/250 v. 50 c. Self-starting. Fitted spindles for hours, minutes and central sweep second hands. Central one-hole fixing. Dia. 2¼in. Depth behind dial only 1in. With back dust cover, **39/6** (des. 2/-). Set of three brass hands in good plain style. For 5/7in. dia. 2/6 For 8/10 dia. 3/6 set.

SYNCHRONOUS TIMER MOTORS (Sangamo). 200/250 v. 50 c/s. Self-starting 2in. dia. × 1⅛in. deep. Choice of following speeds: 1 r.p.m., 12 r.p.h., 1 r.p.h., 1 rev. 12 hours, 1 rev. per day. Any one **42/-** (des. 2/-). Also high-torque model (G.E.C.). 2½in. × 2in. × 1⅝in. 6 r.p.m.. **57/6** (des. 2/-).

SMITHS TIMER MOTORS. Synchronous, self-starting 200/250 volts, 1 ph., 50 c. Clockwise. 4 r.p.m. only. Only **25/-** (des. 2/-).

MINIATURE D.C. MOTORS. 6/12 volts D.C. Ideal model makers. 4,000/9,000 r.p.m. no load. 1⅛ in. × 1⅛ in. diameter. Flange fixing. Only **5/-** (des. 1/6).

EXTRACTOR FANS. Ring mounted all metal construction. T/E induction motor, silent operation, 8in. blade, 10in. max. dia., 400 CFM. **£6/10/0** (des. 5/-) Same model 10in. blade. 12in. max. dia., 500 CFM **£6/16/0** (des. 6/-).

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

OFFICIAL STOCKIST; "PARVALUX" Electric Motors (List G.M. 169)

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

WW—066 FOR FURTHER DETAILS

Mnemo-polymerics*

— or 70 ways of shrinking your sealing, jointing and encapsulation costs!

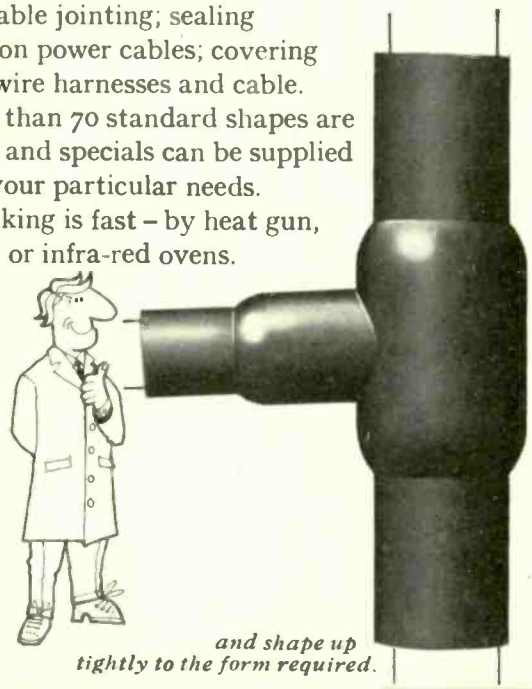
Moldanized Shapes come in shrink ratios up to 5:1, giving you room to work . . .

*Mnemopolymerics – the science of heat-shrinkable polymers with a built-in memory – perfected after many years of research and development by Hellermann-Electric.

The Helashrink ® range of Moldanized ™ Shapes gives you the fast, low-cost answer to encapsulation of electrical connectors; water sealing of cable glands; cable jointing; sealing crutches on power cables; covering spurs in wire harnesses and cable.

More than 70 standard shapes are available and specials can be supplied to meet your particular needs.

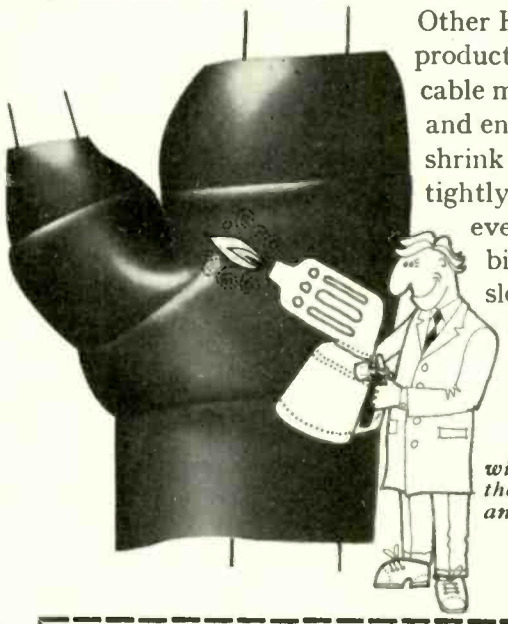
Shrinking is fast – by heat gun, gas flame or infra-red ovens.



and shape up tightly to the form required.

Moldanized Shapes have excellent electrical properties. They add strength, insulation, abrasion and moisture protection – resist acids, alkalis and contaminants.

Other Helashrink products: sleeves, cable markers, tubing and end caps. They shrink quickly, grip tightly, conform evenly – cut cable binding and sleeving costs!



with heat applied, they shrink quickly and evenly . . .

Shrink-it-yourself kit FREE

(All you need is a match)

Please send me your free Mnemopolymerics Demonstration Kit – plus full details of Helashrink Moldanized Shapes.

Name_____

Company_____

Address_____

_____ WW 3

WORLD LEADERS IN CABLE ACCESSORIES

HELLERMANN ELECTRIC

A division of Bowthorpe-Hellermann Ltd.

Gatwick Road, Crawley, Sussex. Tel: Crawley 28888

A member of the Bowthorpe Holdings Group of Companies

WW—067 FOR FURTHER DETAILS

We are exhibiting at:—
IEA EXHIBITION—OLYMPIA
Stand No. G100 11th-16th May

how to take levell-headed measurements...

Long battery life and large overload ratings are leading features of these solid state instruments. Mains power supply units and leather carrying cases are optional extras.

Measure μV's from 1Hz to 3MHz

VOLTMETER RANGES
15μV, 50μV, 150μV . . . 500V f.s.d.
Acc. ± 1% ± 1% f.s.d. ± 1μV at 1kHz.

db RANGES
− 100dB, − 90dB, − 80dB . . . + 50dB.
Scale − 20dB/+ 6dB rel. to 1mW/600Ω.

FREQUENCY RESPONSE
Above 500μV: ± 3dB from 1Hz to 3MHz.
± 0·3dB from 4Hz to 1MHz.
Type TM3B can be set to a restricted B.W. of 10Hz to 10kHz or 100kHz.

INPUT IMPEDANCE
Above 50mV: > 4·3MΩ < 20pf.
On 50μV to50mV: >5MΩ <50pf.

AMPLIFIER OUTPUT
150mV at f.s.d. on all ranges into 200kΩ and 50pF without loss.

SIZES & WEIGHTS
TM3A: 5″ × 7″ × 5″. 5lb. 3½″ scale.
TM3B: 7″ × 10″ × 6″. 8lb. 5″ mirror scale.

type TM3A **£49** type TM3B **£63**

Measure μV's from 1Hz to 450MHz.

H.F. VOLTAGE RANGES
1mV, 3mV, 10mV . . . 3V f.s.d.
Square law scales. Acc. ± 4% of reading ± 1% of f.s.d. at 30MHz.

H.F. dB RANGES
− 50dB, − 40dB, − 30dB . . . + 20dB.
Scale − 10dB/+3dB rel. to 1mW/50Ω.

H.F. RESPONSE
± 0·7dB from 1MHz to 50MHz.
± 3dB from 300kHz to 400MHz.
± 6dB from 400MHz to 450MHz.

L.F. RANGES
As TM3 except for the omission of 15μV and 150μV ranges.

AMPLIFIER OUTPUT
As TM3 on L.F.
Square wave at 20Hz on H.F. with amplitude proportional to square of input.

SIZES & WEIGHTS
TM6A: 5″ × 7″ × 5″. 6lb. 3½″ scale.
TM6B: 7″ × 10″ × 6″. 9lb. 5″ mirror scale

type TM6A **£85** type TM6B **£99**

Measure D.C. μV's, pA's & Ω's

VOLTAGE RANGES
3μV, 10μV, 30μV . . . 1kV. Acc. ± 1% ± 1% f.s.d. ± 0·1μV. LZ & CZ scales.
Noise <0·5μV p-p on 3μV range.
Drift < 0·7μV/°C & <0·7μV/day.
Input res. > 1MΩ/μV up to 10mV, >10kMΩ on 30mV to 1V, 100MΩ above 1V.

CURRENT RANGES
3pA, 10pA, 30pA . . . 1mA (1A for TM9BP) Acc. ± 2% ± 1% f.s.d. ± 0·3pA. LZ & CZ scales. Noise < 0·7pA p-p on 3pA. Drift <1pA/°C & < 1pA/day. Input res. 1MΩ up to 1nA, 100kΩ on 3nA to 1μA, 100Ω on 3μA to 1mA, 0·12Ω on 3mA to 1A.

RESISTANCE RANGES
3Ω, 10Ω, 30Ω . . . 1kMΩ linear. Acc. ± 1%, ± 1% f.s.d. up to 100MΩ. Test voltage 3mV at f.s.d. on Ω ranges. Test currents 1μA & 1nA on kΩ & MΩ.

RECORDER OUTPUT
1V at f.s.d. into >1kΩ on LZ ranges.

SIZES & WEIGHTS
TM9A as TM3A. TM9B & BP as TM3B.

type TM9A **£75** type TM9B **£89** type TM9BP **£93**

LEVELL
PORTABLE INSTRUMENTS

Hire terms and leaflets covering our full range of portable instruments are available from:

LEVELL ELECTRONICS LTD · PARK ROAD · HIGH BARNET · HERTS. · *TEL:* 01-449 5028

W—071 FOR FURTHER DETAILS

Introducing the tape decks that will probably start you thinking all over again about tape decks.

Have you watched a TEAC demonstration yet? Have you seen (and heard) what can happen when a company of unusual capability in the magnetic tape industry decides to create some exciting new standards for the knowledgeable music lover?

The TEAC decks shown here are now available exclusively in select hi-fidelity shops throughout Europe. We think they're pretty incomparable.

Example: Model A-6010 has exclusive features like Phase Sensing automatic reverse which gives you up to four hours of uninterrupted music on a single tape. It has symmetrical soft-touch control operation for fast-winding in both tape directions, playback and stop. And it has outer-rotor motors for reel drive, four TEAC Techno-built tape heads, four solid-state amplifiers with silicon transistors, and much, much more.

The other models cost much less, but still give you TEAC's flawless performance.

In this age of tape recording ingenuity, it still might surprise you to see what TEAC is doing.

A-6010
Our finest 4-track stereo tape deck. Everything about it is professional.

TEAC

TEAC EUROPE N.V.
Amsterdam W2, Kabelweg 45-47,
Postbus 8180, Netherlands

A-1200
Medium priced tape deck with 3 heads, push-button operation, professional performance specifications. 2-track available as special order.

A-1500W
Stereo tape deck with automatic reverse, 3 motors, 4 heads and push-button operation.

A-4010S
4-head, 4-track stereo recorder with symmetrical control operation, 4 solid-state amplifiers, automatic reverse.

TEAC DISTRIBUTORS: **U.K.** B. H. Morris & Co., (Radio) Ltd., 84/88, Nelson St., London, E. 1 **Ireland** International Trading Group Ltd., 5 Cope St., Dame St., Dublin 2 **West Germany** TEAC European Service Center, Dotzheim Wiesbadenerstrasse 68, 6200 Wiesbaden HANIMEX (DEUTSCHLAND) GMBH, 3000 Hannover, Haltenhoffstr. 50 **Belgium** INELCO S.A., 20-24, Rue de l'Hospital, Brussel 1 **France** Fabrications Electroacoustiques Frei 7, Rue Sainte-Isaure, Paris 18 **Netherlands** INELCO N.V., Arent Janszoon Ernststraat 801, Amsterdam Z. II **Italy** Audel s.a.s. 20124 Milano V. le Tunisia 45 **Cyprus** Electroacoustic Supply Co., Ltd., P.O. Box 625, Limassol **Denmark** Quali-Fi, Christiansholms Parkvej 26, Klampenborg **Greece** Elina Ltd., 59 & 59A Tritis Septemvriou Street, Athens 103 **Portugal** Jorge Goncalves, Avenida 5 de Outubro, 53, 1., Lisboa-1 **Sweden** Audio-Nike AB, Sunnanvag 14E, Lund 7 **Japan** TEAC Corporation 2-8-8, Tsunohazu, Shinjuku-ku, Tokyo

WW—079 FOR FURTHER DETAILS

'WATTS' THE NAME FOR RECORD MAINTENANCE

THE ONLY COMPREHENSIVE RANGE OF RECORD MAINTENANCE EQUIPMENT

Watts

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 1/3 P.T.**

Replacements: 1 oz. New Formula dispenser 4/6 Distilled Water Dispenser 4/– Pad Cover and Ribbons 1/9.

STYLUS CLEANER

Available separately complete with instructions.

Price 5/–. Plus 1/3 P.T.

'PARASTAT' Regd. Manual Model with Humid Mop

A dual purpose record maintenance device. Keeps new records in perfect condition. Restores fidelity to older discs. The Humid Mop cleans and conditions the bristles and velvet pads. Ensures correct degree of humidity at the time of use. Complete with 1 oz. New Formula dispenser and instructions.

Price: 52/6

Replacements: Pad Covers 2/- each. Brush 12/6. Sponge Cover Pad 1/-. 1 oz. New Formula dispenser 4/6. Humid Mop Sponge and 4 wicks 3/-. Manual Parastat available separately **47/6**. Humid Mop available separately 5/-.

The original 'DUST BUG' Regd. (Patent No. 817598)

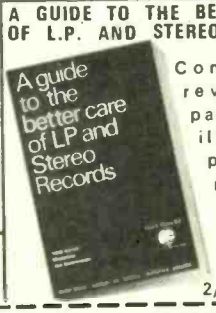
Automatic Record Cleaner. Easily fitted to any transcription type turntable. Provides a simple and effective method of removing static and dust while the record is being played. Surface noise and record and stylus wear is reduced, resulting in cleaner reproduction. Complete with ½ oz. New Formula Dispenser 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.

'PARASTATIK' Regd. DISC PREENER (Patent No. 982599)

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/–.

A GUIDE TO THE BETTER CARE OF L.P. AND STEREO RECORDS



Completely revised. 48 pages, fully illustrated, providing all necessary information on Record Care.

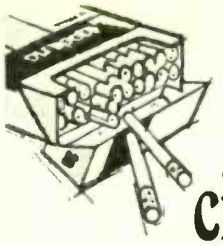
2/6 Post Free.

All obtainable from your local specialist or direct:

To CECIL E. WATTS LTD. DARBY HSE, SUNBURY ON THAMES, MIDDX.

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

..... Disc Preeners @ 6/9 ..... Hi-Fi Parastats @ 42/6 plus 1/3 P.T.
..... Dust Bugs @ 18/9 plus 4/5 P.T. ..... Manual Parastats @ 47/6
..... 48 page Booklets @ 2/6 ..... Stylus Cleaners @ 5/- plus 1/3 P.T.
..... Manual Parastat/Humid Mop @ 52/6 .....
Spares as per attached list.
I enclose cheque/P.O. value £..... (*Do not send postage stamps*)
Name .....
Address .....
.....



We put 23,340 cigarettes in our Budget combination storage unit!

Think what you could put in it!

Storage. Lots of it, for a thousand things you stock: replacement parts: light bulbs: cameras: **anything** up to 7" x 8" x 10⅜". Safety drawer-stops as 'standard'. Smooth quide runners thro'out. All in a compact 3ft 6in. high, 2ft 11in. wide, 1ft deep area. Ready assembled, in stove enamelled green or grey. With 18 handy, 6 large, 8 king-sized drawers. At £19:0s. worth every penny! See the rest of the N. C. Brown range!

£19.0s. carriage free on mainland

N.C. BROWN LTD.
pacesetters in storage equipment

Send your FREE BROCHURE ☐ or Send ☐ (how many) Budget Storage Units @ £19:0s. in green or grey.

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

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

WW—080 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**

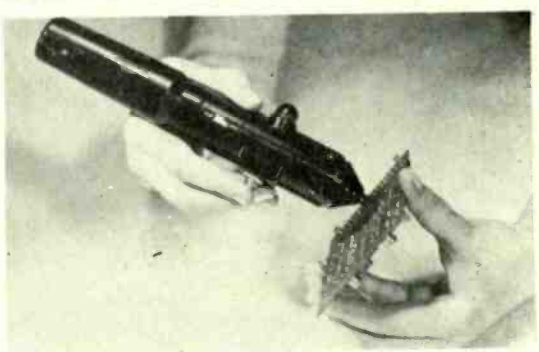
Si 452 ..... **£25.0.0.** Distortion Measuring Unit. 15 c/s — 20 Kc/s — .01%

Si 453 ..... **£35.0.0.** Low distortion Oscillator. Sine — Square — RIAA

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

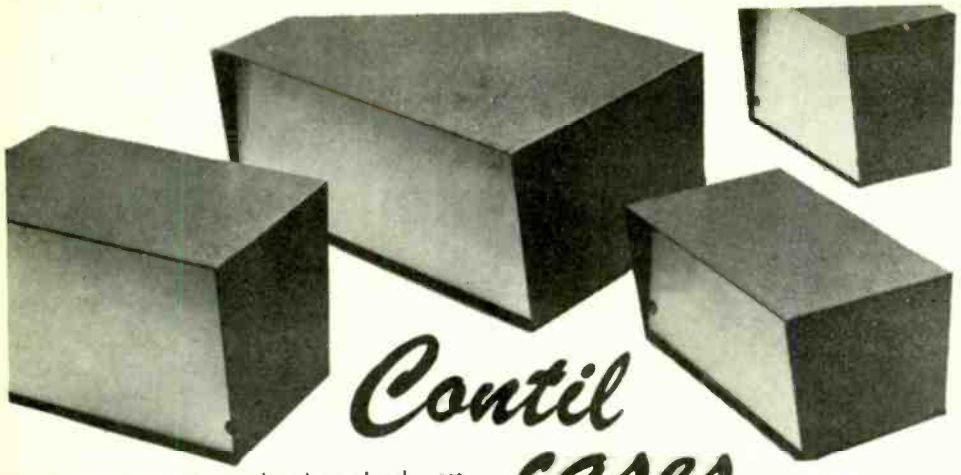
WW—081 FOR FURTHER DETAILS

DIOTESTOR IN-CIRCUIT TRANSISTOR TESTER



BRITEC LIMITED, 17 Charing Cross Road, London, W.C.2
Tel: 01-930-3070

WW—082 FOR FURTHER DETAILS



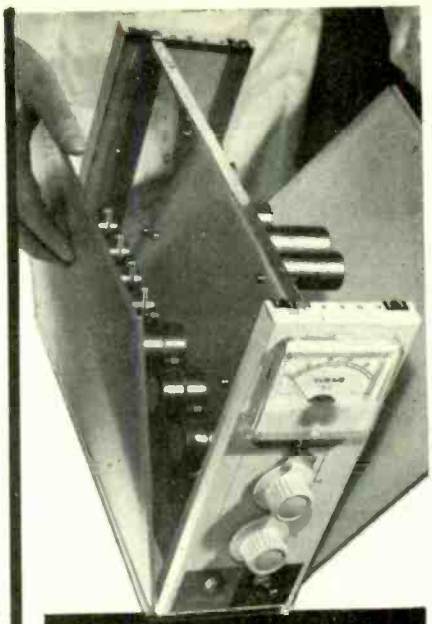
Contil cases

Contil cases are mass-produced to give lowest prices yet. In 21-gauge steel. Finished hammer blue, with 18-gauge front panel supplied with easy-to-strip protective covering for easy marking out. For ease of ordering Contil cases are described by their dimensions, i.e. 755 is 7 × 5 × 5. Individually packed, including feet and screws.

Contil cases are also available with aluminium panels and Contilcote, which is applied after drilling and cutting.

CASE PRICES (*All supplied with protective coated steel panels*)

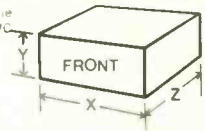
Nos. denote size in inches	1	5	10	25	50	100	P&P
755	48/-	46/-	45/-	44/-	43/-	41/-	6/-
867/975	50/-	49/-	48/-	46/-	45/-	43/-	6/-
1277 white or black panel	55/-	52/-	51/-	50/-	49/-	48/-	8/-
1277 unpainted	45/-	44/-	43/-	40/-	39/-	37/-	8/-
16127	106/-	104/-	102/-	101/-	99/-	97/-	9/6
191010	143/-	140/-	137/-	135/-	134/-	133/-	10/6
191010D	199/-	197/-	196/-	194/-	192/-	190/-	18/-



CONTIL MOD·2

ideal for development cheaper for production

PVC COATED MATERIALS. No outside paint to be scratched. PVC easy to clean, surface is scuff resistant. PVC/ALUMINIUM FOR FRONT & BACK PANELS gives easy cutting with rigidity PVC/STEEL FOR SIDES. TOP & BOTTOM gives rigidity, low cost, ease of assembly. 3 HEIGHTS OF CASE, 4 WIDTHS, 2 DEPTHS, make 24 cases with screws on top and 24 cases with screws on side, that's 48 different cases. LOW COST. Prices include chassis. MODERN DESIGN. Metal work on front and back and chassis is made easier by aluminium with PVC cladding. PVC/steel on sides and bottom for strength. GOOD DELIVERY. Off the shelf range of all PVC coated cases.



NOTE THE LOW COST

	X	Y	Z	1 off	P. & P.
A	4.5	3	6.5	34/-	3/–
B	4.5	7	6.5	40/-	4/6
C	4.5	10	6.5	50/-	4/6
D	9	3	6.5	50/-	4/6
E	9	7	6.5	55/-	4/6
F	9	10	6.5	65/-	4/6
G	13	3	6.5	55/-	4/6
H	13	7	6.5	65/-	4/6
I	13	10	6.5	73/-	6/–
J	18	3	6.5	65/-	4/6
K	18	7	6.5	89/-	6/–
L	18	10	6.5	107/-	6/–
M	4.5	3	13	40/-	4/6
N	4.5	7	13	55/-	4/6
O	4.5	10	13	73/-	6/-
P	9	3	13	55/-	4/6
Q	9	7	13	73/-	6/–
R	9	10	13	89/-	6/–
S	13	3	13	73/-	6/–
T	13	7	13	89/-	6/–
U	13	10	13	109/-	7/6
V	18	3	13	89/-	6/–
W	18	7	13	107/-	7/6
X	18	10	13	138/-	7/6

Sizes in inches

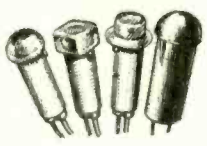
Your third hand

The ONTOS UNIVERSAL VICE is a new type of multi-purpose, multi-position light engineering vice and stand, fully adjustable for any angle and location in any desired plane. Applications are virtually limitless within its size capacity; i.e. holding P.C. boards for assembly or testing, building up modules, as a micrometer or gauge stand, as a light general purpose vice, in the chemical laboratory, or in fact for all those occasions when you could use a third hand! The ONTOS TWIN TWO-IN-ONE UNIVERSAL VICE is a unique two-in-one version of the Ontos vice, with two sets of jaws, each capable of rotation through 360 deg. of every plane independently of each other. Positive locking enables any such setting to be maintained for repetition work. Ideal for copying P.C. boards, assembly, soldering, bonding, welding, laboratory testing, etc.

ONTOS: 68/- plus P&P 4/6.
ONTOS TWIN: £5 18 0 plus P&P 6/-.

'Brightlife' NEONS

25,000 hour average life. PC type ⅜" diameter. 6" leads with resistor inside. Nine different caps available. 160-260V. 10 at 3/- each. 100 at 2/8 each. 1,000 at 2/4 each. 10,000 at 2/3 each. Also available with 30" leads: 110 volt resistor values. PP type ½" diameter also supplied with 30" leads and 110 volt variants. 10 at 3/- each. 100 at 2/8 each. 1,000 at 2/4 each. 10,000 at 2/3 each. Neon/resistor assemblies. 100 at 10d. each. 10,000 at 9d. each. Neons only. 100 at 9d. each. 10,000 at 6½d. each. Neons driven by neon oscillator for 6 to 24 volt input down to 50 mW input. Neons driven by transistors with or without alphanumeric caps.



SUB-MINIATURE NEONS

The smallest yet, type "Q". Overall diameter 1/16", body .7", resistor mounted externally, medium intensity. Minimum quantity 10 at 4/- each. 100 at 3/6 each. 500 at 3/4 each.

REED SWITCH

The West Hyde reed switch works up to 2,000 operations per second with a life of up to 50,000,000,000 operations when used in the recommended circuit. The hermetically sealed switch is protected in a brass tube and moulded into a polypropylene block giving accurate placing of the contents in relation to the mounting screws. 30" nominal leads fitted. Used for Rev. Counters, flowmeters, burglar alarms, under and over speed monitors, etc. 1 at 15/–. 10 at 13/- each. 100 at 10/- each.

ACCESSORIES

Flexible insulated test prods, colour red or black, at 13/– each with fine steel clips at the tip, opened by button on top. High speed resetting counter including bezel and socket with speed of over 40 operations per second 165/–. Plug in octal relay, 24 volts, with two changeovers 17/6.

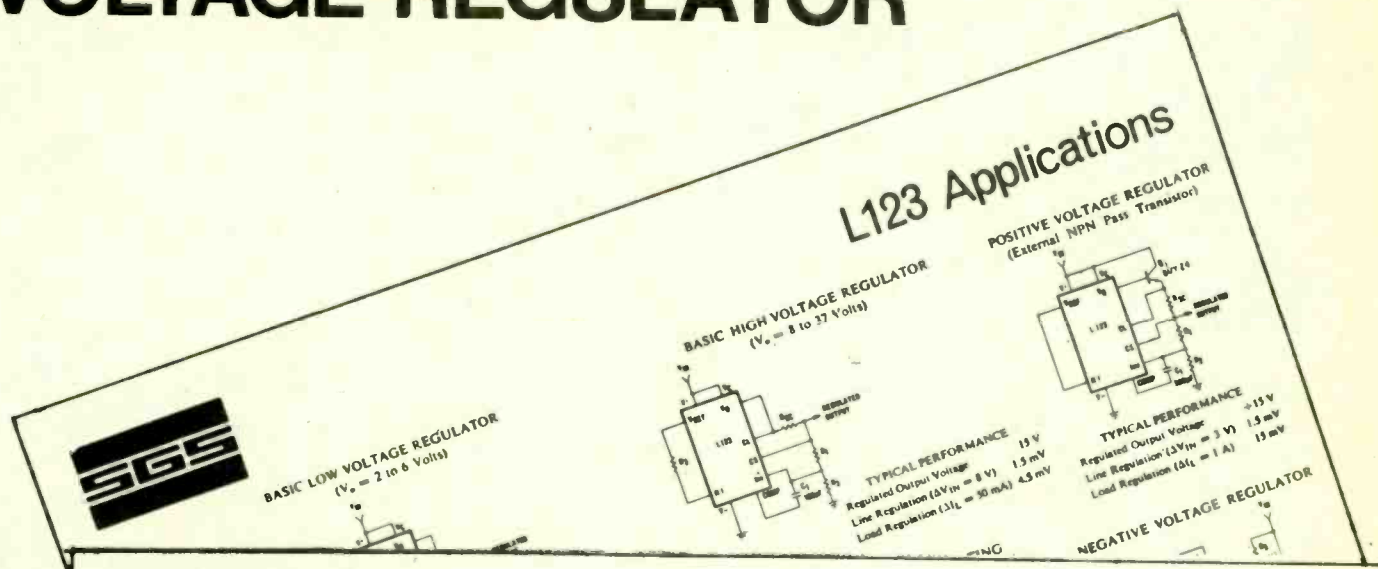
WEST HYDE DEVELOPMENTS LTD.
30 HIGH STREET NORTHWOOD MIDDX.
Telephone: Northwood 24941/26732

PLEASE NOTE
All products ex-stock for normal quantities. Return of post service. Minimum order £1. Fully detailed leaflets available.

WW—084 FOR FURTHER DETAILS

AN INTEGRATED CIRCUIT

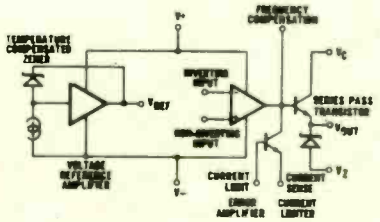
VOLTAGE REGULATOR



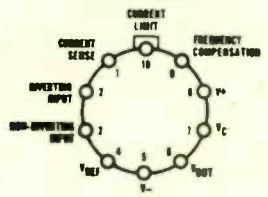
SGS

VOLTAGE REGULATOR L123T1

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS
TOP VIEWS



VOLTAGE REGULATOR

Series, shunt, switching or floating regulator for Positive or Negative Supplies

ABSOLUTE MAXIMUM RATINGS

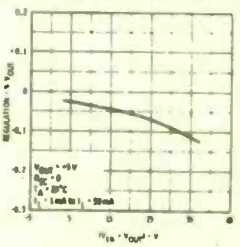
Voltage from V_+ to V_-	40	V.
Input—Output Voltage Differential	40	V.
Maximum Output current	150	mA.
Current from V_Z	25	mA.
Internal Power Dissipation	800	mW.
Operating Temperature Range	0°C to 70°C.	

CHARACTERISTICS. T_{amb} 25°C.

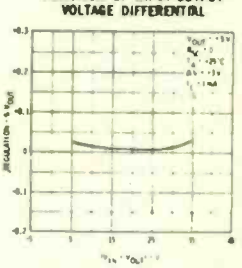
	min.	typ.	max.	
Line Regulation V_{IN} = 12 to 15V.		0·01	0·1	% V_{OUT}.
V_{IN} = 12 to 40V.		0·1	0·5	% V_{OUT}.
Load Regulation I_L = 1 to 50 mA.			0·6	% V_{OUT}.
Ripple Rejection C_{REF} = 5μF.		86		dB.
Short Circuit Current Limit		65		mA.
Reference Voltage	6·8	7·15	7·5	V.
Output Noise Voltage C_{REF} = 5μF.		2·5		μVRMS.
Load Term Stability		0·1		%/1000hrs
Standby Current Drain		2·3	4·0	mA.
Input Voltage Range	9·5	—	40	V.
Output Voltage Range	2·0	—	37	V.
Input—Output Voltage Differential	3·0	—	38	V.
Average Temp. Coeff. of Output Voltage 0°—70°C.		·003	·015	%/°C.

PRICE 1—24 £3 3s. 9d.

LOAD REGULATION AS A FUNCTION OF INPUT-OUTPUT VOLTAGE DIFFERENTIAL



LINE REGULATION AS A FUNCTION OF INPUT-OUTPUT VOLTAGE DIFFERENTIAL



103

IS JUST ONE OF THE 1500 SEMICONDUCTORS DETAILED IN

QUARNDON SEMICON'70

WHICH INCLUDES PRODUCTS STOCKED AND AVAILABLE

BY RETURN OF POST FROM

QUARNDON ELECTRONICS

TELEPHONE (0332) 32651

(SEMICONDUCTORS) LIMITED

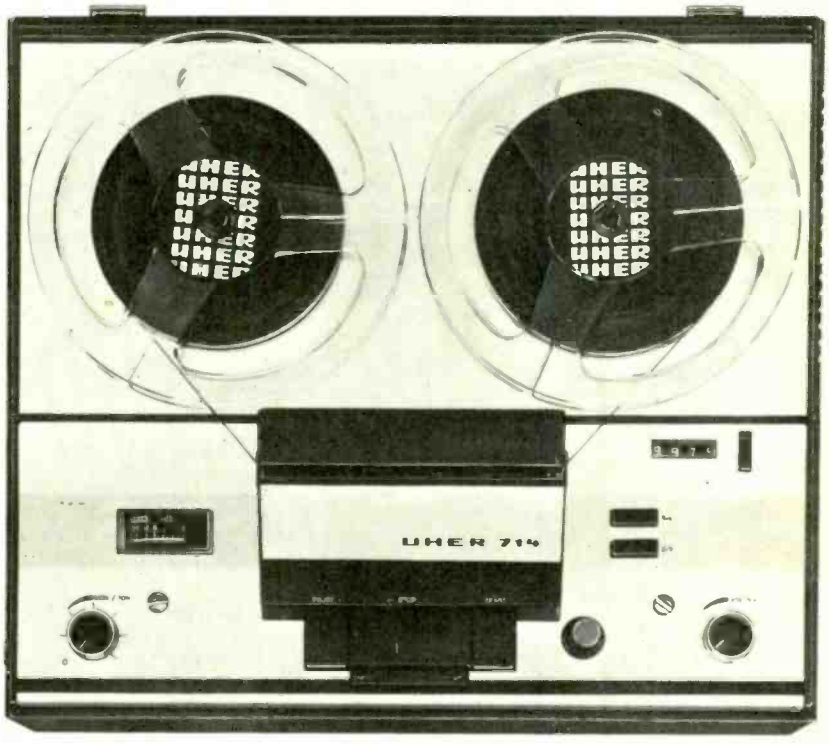
TELEX 37163

SLACK LANE DERBY

WW—083 FOR FURTHER DETAILS

NATO, NASA, Royal Navy, BBC use Uher. Now you can..

..the Uher 714 for less than £60



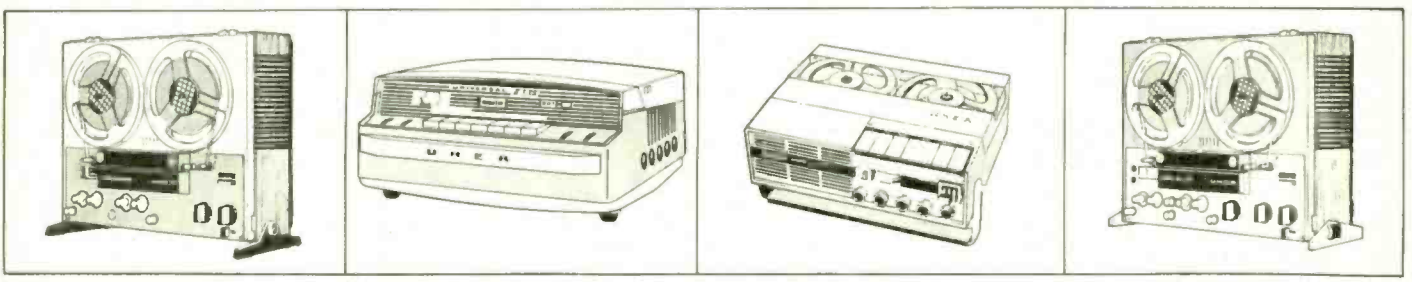
The same exacting standards of technical excellence demanded by these world pacesetters are applied to producing the Uher 714 which, for the first time, brings the superb quality of Uher below £60.

See and hear the Uher 714.

It incorporates many features associated with much more expensive instruments.

- All round tape speed of $3\frac{3}{4}$ ips
- Perfect four-track recording
- 7" reels
- Plays back stereo tapes
- Monitoring during recording
- Solid pressure-cast frame
- Silicon transistors
- Recording Level Instrument with dB scale
- Simple operation
- Light · Robust · Portable

The Uher 714 outclasses everything in its class.



VARIOCORD 23 | UNIVERSAL 5000 | UHER 4000 REPORT L | ROYAL DE LUXE

UHER

DISTRIBUTED IN THE U.K. BY

BOSCH

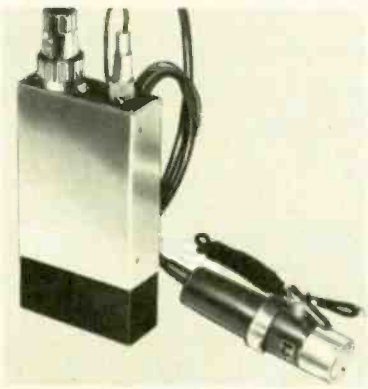
BOSCH LIMITED, WATFORD, WD2 4LB, HERTS. TELEPHONE: WATFORD 44233

WW—085 FOR FURTHER DETAILS

AUDIO

radio microphone systems

system R.M.S.5



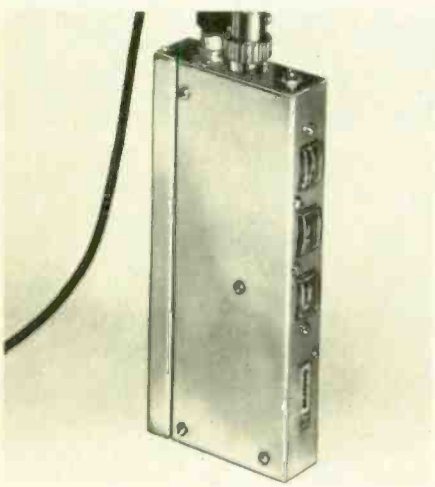
The **AUDIO** radio-microphone system R.M.S.5 meets the most stringent requirements for compactness, reliability and quality. It is extensively used in film, broadcast and television productions including those of the B.B.C and I.T.V companies. It is also the preferred choice in many fields of professional entertainment and has industrial and educational applications as well. As an alternative to the tiny transmitter, usually secreted about the person of the user, a complete hand-held microphone is now available with the transmitter contained within the tubular handle. Performance characteristics are the same for either version.

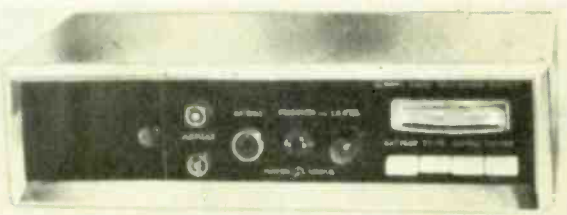
ABRIDGED SPECIFICATIONS

Frequency range from 50MHz to 175MHz, crystal controlled, with ±75KHz deviation. Power output from 1mW to 20mW. Stability ±10KHz at 175MHz from 0°C to 40°C, and correspondingly better at lower Hz. Hand-held model R.M.S.5H with microphone incorporates on/off switch and battery compartment.

NARROW BAND VERSION—The Post Office allows use of two wide band channels, or where speech quality is not important, five narrow band channels. A narrow band version of R.M.S.5 can be supplied accordingly.

RECEIVER. This is a crystal controlled superheterodyne with characteristics to suit the transmitter. A carrier/battery voltage indicator is incorporated.





system R.M.S.7

A fully professional assembly in which exceptionally high standards of quality are maintained within unusually small units of equipment. The receiver is not very much larger than the transmitter. The receiver, shown to the left, is fitted with a flexible plug-in "whip" aerial and includes separate battery, signal level and tuning indicators. The transmitter is as that for R.M.S.5 except that effective audio compression is incorporated. Audio response is ±2dB from 30-15,000Hz over the entire system. System R.M.S.9 uses the same transmitter as R.M.S.7 but has a larger receiver with push button controls and monitoring facilities for headphones.

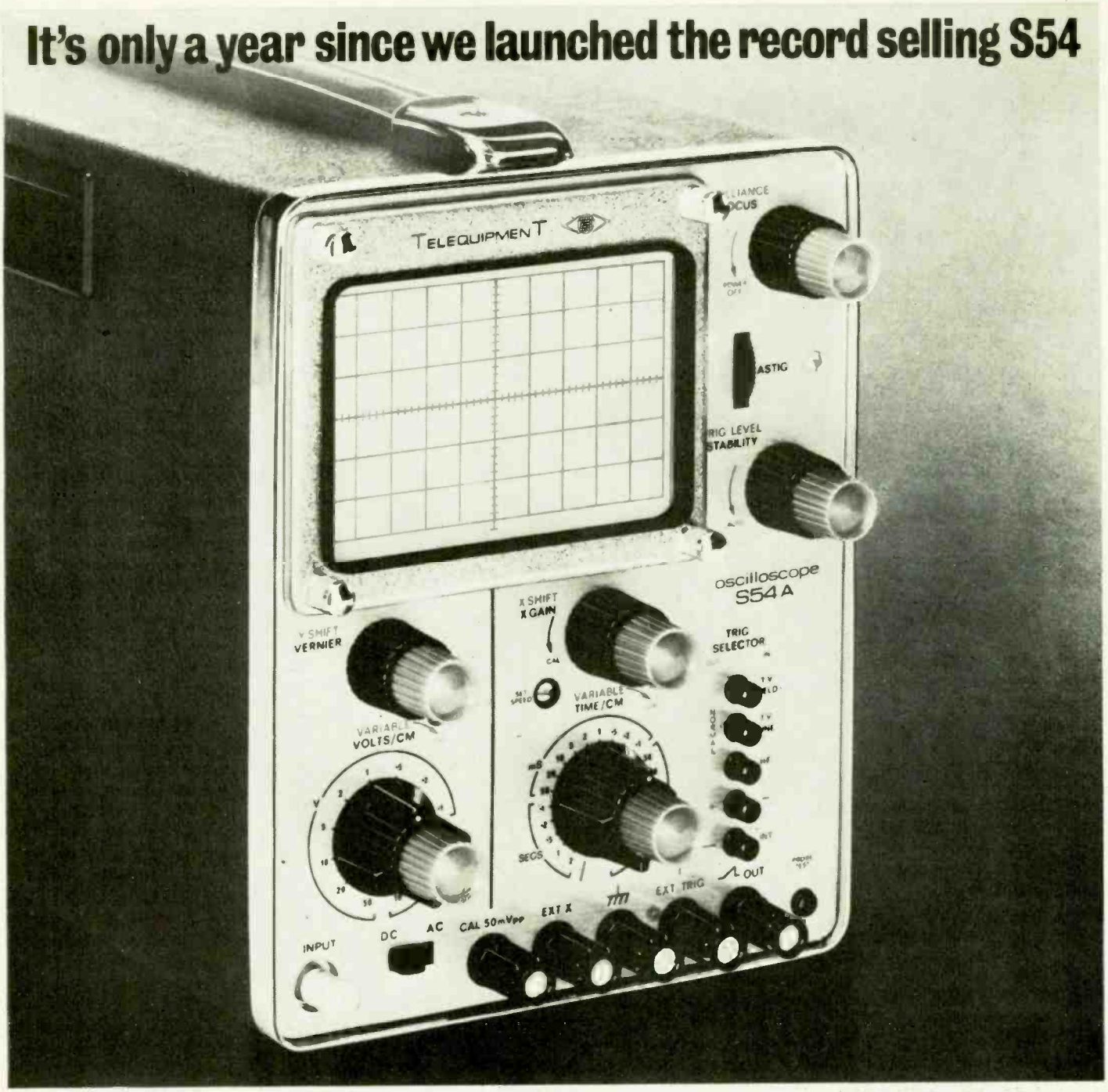
In addition to the programme detailed above, AUDIO LIMITED have under development a 470MHz radio-microphone for TV use overseas, a half-watt radio-microphone for outside broadcasts, a 4 watt transmitter for radio-microphone links, and studio talk-back systems. Enquiries invited.

audio

AUDIO LIMITED, 46 PENTONVILLE ROAD, LONDON, N.1 **Telephone: 01-278 1020**

WW—094 FOR FURTHER DETAILS

It's only a year since we launched the record selling S54



Now we introduce the S54A...

...a single beam oscilloscope with a sensitivity of 10mV/cm at 10MHz bandwidth

The S54A is **an all solid state** oscilloscope developed from the S54. Smartly styled yet ruggedly built, the S54A has a wide application in field work, in the laboratory and in production line testing. Look at the features:

- ✳ 10MHz Bandwidth at 10mV/cm
- ✳ All Solid State Design
- ✳ Small Size — Light Weight
- ✳ FET Inputs
- ✳ Versatile Triggering including T.V. Line and Frame Sync.
- ✳ 6 x 10cm. Viewing Area
- ✳ Built-in Voltage Calibrator.

At £120 you will find no other oscilloscope of its type which offers such features at such low cost. Write or phone for full specification NOW! ! ! !

TELEQUIPMENT

Telequipment Limited, 313 Chase Road, Southgate, London, N.14. Telephone: 01-882 1166. Telex: 262004.
A member of the Tektronix Group. For Overseas enquiries write to: Tektronix Ltd., P.O. Box 48, Guernsey, C.I.

WW—095 FOR FURTHER DETAILS

Wireless World

Electronics, Television, Radio, Audio

Sixtieth year of publication **April 1970** **Volume 76 Number 1414**

This month's cover illustration shows an unusual view of a watchmaker's wheel adopted by Pye to aid the handling of components in the production of small receivers (see p.158).

IN OUR NEXT ISSUE

Simple high-quality pre-amplifier, having a high input impedance, suitable for radio and ceramic gramophone pickups.

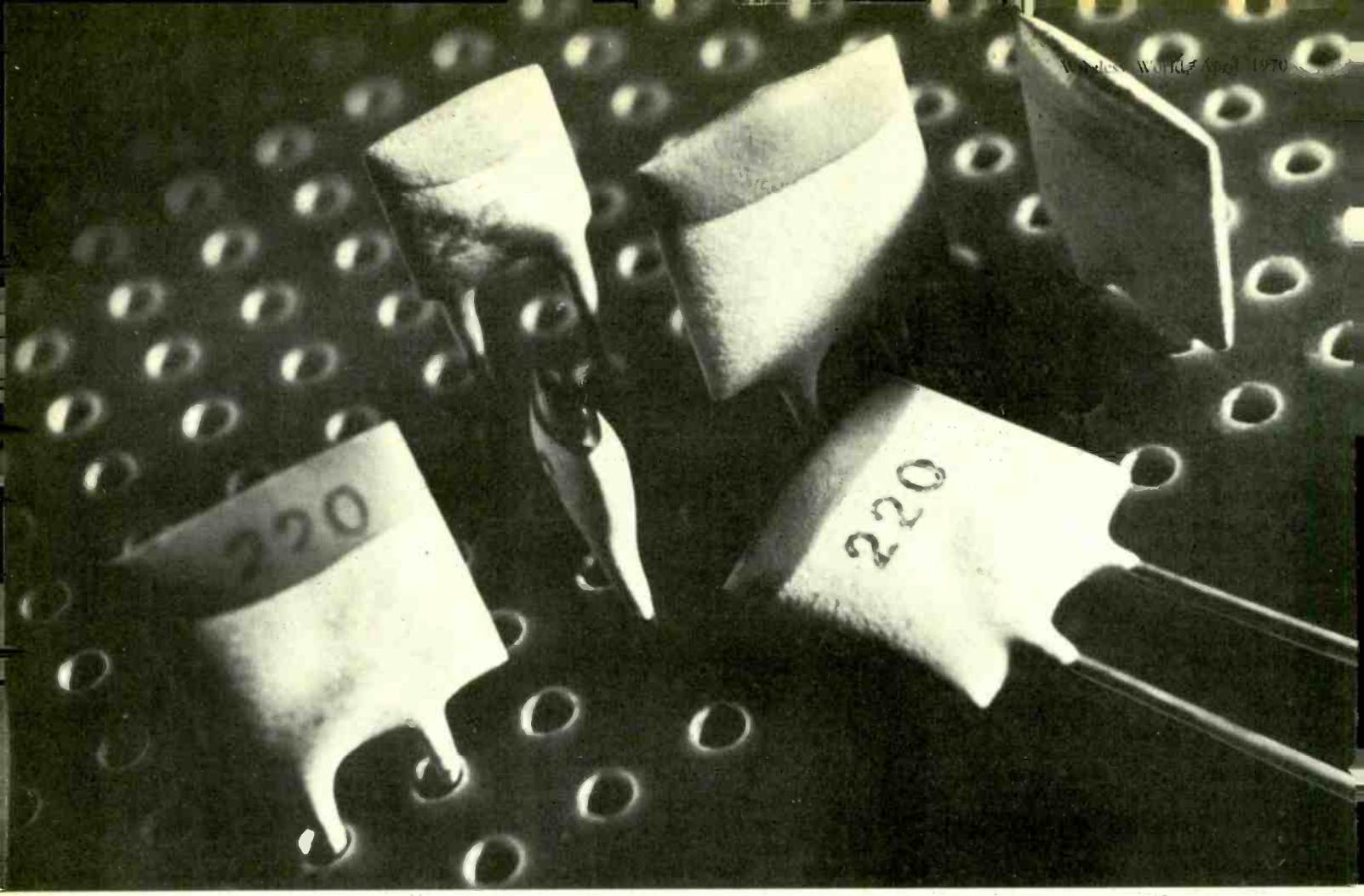
Low-cost horn loudspeaker system

Contents

ibpa
International Business Press Associates

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;* £3 0s 0d. *Overseas:* 1 year £3 0s 0d. (*Canada and U.S.A.;* $7.2). 3 years £7 13s 0d. (*Canada and U.S.A.;* $18.50). 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:* 202, Lynton House, Walsall Road, 22b. *Telephone:* 021-356 4838. *BRISTOL:* 11, Elmdale Road, Clifton, 8. *Telephone:* OBR2 21204/5. *GLASGOW:* 2-3 Clairmont Gardens, C.3. *Telephone:* 041-332 3792. *MANCHESTER:* Statham House, Talbot Road, Stretford, M32 OEP. *Telephone:* 061-872 4211. NEW YORK OFFICE U.S.A.: 205 East 42nd Street, New York 10017. *Telephone:* (212) 689-3250.



Why we are excited about the C333 range

In these fast-moving days you might wonder why we're excited about a new capacitor range. Well, sales figures tell us that a lot of circuit designers are also enthusiastic about this—the latest Mullard range of miniature plate ceramic capacitors. Setmakers have already ordered them by the million. And, as for us, we were excited about this new range long before we even sold the first one. In case you are not already using these plate ceramic miniature capacitors, let us tell you (enthusiastically) something about them.

They're small. Well, of course. This is the mini age. Naturally, we designed them to fit a 2.45 mm. grid printed circuit board. But we also made them rectangular and thin (2.1 mm. max.). In fact they are no bigger than the winder on your wrist-watch, so that they can pack very closely.

Wide range. This is something to be enthusiastic about. For the first time, circuit designers have available a wide range of low-cost, high stability, close tolerance miniatures to choose from —at low prices. The full range (at present) has 28 values in five sizes from 1.8pF to 330pF (the E6 range). With temperature coefficients between NP0 and N750 the stability of tuned circuits can be maintained over a wide temperature range— this is the C333 series.

High quality: low cost. These two conflicting objectives provided their own solution. In the first place we chose the most suitable materials for the performance and stability we required. Then we developed special, highly-automated processes to produce these tiny components within the rigid specifications we had laid down. These very efficient processes gave us the desired results; closely-controlled quality and low production costs.

Stability. This is essential for the applications for which these capacitors are intended. We developed materials which would not oxidise or peel in arduous conditions. And a special lacquer coating to protect them in conditions of high humidity. In brief, we designed in high stability and long life.

Tight tolerance. Again, the use of very stable materials and highly automated manufacturing and quality control equipment ensures that every capacitor is held within very close limits—essential for the components used in oscillator and filter stages. The tolerance on every capacitor is within 0.25pF or ±2% —whichever is the greater.

Worth it? Our rising production figures indicate that a good many people think so.

Set designers appreciate that, at Mullard we continue to apply enthusiasm and care to the manufacture of all our devices— discrete components, valves and tubes, and semiconductors. And we continue to produce exciting results.

Materials research, applications research, automated quality production and control—all backed by experience in component manufacture stretching over the history of the electronics industry. All contributed to the quality and performance of this our latest range of capacitors.

Mullard

components for consumer electronics

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

CED98

Wireless World

Technology versus Education

Technology is a means towards a better material standard of living. Education is a means towards a better quality of life. The two activities have quite different purposes. Yet they do overlap slightly at the edges, particularly in the field of vocational training. Technology needs and draws upon the resources of educated people: education depends to some extent on technology to provide subjects and stimuli for stretching the human mind.

Perhaps because of this overlap we seem to be getting into a muddle, with passions raised on all sides, about the function of some of our newer universities. The rumpus at Warwick University a few weeks ago, when students uncovered documents revealing an intimate liaison between university authorities and big business, is a case in point. The basis of the trouble seems to be that some students feel the universities are being exploited as outside R & D establishments by "the industrial-military complex". They say that the university authorities have abandoned their independence in return for "industrial-military" gold (or even silver). The rejection of technology (more so than science) by boys at school may stem from some knowledge of this situation, coupled with an association of technology with destruction, and a consequent reluctance to be treated by "them" as "technology fodder".

In electronics, of course, we know that there has long been a close collaboration between industrial firms and certain university departments. At Warwick itself, for example, the School of Engineering Science does research in microwave integrated circuits partly supported by G.E.C.-A.E.I. and Racal (and employees of these firms work in the School). The Wayne Kerr Company has endowed a chair of measurement science at Surrey University. For some years the computer department of Ferranti was almost indistinguishable (in staff and activities) from a section of Manchester University's department of electrical engineering. Mullard Southampton run an M.Sc. "bridging" course in partnership with Southampton University. Brookdeal Electronics sponsor work in the physics department of Reading University and the company's research director is a senior lecturer at the university. . . . And so on. This is all quite openly done—in fact great pride is taken in it—and whether or not it is considered sinister depends on which side of the artificial Arts-Sciences barrier one has been forced to stand. (A barrier, incidentally, which the Open University has knocked down.)

There is perhaps one small thing we can do about the emotional muddle. We may not be able to get rid of hypocrisy, snobbery and prejudices about education but we *can* decide to be honest about the verbal descriptions applied to things. *If* some of the newer establishments are not real universities (note, we are not making assertions about this) then nobody is going to be hoodwinked by the mere fact that they have been called universities. If they are really institutes of higher technology with a few Arts courses tacked on to keep the critics quiet, let them be honest in the way they describe themselves. (The Massachusetts Institute of Technology and, more recently, the Cranfield Institute of Technology are, presumably, proud of their titles.)

Ultimately, education, including *all* universities, must get its money from industry. But, for the good of the spiritual side of us, it is questionable whether this money should be transferred so directly that the philistines—and there are plenty—can insist "he who pays the piper can call the tune". Lord Radcliffe, the chancellor of Warwick University, has said as much himself.

Stabilized Power Supply

A versatile unit which will provide a variable stabilized output voltage with adjustable current limiting or a variable constant current with adjustable voltage limiting

by A. J. Ewins

The stabilized power supply to be described provides not only a fully variable, stable voltage output from 0 to 30 V at a continuous current rating of 1 A, but also a fully variable range of constant currents from 1 mA to 1 A at a maximum voltage of 45 V. In the voltage stabilized mode the constant current network provides current limiting over the same range of currents. In the constant current mode the stabilized voltage network provides voltage limiting from 0 to 30 V.

The power supply departs from convention in that the entire electronic circuitry, except the series regulator transistor, is powered by a separate voltage supply. As a result of this, no transistor, except the series regulator, need have a maximum V_{ce} rating greater than 20 V or a maximum power dissipation greater than 180 mW. This enables the constructor to select the transistors needed for the electronic stabilizing circuitry from the ever growing range of cheap, plastic encapsulated, silicon planar devices.

Although the maximum stabilized voltage provided by the power supply is only 30 V, it can easily be modified to provide an output voltage greater than this; the maximum value being dependant mainly on the V_{ce} rating of the series regulator transistor used. (The 2N3055 has a V_{ce} of 100 V max.) However, it is likely that the maximum current drawn from the supply would have to be reduced since a power dissipation of 100 watts (within the capabilities of the 2N3055) would call for an excessively large heat sink.

Circuit Description

Before proceeding to a description of the circuit it will prove useful to show how the power supply departs from convention. Fig. 1 shows a fairly conventional stabilized power supply circuit. The output voltage, V_o is given by; $V_o = (R_v/R_k) \cdot V_r$ and is directly proportional to R_v if V_r and R_k are kept constant. Keeping R_k constant has the advantage that the sensing current, I_v, drawn by the potential divider, R_v and R_k, remains constant for all output voltages, thus the current through the zener reference diode remains constant also, helping greatly towards the stability of the reference voltage. Looking now at Fig. 2 it will be seen that the circuit is similar to that of Fig. 1 in principle, however, the difference amplifier and the first two transistors of the series regulator triplet, Tr_2 and Tr_3, are now powered by a separate voltage supply. The reference voltage is now a positive one since, due to the rearrangement of the circuit, a negative output voltage (with respect to the zero voltage line) is being regulated.

With this rearrangement of the circuit Tr_2 and Tr_3 do not have to withstand the full unregulated power supply voltage when supplying an output voltage of zero volts, with a consequent reduction in the maximum power dissipation required of Tr_2. If the series regulator, Tr_1, has a current gain of 30 at a collector current of 1 A, then Tr_2 must be capable of supplying 33 mA for a maximum output current of 1 A. In Fig. 1, Tr_2 would have had to have supplied this current at a maximum V_{ce} of about 35 V with a consequent maximum dissipation, when the output from the power supply is 0 V at 1 A, of $35 \times 33 = 1{\cdot}15$ W. In Fig. 2 the dissipation of Tr_2 under similar conditions is:

$$33(V_s - V_{eb1} - 33 \cdot R_s).$$

With V_s = 13 V (under load conditions), R_s = 270 Ω and V_{eb1} of the order of 0·6 V the dissipation in Tr_2 is about 133 mW. However, in Fig. 2, the dissipation of Tr_2 is a maximum when its collector current equals $(V_s - V_{eb1})/2R_s$ which, in the above example, equals 23 mA. Thus maximum dissipation in Tr_2 is 142 mW.

The addition of a number of components in Fig. 3 limits the output current in the event of a short circuit or similar overload. When the output current is less than the value of the limiting current, the current flowing into the base of Tr_3 is controlled by the "voltage" difference amplifier, thus maintaining a stable output voltage. When the current flowing through R_c (which is equal to the output current, I_L, plus I_{b1} and I_v) is such that the voltage developed across R_c is equal to $V_{r1}[R_2/(R_1 + R_2)]$ the "current" difference amplifier takes

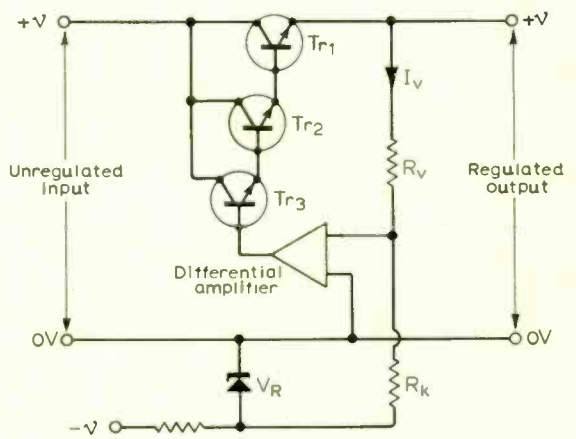


Fig. 1. A conventional stabilized power supply.

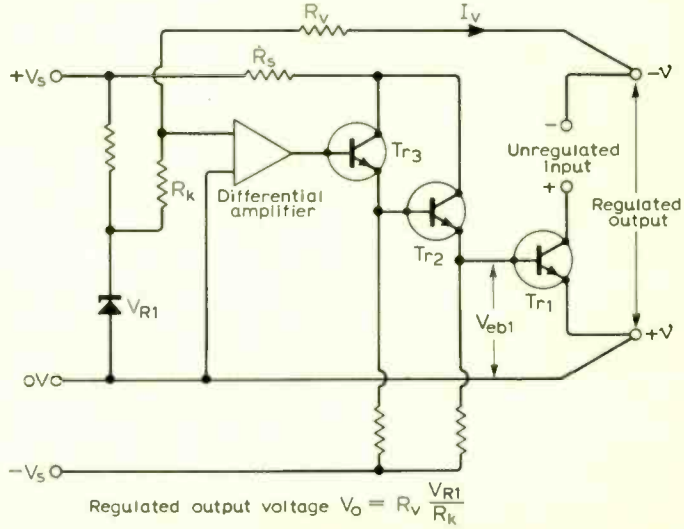


Fig. 2. Using a separate supply line for the stabilizer circuitry.

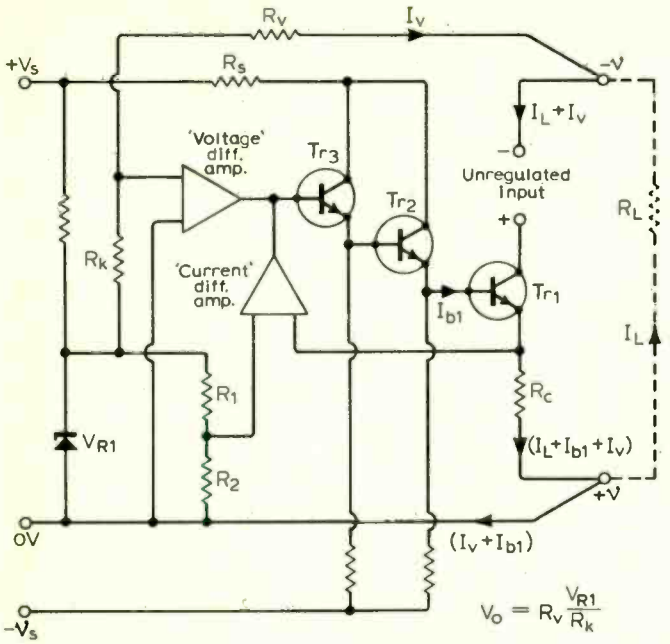


Fig. 3. Adding current limiting.

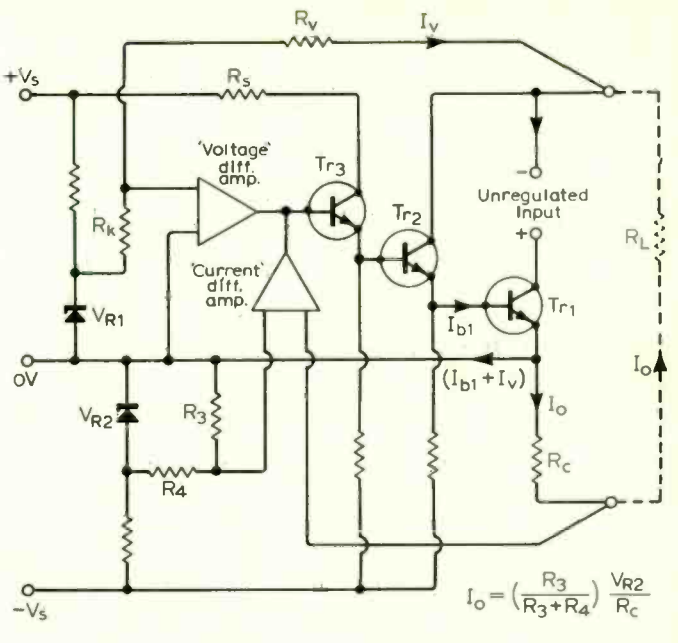


Fig. 4. Using the circuit to supply constant currents.

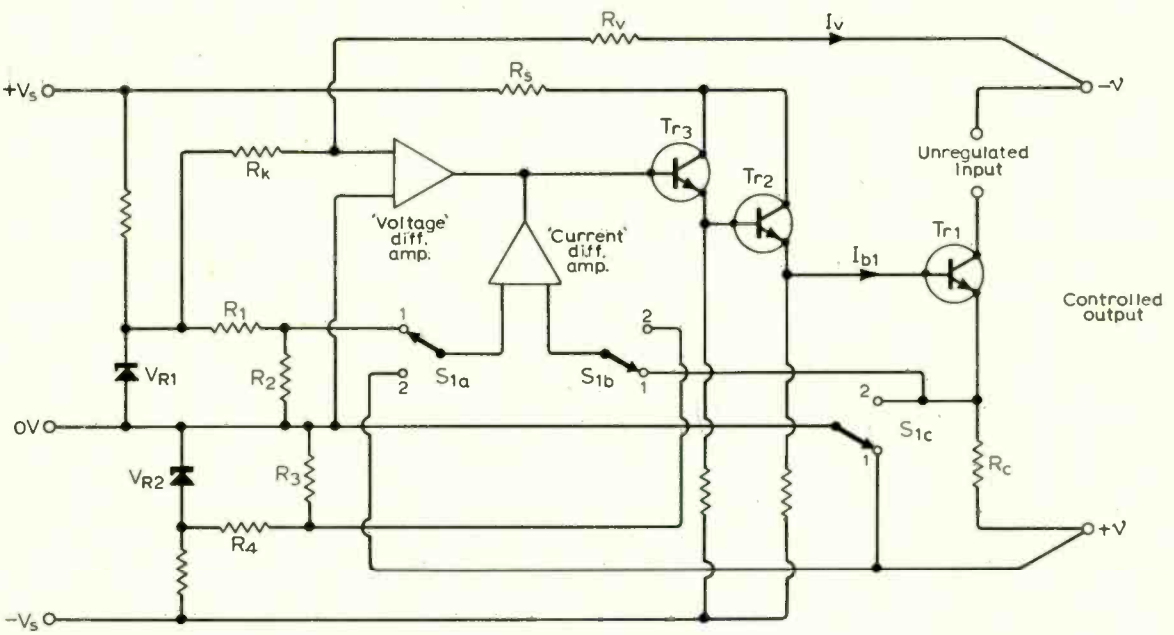


Fig. 5. Combining the circuits of Figs. 3 and 4 to provide a choice between a stabilized voltage output with current limiting or a constant current output with voltage limiting.

over control of the current flowing into the base of Tr_3 with the result that the output voltage is adjusted to maintain a constant current through R_c.

The output current is thus limited to a value given by:

$$[R_2/(R_1+R_2)]V_{r1}/R_c - I_{b1} - I_v$$

now $[R_2/(R_1+R_2)]V_{r1}/R_c$ is equal to the emitter current of $Tr_1(I_{e1})$ and

$$I_{e1} = (\beta_1+1)I_{b1}$$

where β_1 is the current gain of Tr_1. Therefore:

$$I_{b1} = I_{e1}/(\beta_1+1) \quad \text{and}$$
$$I_L = [\beta_1/(\beta_1+1)][R_2/(R_1+R_2)]V_{r1}/R_c - I_v$$

Thus, provided that β_1 is very much greater than 1 and does not vary greatly with the voltage drop across Tr_1, and I_v is very much less than I_L, then I_L is approximately limited to a value:

$$V_{r1}/R_c[R_2/(R_1+R_2)]$$

In order that a range of constant currents may be provided the circuit of Fig. 3 must be rearranged in such a way that the voltage developed across R_c is directly proportional to I_L. Fig. 4 shows such a rearrangement. Whereas, in Fig. 3, R_c was effectively in the emitter line of Tr_1, it is now effectively in the collector line of Tr_1. The currents I_{b1} and I_v do not now flow through R_c and the constant output current, I_o, is given exactly by the expression:

$$I_o = (V_{r2}/R_c)[R_3/(R_3+R_4)].$$

In this circuit, should the constant current fall below the value:

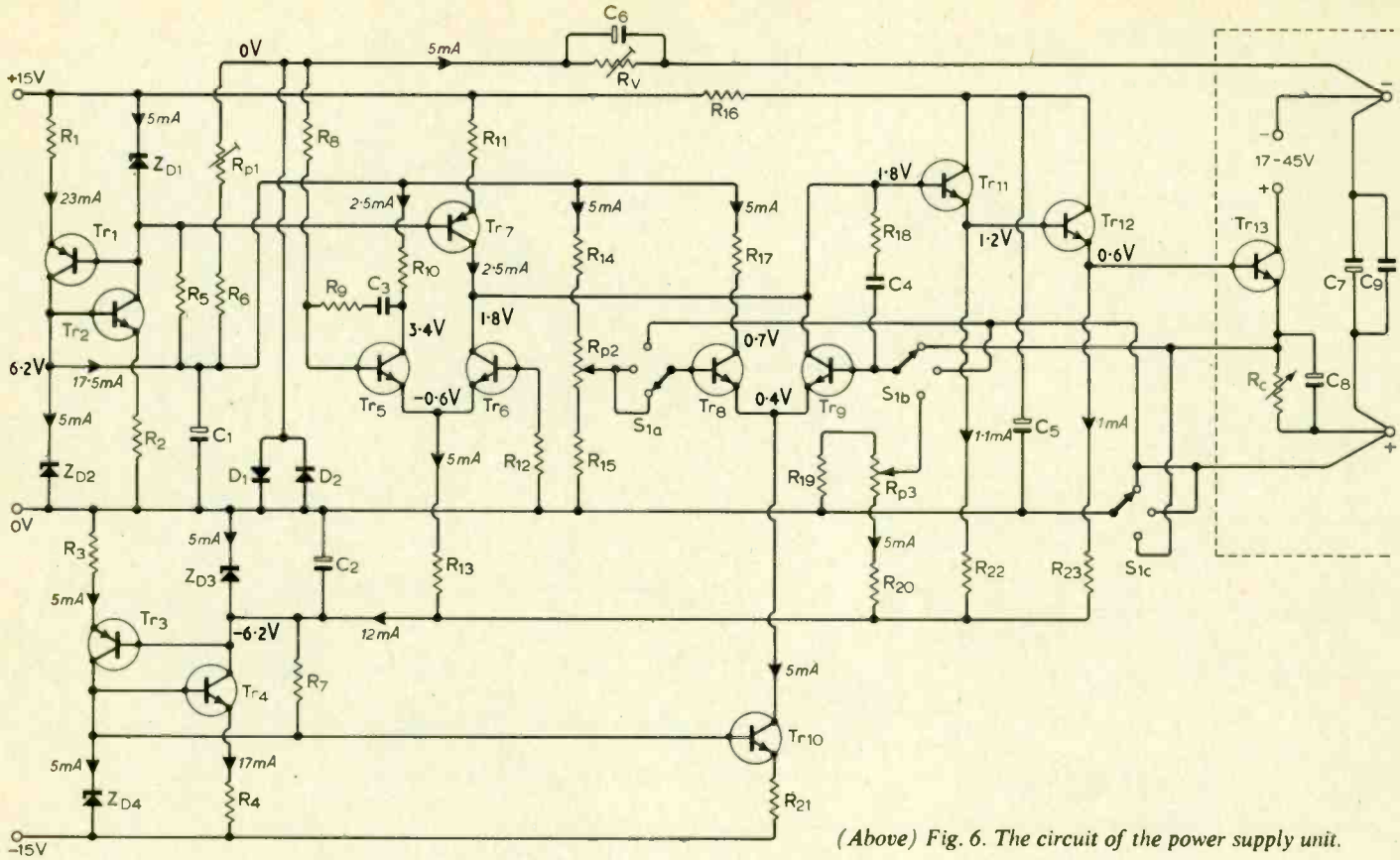
$$(V_{r2}/R_c)[R_3/(R_3+R_4)]$$

the "current" difference amplifier will lose control of Tr_3 base current to the "voltage" difference amplifier. In this event, the output voltage will be adjusted to a value equal to:

$$R_v \cdot (V_{r1}/R_k) - I_L R_c$$

and when the output is open circuited (I_L becoming zero) will be limited to a value $R_v \cdot (V_{r1}/R_k)$.

Fig. 5 is a combination of Figs 3 and 4 and includes the addition of switch S_1 called the "mode" switch. With the mode switch in



(Above) Fig. 6. The circuit of the power supply unit.

position 1 the output voltage is stabilized and the output current limited.

$$V_o = R_v \cdot (V_{r1}/R_k)$$
$$I_L = (V_{r1}/R_c)[R_2/(R_1+R_2)] \cdot (\beta/\beta_1+1) - I_v$$

where $I_v = (V'_o+V_{r1})/(R_v+R_k)$

and $V'_o = R_I \cdot I_L$ is less than V_o

With the mode switch in position 2 the output current is kept constant and the output voltage limited.

$$I_o = (V_{r2}/R_c)[R_4/(R_3+R_4)]$$
$$V_L = R_v(V_{r1}/R_k) - I'_o \cdot R_c$$

where $I'_o = V_L/R_L$, is less than I_o

Fig. 6 shows the electronic stabilizing circuitry of the power supply, as illustrated in simplified form in Fig. 5. The principle of operation is precisely as previously described, but with a considerable amount of circuit sophistication to improve the performance. The transistor pair, Tr_5 and Tr_6, is the voltage difference amplifier and the transistor pair Tr_8 and Tr_9 is the current difference amplifier. The common collector load of Tr_6 and Tr_9 is made to appear very high by employing a constant current source, provided by Tr_7, instead of the usual resistor. Similarly, the emitter load of the current difference amplifier is replaced by a constant current source, provided by Tr_{10}. When switching from the voltage stabilizing mode to the constant current mode the emitter voltages of Tr_8 and Tr_9 vary from +0·4 V to −1·6 V, a change of 2 V. As it is desirable to keep the emitter current at the same value in either mode (for balanced operation of Tr_8 and Tr_9), this could have been achieved by switching in alternate values of emitter resistor. However, providing a constant current source was considered the better (if not cheaper) solution.

The two major reference voltages, V_{r1} and V_{r2}, are provided by the zener diodes, ZD_2 and ZD_3. The currents through these two zener diodes are kept constant because the collector currents of Tr_1 and Tr_4 are constant by design as are the currents flowing away from the diodes. The additional zener diodes used in the reference voltage circuits, ZD_1 and ZD_4, provide stable voltages to the bases of the transistors Tr_7 and Tr_{10}, which, together with their respective emitter resistors, R_{11} and R_{17}, determine the values of the constant currents provided to the collectors of Tr_6 and Tr_9 and the emitters of Tr_8 and Tr_9, as previously described.

The preset resistors, Rp_1, Rp_2 and Rp_3, allow for accurate setting

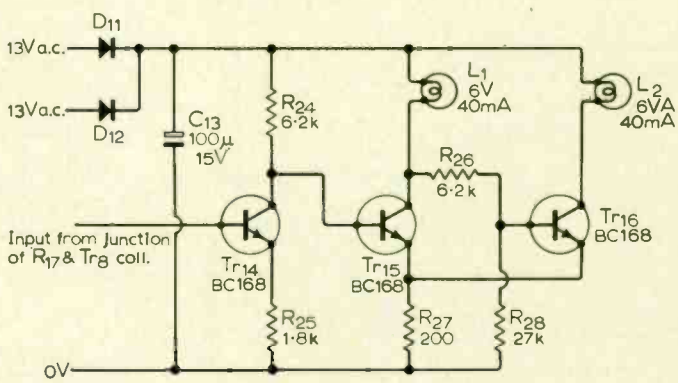


Fig. 7. Overload indicator circuit.

of the voltage, current limiting and constant current ranges.

The silicon diodes, D_1 and D_2, prevent the voltage on the base of Tr_5 from swinging beyond ±0·6 V safeguarding the transistor from possible surges in the output voltage. C_6 reduces the value of R_v to alternating signals increasing the loop gain of the amplifier and thus reducing the ripple content of the power supply. The capacitors, C_3 and C_4, reduce the loop gain of the amplifier at high frequencies, preventing instability. As a result the output impedance of the power supply rises from about 0·01 Ω at 1 kHz to 0·03 Ω at 20 kHz.

It was found necessary to include the resistors R_5 and R_7 because it was discovered that the two reference voltage circuits were not self-starting. Should trouble of this nature still be encountered, a more positive solution is to connect a resistor between the zero voltage line and the negative end of ZD_1 (or the zero voltage line and the positive end of ZD_4) dispensing with R_5 (or R_7). The value of the resistor should be such that the current flowing through it is of the order of 1 mA. This will, naturally, degrade the performance of the reference voltage circuit, but not very seriously.

An additional feature of the power supply is the provision of a current or voltage overload indicator. The circuit of the indicator is shown in Fig. 7. In the voltage stabilized mode, with no current limiting, the collector voltage of Tr_8 is a little above zero volts with the result that lamp L_1 will be normally lit. When current limiting takes place the collector voltage of Tr_8 rises to about 3 V, which is sufficient to turn lamp L_1 off and lamp L_2 on, indicating a current overload. In the constant current mode the operation of the indi-

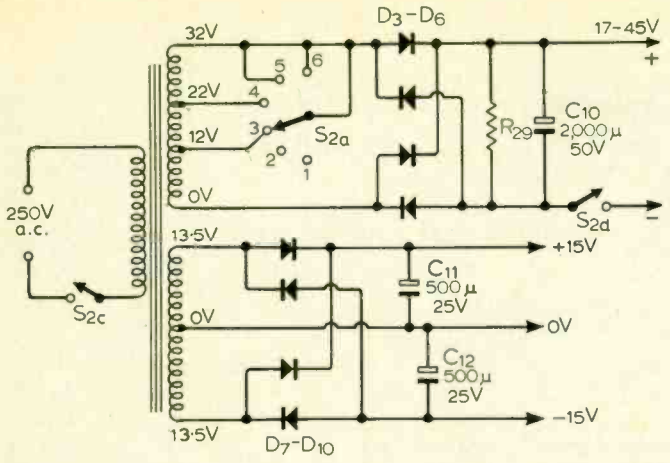


Fig. 8. The d.c. supply circuits.

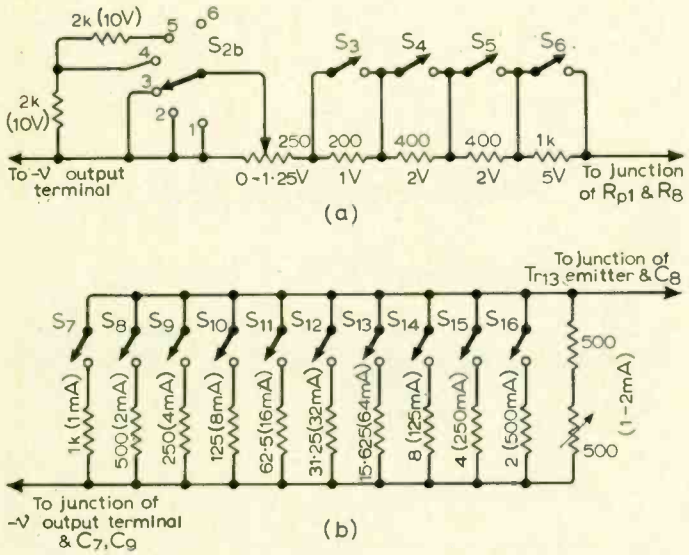
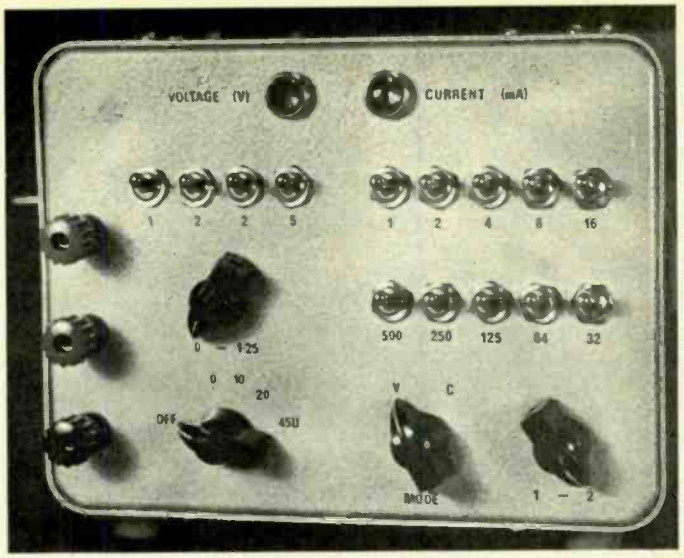


Fig. 9. (a) Construction of R_V; (b) Contruction of R_C.



Front panel of the completed prototype.

Specification

Voltage ranges:	0 to 30 V in switched steps of 1 V, plus 0 to 1·25 V fully variable.
Current ranges:	1 mA to 1 A in switched steps of 1 mA, plus 1 to 2 mA fully variable.
Voltage limiting:	Operative on stabilized current output; limits voltage across the external load from 0 to 30 V.
Current limiting:	Operative on stabilized voltage output; limits output current from 1 mA to 1 A.
Setting accuracy:	1% on all switched voltage and current ranges.
Stability:	10% mains variation—less than 0·1% on all voltage and current ranges. Voltage output—no load to full load—less than 0·1%. Current output—0 to 30 V across load—less than 0·1%. Temperature variation—dependent upon temperature coefficient of zener diodes.
Output Impedance:	(Voltage stabilized mode—no current limiting) 0·01 Ω at 1 kHz to 0·03 Ω at 20 kHz.
Voltage ripple:	(Voltage stabilized mode) 2 mV peak-to-peak on full load.

cator circuit is reversed. L_2 is normally on, indicating a constant current output, and goes off, L_1 coming on, when the output current falls below the "constant" value, indicating voltage limiting. Thus, together with the position of the mode switch, the lamps L_1 and L_2 provide an indication of the operating conditions of the power supply. The voltage supply for the circuit of Fig. 7 is taken directly from the two 13·5 volt a.c. tappings on the mains transformer.

Fig. 8 shows the circuit diagram of the two voltage supplies. A word of explanation is necessary about the OFF/ON-Voltage Select switch, S_2. The two wafer banks, S_2(a) and S_2(b) (see Fig. 9(a) are self-explanatory, save the S_2(a) should be a break-before-make wafer and S_2(b) a make-before-break wafer. S_2(c) and S_2(d) are two halves of a mains ON/OFF switch operated by the 6-way rotary switch. The two halves are open in position 1 and closed in positions 2 to 6. The OFF/ON-Voltage Select switch provides the following functions:

(1) All supplies off. (2) Stabilizer circuitry on—unregulated voltage supply off. (3) All supplies on—unregulated voltage output 17 V max. —0 to 11·25 V stabilized output available. (4) Ditto Position 3 except that unregulated voltage output 31 V max.—stabilized voltage output 10 to 21·05 V. (5) Ditto Position 3 except that unregulated voltage output 45 V max.-stabilized voltage output 20 to 31·25 V. (6) Unregulated output voltage of 45 V available at output terminals.

The inclusion of position 2 can be better understood by considering what happens when the power supply is switched off. If the power supply is operating with the OFF/ON-Voltage Select switch in position 3, the output voltage will be determined by the position of the four toggle switches and the variable control. On switching to position 2, the unregulated voltage supply is switched off and—depending on the stabilized output voltage set, the size of the external load and the reservoir capacitor, C_{10}—the voltage provided by the unregulated supply will stay above the value of the stabilized output voltage for a short time. However, the stabilizing circuitry is still on so that the stable output voltage, V_o, will be maintained until the voltage across C_{10} falls below a value a few volts greater than V_o. If the stabilizing circuitry was switched off at the same time as the unregulated supply, it would be quite possible for the voltage at the output terminals to rise, for a short time, above the value V_o. As an extra precaution, S_2(d) is included in the negative line of the unregulated supply making it impossible for an output voltage to appear at the terminals when the OFF/ON-Voltage Select switch is finally turned to position 1. Including position 2 also ensures that the stabilizing circuitry is operating before the unregulated supply is switched on, again preventing a possible surge in the output voltage should the stabilizing circuitry fail to control the output level immediately.

Fig. 9(a) shows the construction of R_v as used in the prototype power supply. The sensing current, I_v, flowing in the voltage feedback line was designed to be 5 mA. Thus the resistance of R_v is 200 Ω/V.

Fig. 9(b) shows the construction of R_c. For current limiting and the constant current supply, the voltage across R_c is stabilized at 1 V

(it is, in fact, a little higher than this when current limiting because the current flowing through the external load is fractionally lower than that through R_c). The limiting and constant current values are thus determined by dividing 1 V by R_c. Thus I_L and I_o equal $1/R_c$. Switching the ten individual values of R_c in and out provides a range of currents from 1 mA to 1 A. An additional fully variable range from 1 mA to 2 mA is provided by a wire-wound variable resistor connected in series with a fixed one of the same value.

The methods of constructing R_v and R_c have already been discussed but a word about the components may prove useful. 1%, high-stability, carbon resistors of 1 watt rating were used for all the standard values of resistance. The "odd" valued resistors were 1%, wire-wound, 1 watt types, available, to order, from the Planet Instrument Co., 25(E) Dominion Avenue, Leeds, 7.

The mains transformer used was a Douglas, type MT.3AT with rewound secondaries. The original secondary, 0–30 V, multi-tapped and rated at 2 A was removed, carefully noting the number of turns per volt. One secondary, providing 0–12–22–32 V at 1 A, was wound using 19 s.w.g. enamelled copper wire; the other secondary was wound using 33 s.w.g. enamelled copper wire to provide 13·5–0–13·5 V at 50 mA.

The two transistor pairs, Tr_5 and Tr_6, and Tr_8 and Tr_9, of the "voltage" and "current" difference amplifiers were mounted in individual heat-sinks, constructed from $\frac{1}{2}'' \times \frac{1}{4}''$ brass bar, to improve the long-term stability of the power supply.

The series regulator transistor, Tr_{13}, was mounted on a large, finned heat-sink attached, on the inside, to the back of the power supply cabinet.

Components List

Resistors

The prefix *R* and the suffix Ω has been omitted from components in the list below for clarity.

1—160	2—1·1 k	3—1·1 k	4—240
5—560	6—1·1 k	7—560 k	8—680
9—1·1 k	10—1·1 k	11—1·5 k	12—680
13—1·1 k	14—1 k	15—180	16—270
17—1·1 k	18—1·1 k	19—180	20—1 k
21—820	22—6·8 k	23—6·8 k	24—6·8 k
25—1·8 k	26—6·2 k	27—200	28—27 k

29—2·2 k, 1 W, 10%
all 0·25 W, 5%, carbon except where shown

p1—200	p2—50	p3—50

wirewound preset potentiometers

Capacitors

The prefix *C* has been omitted in the list below

1—25 μF, 12 V working electrolytic
2—25 μF, 12 V working electrolytic
3—0·001 μF disc ceramic
4—0·001 μF disc ceramic
5—8 μF, 25 V working electrolytic
6—8 μF, 25 V working electrolytic
7—50 μF, 50 V working electrolytic
8—25 μF, 12 V working electrolytic
9—0·1 μF, 250 V working polyester
10—2,000 μF, 50 V working electrolytic
11—500 μF, 25 V working electrolytic
12—500 μF, 25 V working electrolytic
13—100 μF, 25 V working electrolytic

Semiconductors

The prefix *Tr* has been omitted in the list below

1—2N4289	10—BC 168
2—BC 168	11—BC 168
3—2N4289	12—BC 168
4—BC 168	13—2N3055†
5, 6—BC 109*	14—BC 168
7—2N4289	15—BC 168
8, 9—BC 109*	16—BC 168

*matched pairs
†must have a minimum gain of 30 at 1A

The prefix *ZD* has been omitted in the list below

1—4·3 V, ZB4·3	3—6·2 V, ZB6·2
2—6·2 V, ZB6·2	4—4·7 V, ZB4·7

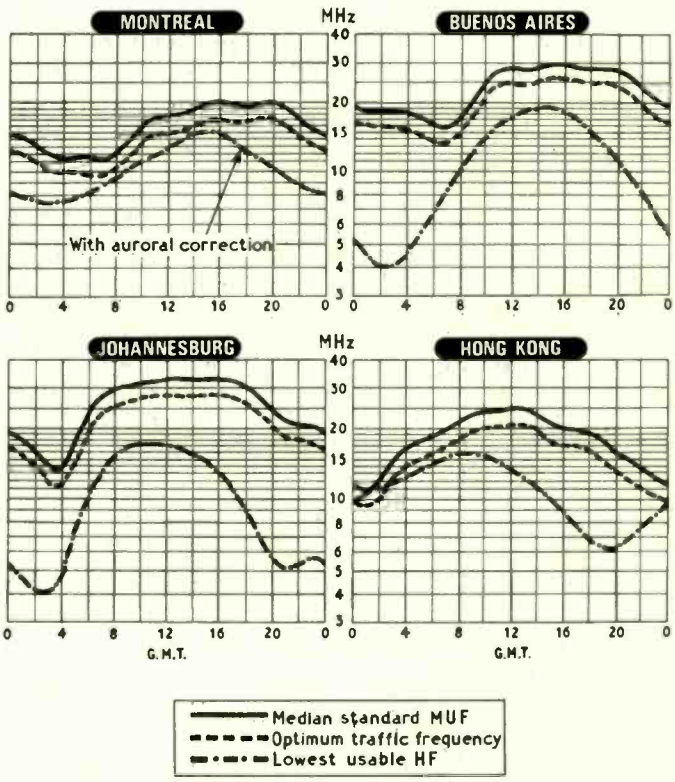
all 250 mW. S.T.C. type numbers shown

The prefix *D* has been omitted in the list below

1, 2—any silicon diode
3 to 6 any diode rated at 1 A, 100 p.i.v.
7 to 12—any diode rated at 100 mA, 40 p.i.v.

Mains Transformer: secondaries
0–12–22–32 V at 1 A
13·5–0–13·5 V at 50 mA
(see text)
6-pole, 6-way rotary switch plus mains ON/OFF switch (see text)
3-pole, 3-way rotary switch
Cabinet type-Y. G. W. Smith and Co. Ltd.
Resistors and toggle switches for constructing R_V and R_C (see text)
Two 6 V, 40 mA bulbs
Plugs, sockets, Veroboard, heatsink ($4'' \times 4\frac{5}{16}''$), etc.

H.F. Predictions—April



The predictions are based on an ionospheric index of 96, the corresponding sunspot number being 83. These are slightly lower than the observed values for 1968 and 1969.

The trans-equatorial paths have their highest MUFs during equinox months and conditions should be good above 20MHz. Evening fading is relatively independent of season and cycle on the South African route but is worse during this period on others. The Far East will have weak unstable signals from midnight to 09.00 G.M.T. and North America will be liable to several days of weak signals from 06.00 to 16.00 G.M.T. The MUFs shown apply to both directions of the route while LUFs are for reception in the U.K. only.

Low-angle Radiation

Describing how long-distance propagation can be improved by exploiting the natural terrain

By L. A. Moxon, B.Sc., M.I.E.E.*

Since first hearing transatlantic morse signals in the early years of short-wave radio, the author has been fascinated by communication over long distances using low-power. This interest has been maintained by the frequent emergence of new and intriguing problems. In particular, by the discovery, when resuming amateur activities after the war from a new location, that communication was easy with Australia but almost impossible with anywhere else. Further, when Australian signals were at their best South Americans were usually weak or absent, clearly inconsistent with the usual theory of long-distance propagation by means of multiple earth-ionosphere reflections.

These mysteries were resolved by a process which stressed not only the importance of low-angle radiation, but also the need for more information on what constitutes a "low angle". A study of two medium-length east-west paths[1] has concluded that for these paths angles as low as 1 deg. are desirable, but for the most part quantitative data is in short supply.

Recent speculation[2] has suggested dramatic possibilities from the use of very low angles of radiation, perhaps even less than 1 deg., and it was with somewhat similar ideas in mind that a low-power (1W output), transistor s.s.b. transceiver was designed and built, light enough to be carried complete with aerial system up steep mountainsides.

**Amateur station G6XN*

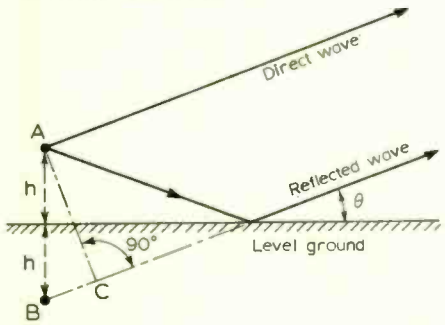


Fig. 1 When a horizontal aerial is erected at a height h over level ground, its image B is an antiphase. The direct and reflected waves are in phase at a distant point when BC = λ/2, i.e. when 2h sin θ = λ/2 where θ is the angle of radiation.

It was hoped in this way to achieve efficient radiation at the desirable low angles whatever these might be, by exploiting natural ground features. An earlier exercise, complementary to this, was aimed at maximising the low angle radiation obtainable from a flat site with limited aerial heights, accepting the inevitable low efficiency and consequent need for relatively high power, to produce a given signal level.

On the basis of these experiments, and such information as can be found in the literature, solutions have been sought to the following problems:

(a) How to select the best site for an h.f. aerial, for communicating with low power over distances of 3,000 miles or more.

(b) How to make the best use of a given site.

The discussion which follows does not necessarily apply to commercial h.f. circuits for which 24-hour availability is likely to be more important than good results over shorter periods.

Avoidance of cancellation

The difficulty of achieving low angles of radiation arises from cancellation of the direct signals by the ground-reflected wave as shown by Fig. 1. This can, in principle, be prevented by one or more of the following procedures:

(a) Using a high mast so that the path difference for the two rays is $\lambda/2$, which then add in phase giving 6dB gain relative to free-space propagation. For 14 MHz and a radiation angle of 1 deg. this requires a mast height of 1,000ft, which is unlikely to be popular with the neighbours.

(b) Using a steep ground slope, as in Fig. 2. If the slope is 45 deg. a height of only 25ft is required at 14MHz to bring the direct and reflected waves into phase. This height is not critical and only 3dB is lost by dropping the height to 12ft 6in. or raising it to 3ft 6in. Moreover, there is the advantage of a single broad lobe in the vertical plane, whereas a large height as in Fig. 1 produces an interference-pattern with lobes and nulls alternating at 1 deg. intervals. The best angle of radiation is not necessarily always the lowest, and the optimum may well coincide with a null. So far all this is well known, but most references overlook the fact that the slope has to end somewhere. As first pointed out by Norton and Omberg[3] this has important consequences, of which more later.

(c) With vertical polarization and perfectly-conducting ground, the phase of the reflection coefficient is reversed and efficient low-angle propagation is achieved independently of aerial height. This can be approximated by laying down a conductive earth-mat of sufficient extent. A beam aerial designed on this principle[4] has been found to operate under radio conditions which render conventional equipment useless. The installation uses an earth mat 1,800ft long and 832ft wide, containing 25 miles of copper wire. Such a system is obviously beyond amateur resources, but sea-water is sometimes available and is a good-enough conductor to act as a useful (though not ideal) substitute.

(d) With vertical polarization and imperfect ground there is a "pseudo-Brewster angle", below which the phase of the reflection coefficient is reversed, so that for low angles and moderate or large aerial heights there is little to choose between vertical and horizontal polarization. In the vertical case, however, the reflection coefficient is less than unity so that cancellation is imperfect and some low angle radiation takes place, however, low the aerial. This principle has been exploited to produce a very effective, cheap and easily-erected beam for 7MHz, as described later.

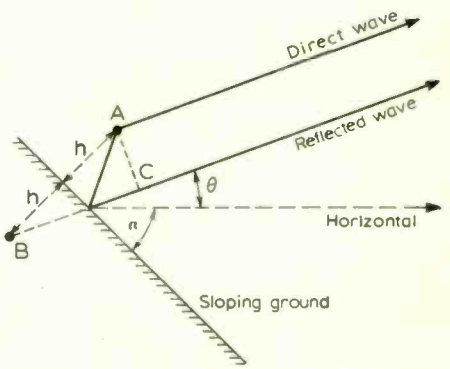


Fig. 2 With the aerial at a height h above ground sloping at an angle α, the direct and reflected waves are in phase when 2h sin (α + θ) = nλ/2. For small values of θ this becomes 2h sin α ≈ nλ/2. This diagram is identical with Fig. 1 except for rotation through the angle α, and the increased ground angle.

Fresnel zones

Figs. 1 and 2 are oversimplified to the extent that reflection takes place not from a point but from a Fresnel zone which is defined by the fact that reflections from all parts of it tend to add in-phase.

Formulae for the sizes and required degrees of flatness of these zones are to be found in the literature[3,5]. The size of the zone for the previous example based on Fig. 1 is very large, the near edge being at $2\frac{1}{2}$ miles range, and the far edge (ignoring earth curvature) at 85 miles. As the height is reduced and the angle of maximum radiation relative to the ground increases, the corresponding Fresnel zone contracts with the far edge moving in roughly as the inverse square of the angle.

For the example based on Fig. 2 the "near edge" is 25ft behind the aerial and the far edge only 175ft down the slope. The shape is elliptical, its effective width being roughly 5 times the aerial height, and the ground need not be particularly flat. Obstacles with dimensions up to about a quarter of the aerial height are acceptable. Very long distances to the far edge (as in the first example) are reduced somewhat when due allowance is made for earth curvature[3].

Double reflections

Discussion so far has been concerned with situations which may seem ridiculous, since amateur resources have been implied and angles of 1 deg. assumed. Even if the angle is increased to 5 deg and a loss of 3dB accepted, the Fig. 1 situation would require a 100ft mast, and bottomless slopes exist only in mythology or mathematical fiction.

In practice, however, the steep slope is quite likely to sweep down like the Mountains of Mourne, or even Mull where the author conducted some experiments, to the sea, as illustrated by Fig. 3. A flat plain, however, is also a possibility and will serve equally well for the next part of this discussion.

It will be seen that there are now four waves to be considered, including two single and one double reflection, and if all these can be made to add up in phase there is a possibility of obtaining not 6 but 12dB gain compared with free-space propagation. This may appear complicated, but resolves quite simply into a practicable combination of the two situations which have just been criticised as absurd; 6dB gain being obtained from each of them.

For numerical consistency with the previous examples there is required only a sloping patch of mountainside extending for at least 25ft above and 175ft below the aerial. It should be centred on 1,000ft altitude with an unobstructed view of the sea, of which the nearest visible point should be not more than $2\frac{1}{2}$ miles away.

Since the mountain is, in effect, being used as a "tall mast", however, this entails the penalty of a multiple-lobe radiation pattern in the vertical plane (as in the case of Fig. 1 with a tall mast). So that if the appropriate angle of radiation happens

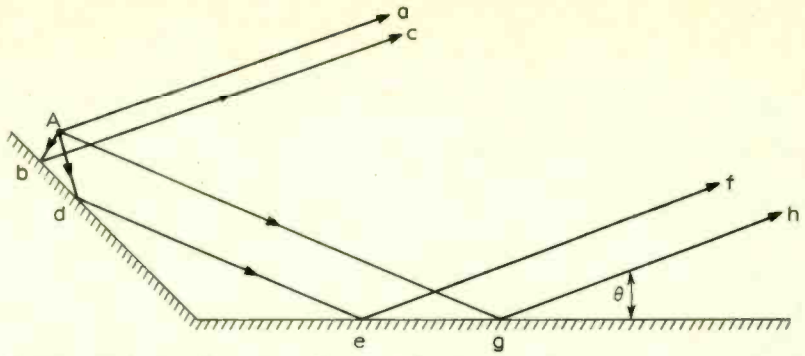


Fig. 3 Ground sloping down into the sea. The direct wave Aa, foreground reflection Abc, distant reflection Agh, and double reflection Adef add in phase if θ is small, $hg \approx \lambda/(4 \sin \theta)$, $h_s \approx \lambda/(4 \sin \theta)$, these being the heights of A above ground and sea respectively.

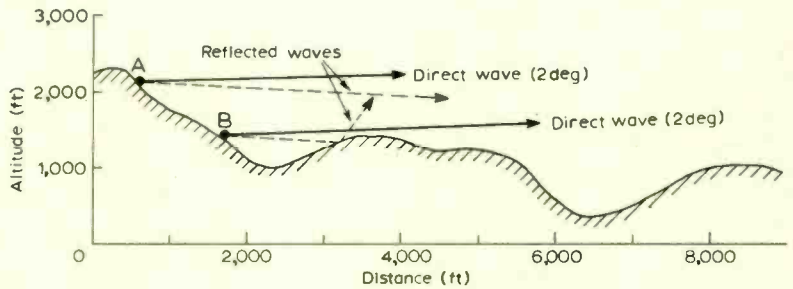


Fig. 4 Typical ground profile for mountainous country. Distant low-angle reflections are non-existent for transmitter at B, and probably unimportant (due to break up of Fresnel zones) for transmitter at A. In both cases low-angle reflections (not shown) are obtained from the foreground. (Isle of Mull, grid ref. NM 568332 bearing 104 deg.)

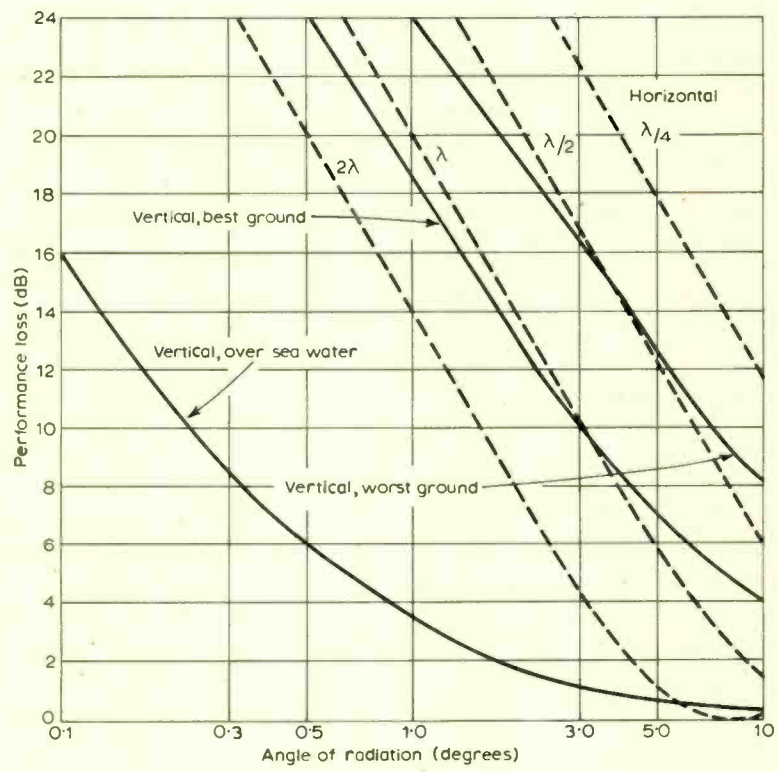


Fig. 5 Comparison of short horizontal and vertical radiators at h.f. assuming flat open country. "Zero loss" occurs with in-phase addition of the direct wave and a reflected wave of equal amplitude. Aerial heights are indicated in wavelengths for horizontal polarization (dotted curves). Vertical polarization curves are calculated for low height and a frequency of 7MHz; performance deteriorates slightly as frequency increases.

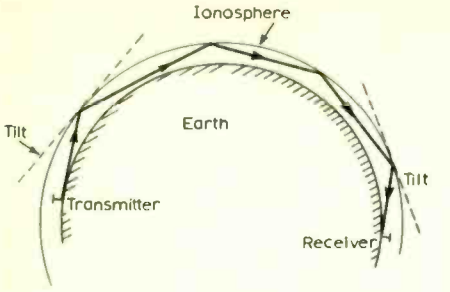


Fig. 6 Chordal hop. At the first and last reflection points, the ionosphere behaves as if tilted slightly towards the terminals. For tangential radiation (i.e. zero deg.), and tilt, however small, prevents a return to earth until a tilt of opposite sign occurs. (Ionosphere not to scale.)

to be not 1 deg. but 2 deg. signals will be almost completely cancelled and even if the operator were aware of this he would scarcely relish the idea of moving the aerial down 500ft to put the matter right. He might even prefer to sacrifice the 6dB gain obtainable from the sea reflection. But at this point it becomes appropriate to consider the situation sketched in Fig. 4.

Locations such as this are usually easier to find than those corresponding to Fig. 3 and it will be noticed that the distant reflecting areas are either blocked off by the foreground or badly broken up, thus failing to meet the required specification for the Fresnel zones. If the distant reflections are sufficiently reduced, Fig. 2 becomes after all a valid representation for the practical case and low-angle radiation should then be obtained with a gain of 6dB relative to free-space propagation.

Neglecting diffraction, this would be true for angles of elevation down to zero, assuming an aerial height of, say, 0.7 λ above any 45 deg slope 200ft in extent. For a 15 deg slope an aerial height of 2 λ and an extent of 1,800ft would be needed for the same result, but these dimensions are not critical and could probably be halved without serious loss of performance.

Polarization

With sloping ground horizontal polarization is preferable, because in the vertical case efficient use of the reflected wave is usually prevented by the Brewster-angle effect, tilting of the image, or both. In the case of flat ground, the best choice of polarization depends on the available aerial height, soil characteristics, and frequency.

Fig. 5 has been calculated from handbook data for vertical aerials above various types of ground[9] and on the basis of Fig. 1 for horizontal aerials at various heights. This provides a rough comparison between different aerials for given angles of radiation and soil conditions assuming, in the vertical case, heights low enough for the effect illustrated by Fig. 1 to be negligible.

In using these curves two points should be noted. Where horizontal polarization appears to be better, equally good results could usually be obtained with vertical aerials by raising them to the same height. The vertical aerial is then likely to be the more difficult of the two to support and feed. On the other hand height is usually the main problem in aerial construction. Horizontal supporting wires for vertical elements can be used to provide end-loading which allows considerable reduction of vertical length and, therefore, height.

Although the useful energy radiated per element is rather small, it is often easier at the lower frequencies to construct, say, a 5- or 10-element vertical array in this manner than to put up a horizontal dipole at a height which would give comparable performance.

Fig. 5 shows the possibility of radiation at 0.5 deg. elevation with a loss of only 6dB by using vertical aerials surrounded by sea water, which may appeal to amateur enthusiasts with portable transceivers and a preference for paddling rather than mountain climbing.

Experimental results

The good results at 14MHz in the direction of the long path to Australia mentioned earlier, were attributable to a steep ground slope (22 deg.) in that direction. Aerial height was only 23ft which was adequate for the down-slope direction, but resulted in poor propagation in the opposite direction even for short ranges.

The use of a full-wave dipole, later backed by reflectors, produced a narrow azimuthal pattern, thus discriminating against directions other than towards Australia. Comparative tests were carried out over several years with the cooperation of numerous Australian stations plus a local amateur (G3DVM), whose location was more conventional, his aerial being located at a height of $\lambda/2$ over flat ground.

Comparative reports, allowing for power differences and assuming 6dB per S-point, usually indicated an advantage of about 8dB in favour of the author's location and aerial system. Referring to Fig. 5, the loss for 6 deg. elevation at G3DVM would be 10dB, and a loss of 2dB would be applicable to G6XN for the same angle, which would, therefore, be the "most probable". It was noticed, however, that quite often the path remained open longer at G6XN with signal-strength differences reaching 20dB or more. This would be consistent with radiation angles in the region of 1-2 deg. On other occasions the advantage in favour of G6XN almost disappeared, suggesting angles in excess of 10 deg.

It is interesting to note that good conditions on the long path to Australia occur when the path is mainly in darkness, and complementary ionospheric tilts might be expected at each end of the circuit due to the darkness-daylight transition. This leads to the chordal hop mode of propagation first described by Albrecht[6,7] depicted in Fig. 6, in which waves travel by successive F-layer reflections without intermediate ground reflection.

Note that the lower the angle at which the ray strikes the ionosphere, the less likely it is to be reflected back to earth. Similar modes of propagation occur frequently on other long-distance paths especially north-south paths[8]. Because of reduced D-layer absorbtion and ground-reflection losses, these modes tend to produce very high signal levels over very long paths.

Tests with the portable s.s.b. transceiver have been carried out from steep ground slopes, using an inverted-V dipole having its centre propped up to a height of 20-25ft and about 1W of peak r.f. power. Attempts to communicate with Australia over the long path were made from six different locations having features typified by Figs. 3 or 4, with success in every case. The inverted-V dipole when erected over ground sloping at angles of 30-40 deg. appeared roughly equivalent to a Quad aerial at the home location erected at a height of 50ft, although direct comparison was not possible.

This result is consistent with the previous estimate of a 6-deg. angle of radiation since, from Fig. 5, a loss of 7½dB would be expected for the Quad despite its greater height, but this would be offset by an estimated 6dB or so of aerial gain. Insufficient results have so far been obtained to establish the practical advantage, if any, of using distant as well as foreground reflections on the lines of Fig. 3.

These tests were conducted in the 14MHz amateur band, but other contacts were made with Australia on 21MHz (short path), and with North America on 28, 21 and 14MHz. In these cases also, the combination of portable dipole plus steep ground slope appeared roughly comparable with the home "Quad". This was judged by the degree of difficulty in establishing contacts.

Fig. 7 shows one of the two "bays" of a

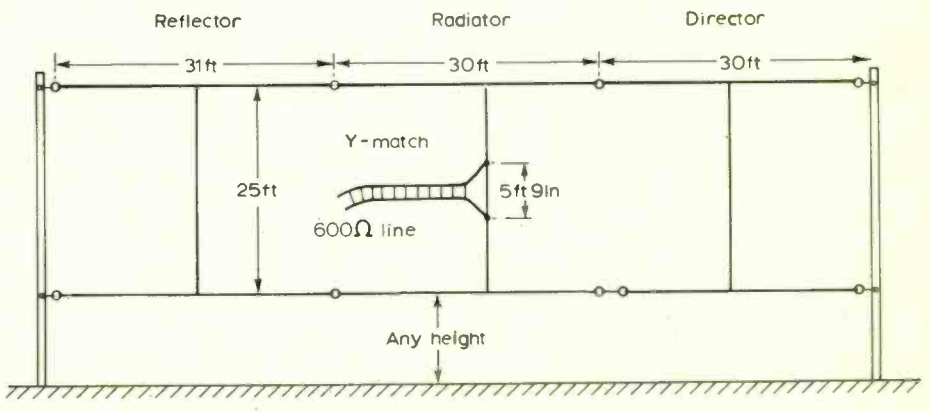


Fig. 7 Low-angle aerial for 7MHz. Height not critical. Reflector and director tunable, by adjusting length of verticals or of the lower horizontal wires. Dimensions approximate.

6-element 7MHz beam using short end-loaded vertical elements with the lower ends about 2ft from the ground. Results over the long path to Australia included good DX contest scores and, on one occasion resulting from failure of the main transmitter, two contacts with only 5 watts of peak r.f. power (s.s.b.). Fig. 5 suggests that for an angle of 6 deg., a vertical array having 6dB gain and located over average ground should be roughly equal in low-angle performance to a dipole at a height of $1\frac{1}{2}\lambda$ or a Quad at $\frac{3}{4}\lambda$.

Relative to typical aerials at a height of 50ft the vertical array would, therefore, be expected to do much better at 7MHz and be roughly equal at 14MHz; the latter estimate has proved to be over-optimistic since results, though good on 7MHz, averaged about 6dB down relative to the Quad at 14MHz.

Conclusion

From most locations it is difficult with simple aerials to achieve efficient radiation at angles below 5 or 10 deg. Attempts to reduce the angle lead to rapid escalation of cost and practical difficulties, and the difficulty of making cost-effective decisions is aggravated by lack of such information as how low an angle is desirable, and for what percentage of the time. On the other hand, given freedom in choice of location, a low angle of radiation is readily achievable by exploitation of natural ground features and is within the means of amateurs equipped with portable apparatus, and a set of Ordnance survey maps.

Much could also be learned from comparative tests from a number of fixed locations having different ground characteristics and various types of aerial.

REFERENCES

1. N. F. Utlaut, "Effect of Antenna Radiation Angles upon H.F. Radio Signals Propagated over Long Distances." *Journal of Research of the National Bureau of Standards*, Vol. 65D No. 2, p. 167 March/April, 1961.
2. "Technical Topics," *Radio Communication*, p. 394, June, 1969.
3. K. A. Norton and A. C. Omberg, "The Maximum Range of a Radio Set," *Proc. I.R.E.*, Vol. 35, p. 17, 1947.
4. J. F. Ward, "A Low Delta, Surface Wave, Interferometer Array for High-Frequency Radio Communication," *Nature*, Vol. 205, p. 1062, March 13, 1965.
5. D. K. Bailey, R. Bateman and R. C. Kirby, "Radio Transmission at V.H.F. by Scatterers in the Lower Ionosphere," *Proc. I.R.E.*, Vol. 48, p. 1226, Oct. 1955.
6. H. J. Albrecht, "Further Studies on the Chordal-Hop Theory of Ionospheric Long-Range Propagation," *Archiv fur Meteorologie, Geophysik und Bioklimatologie*, Serie A, Vienna 1959 (Springer Verlag), p. 84.
7. H. J. Albrecht, "Investigations on Great-Circle Propagation between Eastern Australia and Western Europe," *Geophys. pura e applicata*, Vol. 38, pp. 169-180, 1957.
8. S. Stein, "The Role of Layer Tilts in Ionospheric Radio Propagation," *J. Geophys*, Vol. 68, p. 217, 1958.
9. F. E. Terman, *Radio Engineers' Handbook*, pp. 700-709, McGraw Hill Book Company Inc., 1943.

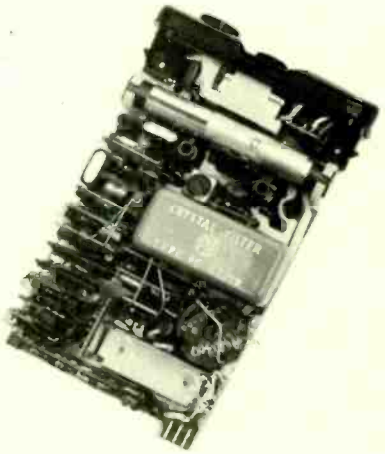
Radio Fire alarm

Personal call-out system for firemen

Production techniques are not in general the concern of *Wireless World* but this month one is featured on our front cover. It shows, albeit in an artistic setting, a watchmaker's wheel which has been adopted by Pye Telecommunications Ltd to facilitate the production of the "microboards" used in the pocket receivers for a fireman's call-out system. The system, which is being adopted by the fire brigades in several areas, operates in the 142-174 MHz band. The transmitter carrier of the 25-W base station is frequency modulated by two signalling tones—one as a test call and the other for a fire call.

The pocket receiver, which measures 12.7 × 6.3 × 2.5 cm and clips in a breast pocket, has a built-in aerial and is powered by a rechargeable 9-V nickel-cadmium battery giving 30 hours operation. The receiver incorporates a battery economizer circuit which switches it on for 0.5 sec and then off for 2.5 sec until the carrier is received and locks it on.

Studs fitted to the receiver enable it to be inserted in a bedside battery charger. It remains fully operative while in the charger.



(Right) Chassis of the fireman's pocket receiver which has an operating range of between 5 and 8 km from the base station according to terrain.

(Below) The watchmaker's wheel in use at Pye's Cambridge works.

Some improvements in the design of

Class-B Audio Amplifier Circuits

by K. C. Johnson

A bewildering number of articles have appeared both in this journal and elsewhere describing class-B audio amplifiers using transistors. The reader might well think that all the possibilities had been thoroughly explored already. When, however, I started to build a new system recently I was surprised to discover just how many small improvements can be made even to a well-tried design. It is true that none of them is either overwhelmingly important or even really original, but taken together they make an appreciably better circuit and so seem to justify yet another article on this subject.

The amplifier from which I started was the Fairchild AF11, which was offered as a kit of semiconductor devices and a tested circuit, though it is no longer in production. The arrangement had been clearly derived from the pioneer circuit of Tobey and Dinsdale, but was brought up to date and much improved by the use of diffused silicon transistors throughout. The first stage was changed so as to use a complementary type of device, since these are now scarcely more expensive in the small sizes and allow some advantage to be gained in the feedback arrangements, but the final power stage still employed two identical devices.

My final circuit is shown opposite, and the various ways in which it differs from the more conventional arrangement will be described in turn.

Earthing arrangements

Several writers have pointed out that it is an advantage to return the "dead" sides of the input, the feedback network, and the output all to the same power rail so as to avoid instability troubles. The first unusual feature of this circuit is that it is the *upper* rail which is chosen for this service rather than the lower one. One obvious advantage of this is that it allows the bootstrap line to be taken directly from the loudspeaker and so saves the need for a second electrolytic capacitor network. But there is a further advantage in that variations in the power supply voltage are much less important since there are no longer any large coupling capacitors bridging the supply rails. If the two rails are taken abruptly to the full working voltage, at switch-on for example, only the 40μF high-frequency bypass capacitor C_4 carries any large current and it is essentially just an extension of the power supply. The long time-constant at the base of Tr_1 controls the charging rate of all the other capacitors and the maximum current in the loudspeaker is no more than 30mA.

In the same way this use of a common return rail and the absence of any signal capacitors bridging the power rails allows a considerable amount of ripple to be tolerated on the power-supply voltage so that power-pack requirements are eased. There are just four places in the circuit where signals change their reference from one power rail to the other, and in every case the collector junction of a transistor is used so that only the current flow is of importance and the voltage is relatively immaterial.

To keep the loudspeaker current surge within similar limits at switch-off it is only necessary to ensure that at least 1000μF of charged capacitor are left connected across the power rails. This enables the currents in Tr_1 and Tr_2 to be kept flowing so that the circuit is able to shut itself down at the rate determined again by the long time-constant at the base of Tr_1. This requirement will normally present no problem, but even if it is not met the surge generated will certainly be no worse than in most other circuits of this type. R_{16} serves to keep the circuit biased properly if the loudspeaker is disconnected whilst the power remains switched on.

The pre-amplifier for this circuit must also be arranged so that the positive rail is the earth and so that the output voltage measured this way changes smoothly when the power is switched.

Middle rail voltage

In any circuit of this type the average voltage at the middle point between the output transistors must be set about half-way between the power rails so that equal output swings can be developed. The first-stage transistor is used at its full gain in this circuit for this purpose. The potentiometer formed by R_1 and R_2 sets a voltage on C_2 which is applied through R_3 to the base of Tr_1, while the actual average level is set on C_3 by R_6 and fed to the emitter. If these voltages do not correspond, the full power of the amplifier is available to correct the situation, with C_3 ensuring that the action is stable.

Thus if slow variations of the supply voltage occur, or if the amplifier is used on different supplies, the middle voltage is always automatically adjusted so as to be close to the actual half-way value rather than remaining at some pre-set level. As a refinement the precise value of R_2 can be set so that limiting of the output on overloading occurs symmetrically at the normal supply voltage, but if components of ordinary tolerance are used the loss of output swing if this is not done will be quite small.

Transistor currents

In contrast to the above it is desirable that the levels of average current at which the various transistor stages work should remain comparatively constant when the power supply is altered. There is no reason to drive a stage with less current just because less voltage is applied, although it is true that a lower impedance loudspeaker system must be used if advantage is to be taken of the current available.

In the conventional form of circuit these standing currents are in fact stabilized in every stage except the second. The third improvement in this circuit is that the diodes D_3 and D_4 are added so as to control this stage also.

With the circuit shown the supply voltage can be reduced from 60V to as little as 18V and the full output current of 2A remains available at almost the full swing the voltage allows, without any adjustment. To match this the loudspeaker impedance required must be reduced from 15Ω at the high voltage to about 4Ω at the lowest. If the loudspeaker is not matched then some output is lost, since either the voltage or the current reaches its limit whilst the other one is less than maximum, but there is no other serious penalty if the mis-match is not worse than a factor of two or so.

Cross-over current stabilization

Thermal runaway of the final transistors is not the problem with silicon devices that it was with germanium. Nevertheless the circuit has the resistor-diode networks R_{12} D_1 and R_{13} D_2 included between Tr_7 and Tr_8 to stabilize the cross-over current level more tightly. These resistors act to give a proportionate voltage for currents near the design value of 20mA, whilst the

diodes take over for currents greater than about 50mA so that the peak output capability is scarcely reduced at all.

Now it might be thought that non-linear networks of this kind would cause serious distortion—and arguments to this effect have indeed appeared in print—but consider what is actually happening. The signal being amplified leaves Tr_2 as a collector *current*. Tr_4 is arranged to supply a constant *current* and thus the signal is still in the form of a *current* when it arrives at Tr_5 and Tr_6. It is amplified there and again at Tr_7 and Tr_8, but at no point in these stages is there any sort of a load resistance. Thus the voltages are irrelevant, except in so far as small amounts of current can be lost since no system is ever perfect.

There is, however, an improvement of the thermal stability of the cross-over current by a factor of about five over the customary arrangement of linear resistors of about 0.5Ω at these positions, and less output swing is lost. Thus these networks are well worth having even though silicon devices have so much less leakage and much better stability anyway. The diodes used for D_1 and D_2 should be of germanium, so that they take over at about 250mV, and they must be capable of carrying the full output safely. Their reverse characteristics and switching speeds are clearly of little importance and Mullard type OA10 is suitable. The resistors can be of the ordinary small composition type, as they never have to carry more than perhaps 50mW of power at the most, and there is then no worry about their being inductive.

Constant current transistor

The transistor Tr_4 has been added to serve as a constant current source, as has already been mentioned. It supplies the collector of Tr_2 with about 2mA and draws this current from the loudspeaker side of C_8 so as to obtain the customary bootstrap action. The resistor R_7 and capacitor C_6 help to keep the current constant, whilst D_3, D_4 and R_{15} stabilize the value against variations of the supply voltage. The transistor for this position must be capable of withstanding half the maximum supply voltage but need have no other special features. The Fairchild type BC116, as used already in the first stage, meets the requirements.

In conventional circuits a simple feed resistor carries the current to Tr_2 and the value used is usually no greater than 5kΩ. But the input impedance to Tr_5 and Tr_6 can easily rise to this same sort of value at the cross-over region, since the input impedances of the final transistors rise sharply at low currents and the value is directly multiplied by the current-gains of the driver stage devices. Away from cross-over these input impedances are very much lower, so that the effect is a fall in the value of the open-loop gain at cross-over. Put in figures we can say that the open-loop gain is multiplied by a factor of about 0.5 in this region.

Now the purpose of Tr_4 is to force as much as possible of the signal current from Tr_2 into the driver stage devices and so reduce this form of distortion. Since the effective resistance value obtained is in the region of 100kΩ the improvement is substantial despite the increase of the input impedance that results from the inclusion of R_{12} and R_{13}. The cost of the extra transistor required is comparatively small and in return we have obtained less distortion and better current stabilization in two stages of the amplifier.

Voltage reference transistor

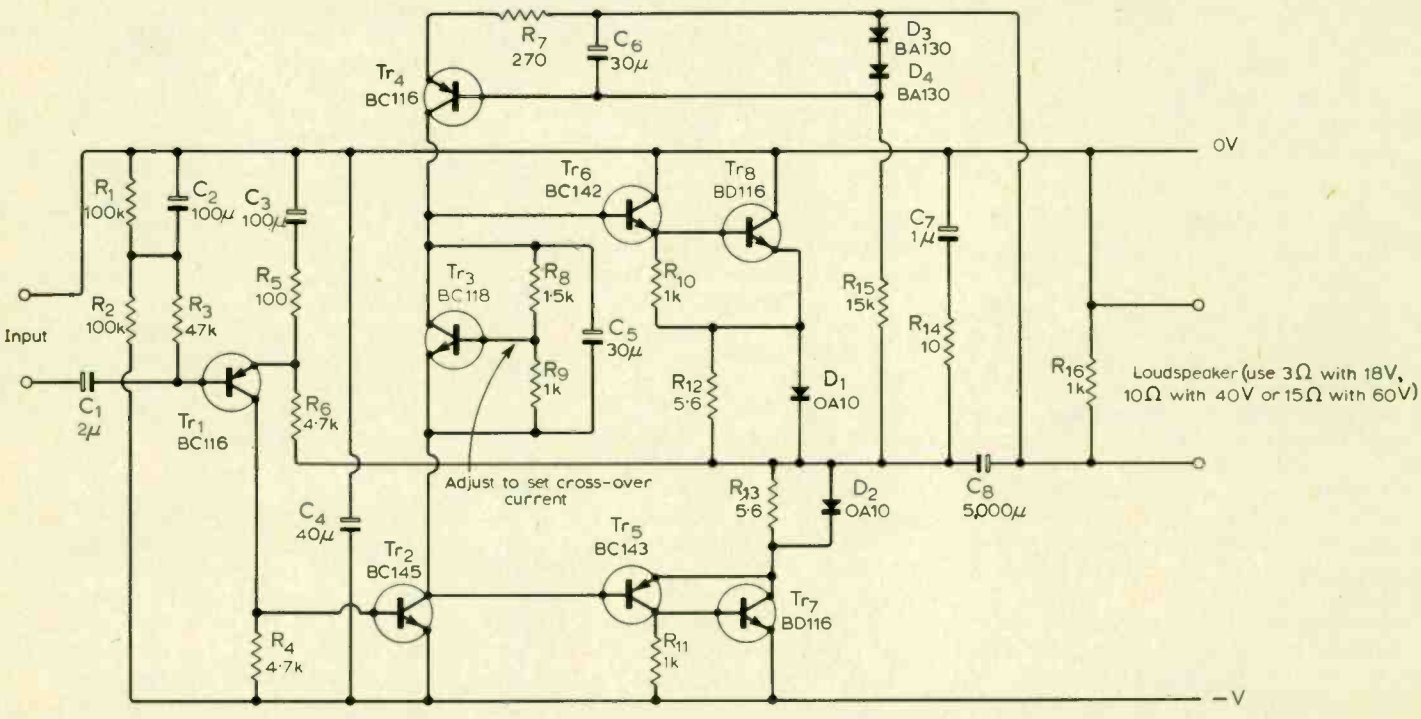
The transistor Tr_3 together with R_8, R_9 and C_5, determines the voltage used as a reference in the fixing of the value of the cross-over current. A transistor replaces the usual chain of diodes as it can provide a more satisfactory form of adjustment and may perhaps now even actually be cheaper. Almost any type of transistor will do provided that there is a gain of at least ten at a current of 1.5mA. Clearly a silicon device can be expected to be more stable and to provide a better tracking when the stages being stabilized all use this same material.

Resistor R_8 has to be reduced in value if the cross-over current is too large whilst R_9 must be reduced if it is too small. Make any adjustment carefully as this setting is fairly critical. Capacitor C_5 serves merely to provide an easy path for the signal current to reach Tr_6.

With silicon transistors of this kind the cross-over current is not at all critical. The value can rise to 50mA or more before the heating effect becomes significant whilst it can fall as low as 5mA before there is any appreciable increase in the distortion. The temperature differences would have to be in the region of 100°C before either of these limits could be approached, and temperatures of this order are certainly not developed in ordinary domestic usage even when no special heat-sink arrangements are made as is the case with my amplifiers.

Matching the transistor gains

The gain from the collector of Tr_2 to the output in a circuit of this type is determined primarily by the products of the current-gains of the driver and final transistor on the two sides. Thus in this circuit it is the product for Tr_5 and Tr_7 for negative swings and Tr_6 and Tr_8 for positive ones. It is these *products*, rather than the gains of the corresponding devices, that ought to be matched to reduce distortion. There is no great difficulty in doing this and indeed it offers the big advantage that relatively poor specimens of one device can be sold paired with star performers of the other



Except for Tr_3 and Tr_4 the transistors are from the Fairchild AF11 kit, as are D_3 and D_4. All the electrolytic capacitors must carry half the supply voltage except for C_4, which carries the full voltage, and C_5 and C_6 which carry a couple of volts at the most.

so as to give a standard product despite production spreads. So far as I know, though, no manufacturer has ever offered devices on this basis. When building an amplifier of this kind it is well worth taking the trouble to test the devices available and to select pairs for a constant value of this gain product.

An amplifier of this type has then, in principle, got a constant gain right through the cross-over region. The current from Tr_2 is indeed split into two pieces in some ratio determined by the relative impedances at the inputs of Tr_5 and Tr_6, and these are amplified separately. But they are simply added together again for the output, so that if the amplification factors are equal the exact manner of the splitting is of no importance. This situation is quite different from that in a valve class-B circuit where the signal is applied as a voltage to the two devices equally at all times, and their characteristics must be so shaped that the sum of their responses remains constant as the action transfers from one to the other. In this latter case a critical level of biasing, determined by the design of the valves, must be maintained so that the responses dove-tail together, but there is no corresponding requirement in the transistor circuit.

The only objection to an indefinite increase of the cross-over current here comes from excessive heating of the power stage and the need for a larger power-pack. There is no clear distinction with this type of circuit between class B with a large cross-over current and class A. The distortion decreases as the standing current is increased, and a compromise must be made between the distortion acceptable and the power level.

Choice of cross-over current

The value chosen for the cross-over current in my amplifiers is 20mA. This gives a standing power dissipation in the final transistors of 0.6W each at the full voltage. At this power level no heat-sinks are required in normal service, so that the devices can be mounted directly on the same small paxolin board as the other components. This in turn means that none of the wires concerned in the feedback loop need be more than 3in long and the stability problems are correspondingly reduced. There is no objection, however, to running at a higher level of standing current simply by reducing R_9, if a different compromise is required and heat-sinks and stabilization capacitors are provided.

But how serious is the distortion even at this level of 20mA? With modern diffused power devices, such as the Fairchild BD116, well over half the peak gain is still available at this sort of current. If we assume that the amount left is actually 75%, then this gain loss will cause a fall in the open-loop gain, due to the simple product of the betas, by a factor 0.75 at the cross-over point.

Further to this there is a loss of signal in the resistors R_{10} and R_{11} due to the rise of the input impedances of Tr_7 and Tr_8 at low currents. With typical silicon devices this is no worse than a factor of 0.95, and it is far less serious now than it was with germanium where the leak resistors had to be made much lower in value. It is tempting to omit these resistors altogether with silicon but, in fact, this is foolish as they are required to help the power devices turn off after fast transients.

Lastly there is the fact that Tr_2 is not really a perfect current source, but has a a finite output impedance. Even if the standing current in this stage is cut to the bare amount required for driving the full output together with a minimum safety margin (2mA in this circuit) the collector impedance will still be no higher than about 50kΩ, as the base is current fed. The input impedance to Tr_5 and Tr_6 is, however, 45kΩ or more, since the 15Ω of the loudspeaker is multiplied by at least 3000 due to the current-gains of the stages. Moreover, there is a further 10kΩ added to this, due again to the rise of transistor input impedances, at the cross-over point. Thus the loss of gain here is a factor 0.55 worsening to 0.45 at cross-over. The corresponding effect at Tr_4 is rather less than this as it is voltage fed and returned to the bootstrap line. Its inclusion does not make any serious difference to the general picture.

The combined effect of all these causes is then a loss of perhaps a factor 0.6 in the open-loop gain in the region of the cross-over. If the cross-over current value were made greater than 20mA this loss would certainly be reduced, but what other changes occur in this open-loop gain that would remain unaltered despite such an increase of this current?

The most serious effect here comes again from the collector impedance of Tr_2 and is due to the fact that this impedance is inversely proportional to the current in the device. Thus at the peak negative swing this impedance will fall as low as 30kΩ, while at the positive peak it will rise to perhaps 100kΩ. This causes a factor of loss of open-loop gain varying from 0.4 to 0.7. This effect is thus comparable with the factor 0.6 due to the effects at cross-over. The conclusion from this is that although a further increase of the cross-over current would indeed reduce the distortion the rate of reduction is becoming rapidly less so that, on balance, this value represents a reasonable compromise. If a more constant openloop gain is required then something must be done to increase the effective output impedance of Tr_2.

Stability of the feedback loop

The full product of the current-gains of the second, third and fourth stages of this circuit is in the region of 350,000, but, as we have seen, this is reduced by various factors so as to be perhaps 140,000 at the least and 250,000 at the most with variations over the signal swing. Now roughly 1/600 of the output current is fed back through R_6, R_5 and Tr_1, so that the effective gain round the feedback loop in the passband varies over the range from 230 to 420. This very large amount of feedback serves to make the overall incremental gain fall short of the value determined by the potentiometer formed by R_6 and R_5 by no more than 0.43% at the worst and 0.24% at the best.

This variation is less than ±0.1% from the mean and indicates that the performance of this type of amplifier is very good indeed. It is quite probable, in fact, that the linearity of the resistors used for R_6 and R_5 is not even as good as this and that they are, therefore, a major source of distortion. In any case there is little doubt that there are other components in any real audio system which are far worse than this circuit, so that there is little point in worrying about it overmuch.

However, this feedback will be quite useless unless the loop can be kept stable. The last feature in which my circuit is unconventional is in the fact that adequate stability is obtained without any extra capacitance having to be added between the collector and base of Tr_2. The network R_{14}, C_7 provides the usual dummy load to restrain the output voltage at the very high frequencies where the loudspeaker system is likely to be inductive and where oscillation is likely to occur, but the amplifiers as built have a response time to a sharp step input of about 1μs rise-time with an overshoot of no more than perhaps 10%. Notice that the sort of wiring commonly used to feed loudspeakers has a characteristic impedance substantially higher than the load resistance, so that a long lead will make the inductive effect greater rather than less.

As already mentioned, the layout used is very compact with no signal lead more than 3in long, but the rather unexpected stability seems to come from the very high impedance at the collector of Tr_2 due to the constant-current effect of Tr_4. This apparently makes the ordinary stray capacitances at this point have a time-constant which dominates the feedback action. At the same time the diffused power transistors used for Tr_7 and Tr_8 are so fast (they have f_T = 40MHz), that they no longer make a serious second time-constant. With germanium the final devices used were more than a hundred times slower than this and their response was an important factor in the stability considerations.

It follows from this step-input behaviour that the high-frequency cut-off of this circuit is at over 100kHz. If this is thought to be excessive it can be reduced as required by adding collector-base capacitance at Tr_2, and this will still further ensure stability. The low-frequency cutting action of the circuit comes directly from the increase of the feedback factor due to the time-constant of R_5 and C_3. The value of this is 10ms, so that the cut will come at about 16Hz. If this value is to be changed then C_1, C_2, C_3 and C_8 must all be multiplied by the required factor.

The result of all these modifications is an amplifier arrangement that works appreciably better than corresponding circuits of the same general type with only a marginal increase in the complexity. It is even possible that the total cost is no greater when the savings that can be made in the power pack are taken into account. Certainly there is no doubt that the component tolerances have been made substantially easier, and that these various features deserve consideration in the design of any future amplifier of this type.

Speakers in Corners

A disagreement with the widely held view that placing a loudspeaker in a corner of a room gives better sound quality

by H. D. Harwood, B.Sc.*

In his article "Loudspeaker Performance" in the February issue of *Wireless World*, P. W. Klipsch, states that "All speakers (I have found no exceptions) work better in a corner". This view, which seems to be very commonly held, does not agree with experience in the B.B.C.[1]. Historically it has been found that as the general sound quality of loudspeakers has improved, so the deleterious effects of mounting the loudspeaker in a corner have become more and more noticeable. The deterioration in quality has been found to be mainly in the middle and upper bass regions. It sounded as though the loudspeaker had a very irregular response/frequency characteristic and that the sound was apparently more reverberant and coloured. The effects in the lower frequency range were particularly noticeable on polyphonic organ music, the separate parts of which are changed in level according to their positions in the scale.

In the B.B.C. television sound control rooms have been chiefly affected, as the most convenient position for the monitoring loudspeaker has been above a group of picture monitors which are placed across a corner. This listening position is largely a forced choice because the listener's strong directional sense in the horizontal plane discourages the use of positions to one side of the monitors, while the space below is normally screened by the control desk and other obstacles. The monitoring loudspeaker is therefore normally placed near the ceiling in a corner, exactly the acoustic position favoured by Mr. Klipsch.

The hanging version of the LSU/10 studio monitoring loudspeaker (introduced in 1958) sounded satisfactory in such a position after a bass lift had been added. With the completion of Television Centre and the introduction in 1959 of the LS5/2A, it was found that these loudspeakers, which performed very well in most circumstances, gave inferior quality when hung in a corner, although it was often possible partially to overcome this by changes in the acoustics of the room. When the LS5/6[2] was introduced recently, the effect of mounting it in a corner was quite marked.

*B.B.C. Research Department

Three hypotheses have been suggested to explain the effects:

1. The release of load on the base of the cabinet when the loudspeaker is removed from its plinth allows the cabinet to vibrate more freely, thus colouring the sound at a series of resonance frequencies.
2. The quality change is entirely due to interference effects between the direct sound from the loudspeaker units and that reflected from the walls and ceiling in the neighbourhood of the loudspeaker.
3. The effects are psychological in origin and associated with the unnatural or unaccustomed direction of the sound reaching the listener. This is very difficult to check and therefore the first two suggestions were examined first.

To check the first suggestion, listening tests were carried out, using both speech and music, when the loudspeaker was on its plinth near the middle of a wall and when it was raised just free of the plinth by means of a rope and pulley. No difference in sound quality could be detected at all and it was concluded that vibration of the base of the cabinet was not a cause.

If interference from reflections was the cause of the changes in quality, then past experience[3] would indicate that their amplitudes would be comparable with that of the direct sound, and the output of a microphone placed in the listening position would have a series of easily identified fluctuations.

Fig. 1 shows the arrangement used for experiments to test the hypothesis that the deterioration in quality was caused by reflections from the surfaces of the walls

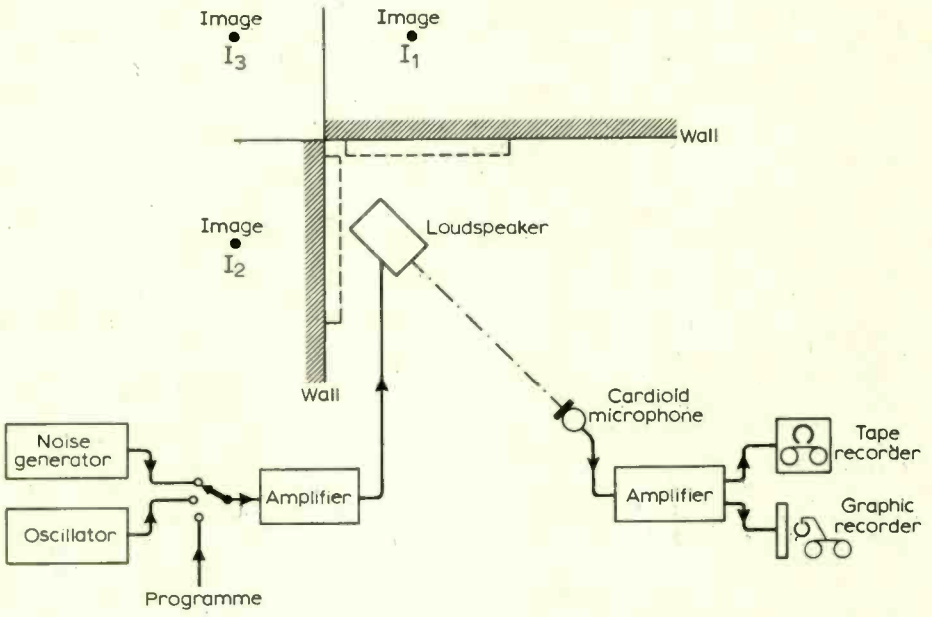


Fig. 1. Experimental set up used for investigating effects of corner placing.

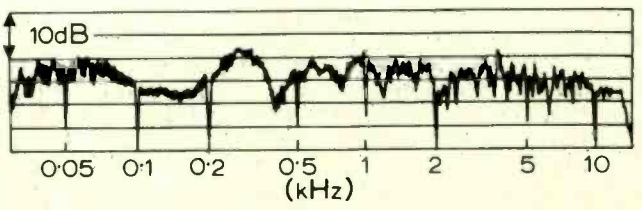


Fig. 2. Response/frequency characteristic with loudspeaker symmetrically placed in upper corner of room. The signal source was a warble tone.

and ceiling. For clarity it is shown in two dimensions only, but the extension to three dimensions is fairly obvious. For walls at right angles three images are formed, I_1, I_2, and I_3. If the walls are not at right angles then I_3 is split into two images, but for most rooms these two will coalesce at the wavelengths we are concerned with. Corresponding images will be formed in the ceiling.

In the tests the loudspeaker could be fed with pink noise, pure tone modulated over a range of ± 63 Hz at a rate of 10 times a second or with programme from recordings. A microphone with a cardioid directional pattern was used to reduce the effect of room reflections elsewhere and the output could be recorded on a graphic level recorder or on a magnetic tape recorder.

Fig. 2 shows the steady state characteristics with the loudspeaker in a symmetrical position in the corner of a room acoustically treated on surfaces other than that of the corner. The microphone was 1.3m above floor level on the loudspeaker axis. Fig. 3 shows the curve obtained in a listening room in an asymmetrical position with respect to the walls of the room. These curves of course represent the combined effect of room and loudspeaker and should in no way be confused with those of the loudspeaker alone.

Compared with Fig. 3, the curve in Fig. 2 shows a series of broad maxima and minima at low and middle frequencies, the maxima occurring at 50, 280, 630 and 950 Hz, the peak to trough variations reaching 11 dB; at high frequencies, too, there is a series of interferences. Listening tests on the loudspeaker using both pink noise and speech, in the condition corresponding to Fig. 2, showed a definite colouration just below 300 Hz, which agrees with the main peak in this region. There is a clear suggestion therefore that the colourations at low frequencies are associated with these peaks.

Fig. 4, curve A, shows the expected resultant of the sound pressure from the loudspeaker and its images calculated by ordinary vector summation from the following data:

1. Measured positions of loudspeaker and microphone.
2. Assumption of a value of 90% for the reflection coefficient at the walls with no significant phase change in reflection.
3. The assumption that the two images lying directly behind the loudspeaker could be neglected. One of these is formed by two successive reflections and the other by three, and both are formed by radiation inside a small solid angle at the back of the loudspeaker where the radiation is in any case low; otherwise the loudspeaker was assumed to be omnidirectional.

Curve B in Fig. 4 is a smoothed reproduction of a portion of Fig. 2 deliberately displaced from curve A. The similarity between the two curves is sufficiently close to confirm that interference by reflections from the surfaces surrounding the corner is an adequate explanation of the low frequency effects.

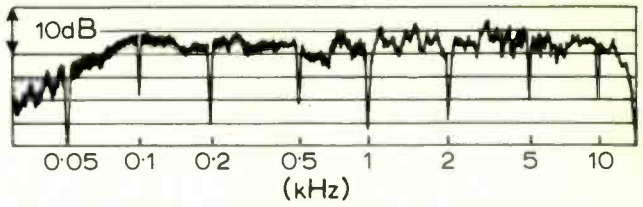


Fig. 3. Characteristic with loudspeaker in an asymmetrical position in a quality listening room (warble tone).

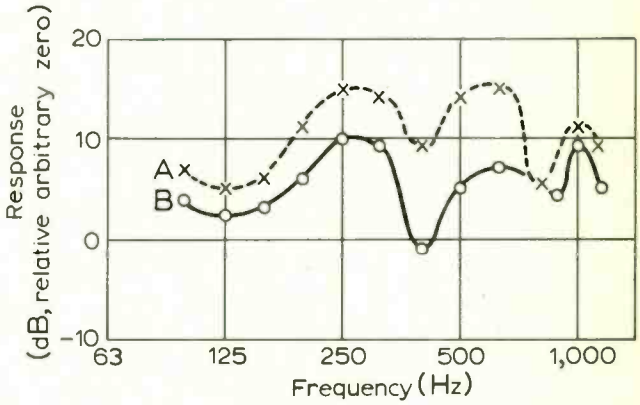


Fig. 4. Calculated response/frequency characteristics from loudspeaker in corner of room: curve A, calculated from direct and strongest three images; curve B, smoothed from measured characteristic in Fig. 2.

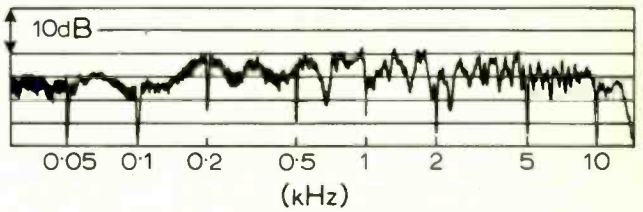


Fig. 5. Speaker moved to unsymmetrical position in room (warble tone).

As the frequency is increased the fluctuations of Fig. 2 vary in depth owing to the varying directivity of the loudspeaker and the interaction of images at several different distances. From 3 kHz, however, the pattern becomes more regular, probably because the tweeter is in operation here and is more omnidirectional, giving stronger reflections from the nearby surfaces. The fluctuations still seem to be harmonically related to 270 Hz.

Fig. 5 is the steady state characteristic, for comparison with Fig. 2, obtained after moving the loudspeaker from its symmetrical position by 45 cm parallel to one wall. In this position the path lengths from two of the primary images are different and the fluctuations are therefore reduced at low frequencies.

A further response characteristic was taken at a symmetrical corner floor position, a carpet being on the floor. The low frequency fluctuations were similar to those in Fig. 2 but the high frequency ones were smaller, presumably due to the absorption of the carpet.

Fig. 6 shows the disastrous effect of placing the loudspeaker right in the corner so that it touches each of the walls.

The evidence given above shows that interference between reflections and the direct sound is sufficient to explain the measurable effects of the loudspeaker environment. It is also consistent with the subjective observations which were the starting point of the investigation. It may be a matter of some surprise that such large fluctuations as exist even in the best curves, i.e. Fig. 3, do not make the loudspeakers completely unacceptable in any other situation than that of a free field room, but it is a common observation that one does not normally notice the even larger fluctuations due to room modes which must equally affect live speech in a room. The faculties of binaural hearing and central nervous analysis give considerable weight to the direct sound.

Assuming that the effects are entirely due to interference, there are thus three alternative methods for improving reproduction from a corner placed loudspeaker.

1. To absorb sound falling on the neighbouring surfaces. This will require a highly efficient absorber working over the entire audio bandwidth to be applied to a suitable area around the loudspeaker position. A suitable type is a partitioned air space 15 cm deep closed by 5 cm of dense rockwool and a fabric or highly perforated cover.
2. To use unsymmetrical loudspeaker positions, preferably chosen to eliminate the major fluctuations.
3. To avoid the corner as far as possible, will give the best results.

An opportunity to test out these conclusions arose in the sound-control cubicle of Studio 1 in Television Centre. A loudspeaker, type LS5/2, which it was agreed gave a high quality of reproduction when near the floor, gave an objectionable quality described as "tunnelly" when hung above the television monitors in a corner of the room. The position of the loudspeaker is such that very little can be done in the way of adding absorbent at the sides of the loudspeaker without covering large areas of viewing window in the

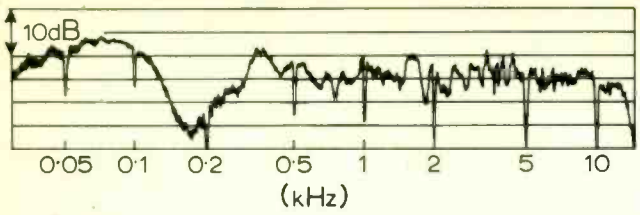


Fig. 6. Effect on characteristic of placing loudspeaker in corner touching walls and floor (warble tone).

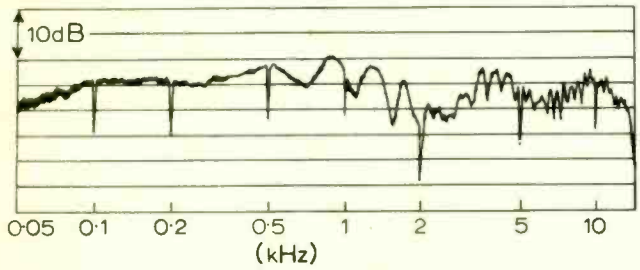


Fig. 7. High quality monitoring speaker placed in upper corner of television sound-control room (warble tone). The microphone had a cardioid characteristic.

control room. The wall area available behind the loudspeaker was treated as described above, but the quantity of absorbent involved was so small that it was not surprising that very little benefit resulted.

A response/frequency curve was taken with a cardioid-type microphone at the edge of the control desk facing the axis of the loudspeaker and with warbled tone applied as in the earlier curves. The result is shown in Fig. 7 and the expected irregularities are evident in the 500 Hz to 2 kHz region. To check that the irregularities were not due to interference from a reflection off the desk the measurement was repeated, the microphone having a figure-of-eight polar characteristic, the null being directed towards the desk. Results were substantially the same.

It was noted that the sound quality varied rapidly with distance from the desk and indeed throughout the whole room, although the impression of "tunnelliness" persisted everywhere.

Since the first suggestion of improving the sound quality was inapplicable, the second was tried. The loudspeaker was lowered about 35 cm from the ceiling until it touched the monitors and the angle adjusted until it again faced the sound supervisor.

It was immediately obvious on listening that the sound quality had greatly improved in the normal monitoring position and furthermore that it did not vary substantially with position and was acceptable throughout the whole room.

A further response/frequency curve was taken at the monitoring position with the microphone in the cardioid condition. It was observed that the irregularities in the 500Hz to 2kHz region had almost disappeared, and that even those at high frequencies had been somewhat reduced. As a matter of interest, it was not possible even on careful listening to attribute any effect to these latter irregularities and it appears, therefore, that the ear is more tolerant in this frequency range.

Enough has been said to show that, far from all loudspeakers working better in a corner, this position is to be avoided for direct radiator loudspeakers whenever possible, if high quality sound is the criterion and not just a loud noise. If such a position is unavoidable, try first to make the distances to neighbouring surfaces appreciably different and if the floor is one surface use a thick carpet. If this measure is insufficient, acoustic absorbent material should be placed on the surfaces involved.

Acknowledgement. This article is published by permission of the Director of Engineering, B.B.C.

REFERENCES

1. B.B.C. Engineering Division Monograph No. 78, September 1969. Part II, by H. D. Harwood and C. L. S. Gilford.
2. "New B.B.C. Monitoring Loudspeaker", by H. D. Harwood. *Wireless World*, March, April, May 1968.
3. "Recent work on the effect of reflectors in concert halls and music studios", by T. Somerville, C. L. S. Gilford, N. F. Spring and R. D. M. Negus. *J. Sound Vib.*, 1966, 3 (2), pp. 127–134.

Corrections & Amendments

We regret the need to draw readers' attention to the following amendments and corrections to recently published articles.

L. Ibbotson writes: My attention has been drawn to an error in question 15 of **"Test Your Knowledge"** No. 20 on Colour (January issue). The supposedly correct answer, (*b*), is wrong in the following particular. The three spectral wavelengths quoted were selected because the triangle on the chromaticity diagram with these as apices includes the largest possible range of real colours. It is clear from the chromaticity diagram that colour-mixing curves in terms of constant luminance would have maximum values around the three primary wavelengths quoted. However, to get the required filter (radiant flux) transmission characteristics, these curves require to be multiplied by the relative luminous efficiency curve: as a result the required radiant flux transmission peak for the red occurs at a wavelength of about 600mμ The other two transmission curves still peak at round about the primary wavelengths.

"Ceramic Pickups and Transistor Pre-amplifiers" (Feb. p. 56): Referring to Fig. 8(b) mechancial compensation can be allowed for by adjusting R_4, not R_1 as stated in the text. In the appendices (p.80) the diagram at the foot of the centre column should follow ". . . by thinking of the ceramic pickup capacitance as being a part of Z_1:", and the diagram in the right hand column should follow the text at the foot of the centre column.

"Digitally-controlled Tape-recorder Pre-amplifier" (March p.127): In Fig. 2 Tr_9 is n-p-n and should be drawn as is Tr_{11}. In Fig. 4(b) D_7 should be inverted and C_{15}, D_4, D_5 and D_6 should share a common connection. In the caption to Fig. 4(a) and in Fig. 5 it is suggested that diode 1N914 is a germanium type when it is actually a silicon planar device. Four such silicon diodes should be employed (D_8-D_{11}) to give V_{ee}.

The following amendments should be made to the article **"80-metre S. S. B. Receiver"** by W. B. de Ruyter which appeared in the March issue: R_{12} should be connected to the a.g.c. line and not chassis as shown and the values of R_{28} and R_{21} should be interchanged.

Two corrections should be made to the article **"Pulse Generator using Integrated Circuits"** by C. Djokic (March p.130). The variable resistors in the output amplifiers (Fig.4) should be connected across the power supply as potential dividers with the wipers connected to the upper end of the 470Ω resistors, and gate C pin connections should be altered to 5 and 6 as per Fig. 6.

"Simple Linear A.C. Voltmeter": A printer's error in G. W. Short's letter (March, p.113) made nonsense of his correction. The oblique stroke was again omitted from the expression $R_2=(V_{CC}-V_{CE})/I_C$.

"Pickup Characteristics" (December, p. 553): The stylus supplied with the Bang & Olufsen SP10 cartridge is spherical (0.6 thou) and not eliptical.

An Electronic Dice

Design for a digital novelty, the final details of which are left to the reader

*by Brian Crank**

A chance remark made at a game of snakes and ladders led to an interesting excursion into logic design. The dice had fallen off the table and as people searched the floor for it someone said "At least in this house you would think that there would be an electronic something to save all this trouble". Later the possibilities of making an electronic dice were investigated.

The circuit must have six stable conditions or states, each state corresponding to one of the sides of a dice as shown in Fig. 1 (a), and it must be capable of selecting anyone of these states at random. In practice the random element is provided by a high-speed multivibrator.

The groups of spots on the sides of the dice can be made up by using one, or by superimposing more than one, of the four patterns given in Fig. 1 (b). There are several ways in which these patterns can be displayed. One possibility is to use seven lamps, one lamp for each spot; in this case all the lamps to form a particular pattern in Fig. 1 (b) would be connected in parallel. Another solution would be to partially drill the spots in four sheets of Perspex, one sheet for each pattern, and to illuminate them using the edge lighting method employed in some numerical indicators. Finally, fibre optics could be tried. This would entail guiding the light from the lamps along fibre "light pipes" on to some form of translucent screen. (Fibre optic light guides which might be suitable can be obtained from Proops.)

The precise method of display is left to the ingenuity of the reader. However, it has been established that the logic circuit needed to drive the display must have four outputs, that is one output to illuminate each pattern.

*Assistant editor *Wireless World*

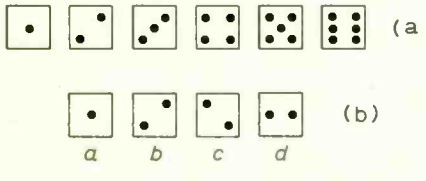


Fig. 1. (a) The arrangement of spots on a conventional dice; (b) the six scores of (a) can be formed with these four patterns

Several logic circuits were tried in the search for one using the minimum number of parts. The circuit finally chosen, although very simple, was arrived at after a good deal of effort had been expended.

The first stage in analysing the problem is to decide which of the four patterns are required to form the six sides of the dice and to present this information in a logical manner:

Dice score		Patterns required
1	=	a
2	=	b
3	=	ab
4	=	bc
5	=	abc
6	=	bcd

This states the facts but not in a way that is very meaningful. However, from these facts a table can be constructed. In this table a 1 is written when a particular pattern is required and a 0 is written when it is not.

Dice score	Patterns a	b	c	d
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	1	1	1

Do the first three columns of this table look familiar? If not some re-arrangement may help:

Dice score	Patterns a	b	c	d
1	1	0	0	0
3	1	1	0	0
5	1	1	1	0
4	0	1	1	0
2	0	1	0	0
6	0	1	1	1

The first three columns closely resemble

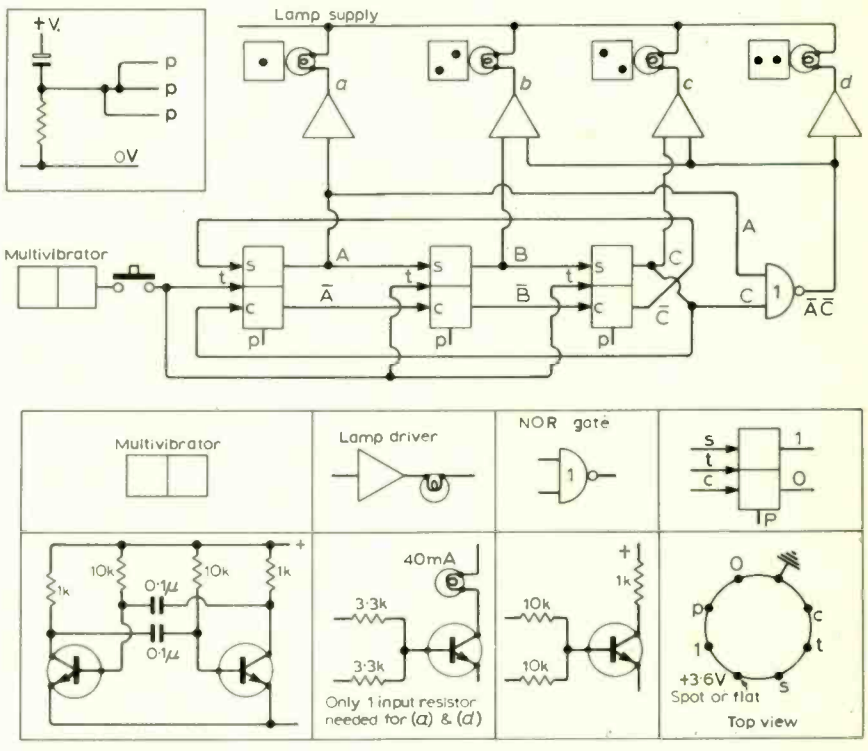


Fig. 2. The suggested circuit for a digital dice, the method of display is left to the reader, almost any general-purpose silicon transistors may be used.

the Johnson code. For readers who are not familiar with it the Johnson code is as follows:

0 0 0
1 0 0
1 1 0
1 1 1
0 1 1
0 0 1

This code is formed by a counter called a Johnson counter, sometimes known as a switch-tail ring counter. If the pattern requirements can be made to follow the Johnson code the lamps illuminating the patterns could be controlled directly by the counter and no gating at all would be required. Although we cannot reach this ideal solution we can come very close to it.

We will consider only the columns for patterns a, b and c at this stage; column d will be dealt with later.

The first line to depart from the Johnson code is the line for score two. This is 010 instead of the Johnson 001. This means that the Johnson code would have us illuminate pattern c instead of the required pattern b. Examining Fig. 1 (b) we find that patterns b and c both show a score of two so it does not matter which is used; 001 instead of 010 can be used, therefore, with no circuit changes.

The other line that needs modification is for score six. This should be 000 in Johnson code instead of 011. If the Johnson code is used no patterns would be shown at all for six, but we require patterns b, c and d to be illuminated. A gate must be employed to detect 000 and light the required patterns. A new table can now be drawn up:

Dice score	Patterns a b c	
6	0 0 0	— light b, c and d
1	1 0 0	
3	1 1 0	
5	1 1 1	
4	0 1 1	
2	0 0 1	

The gating requirements for the patterns can now be derived. It is assumed that a Johnson counter is employed in which the bistables are labelled A, B and C.

$a = A$
$b = B + \bar{A}\bar{C}$
$c = C + \bar{A}\bar{C}$
$d = \bar{A}\bar{C}$

The term $\bar{A}\bar{C}$ detects line 000 for score six and illuminates the lamps b, c and d.

A circuit based on the foregoing is given in Fig. 2. The Johnson counter is a standard shift register with the output crossed and fed back to the input. The term $\bar{A}\bar{C}$ is formed by a NOR gate fed with A and C. The $+\bar{A}\bar{C}$ function for lamps b and c is carried out using two resistors from the output of the NOR gate. Connection details for Fairchild μL 923 bistables are given although any similar device may be employed.

To "throw the dice" the push-button is pressed and released; during the time that the button is "made" the counter counts pulses from the multivibrator; the score is then displayed.

The Johnson counter has one serious drawback. Three bistables have eight possible states, only six of these being used in the Johnson counter. If on switch-on the counter goes into one of the two unused states it will switch between these states on each input pulse and will never get into the proper counting sequence. This is eliminated by the resistor and electrolytic capacitor shown in the inset of Fig. 2. These cause the preset inputs of the bistables to go positive for a short period after switch-on ensuring that the counter starts at 000. The value of this capacitor can be found by experiment and is not critical.

An experimental lash-up of this circuit was found to perform well. If required more push buttons can be connected in parallel with the one shown in the circuit so that each player may have one.

The logic side of the circuit has been reduced to three bistables, one gate and two resistors. This is thought by the author to be the minimal form of the circuit, but perhaps this is a "dicey" statement as *Wireless World* readers are almost certain to find a better solution?

Announcements

Revised dates have been announced for this year's London **Audio Festival and Fair** which will again be held at Olympia. The new dates are October 19th to 24th—the first day being reserved for the trade.

A summer school in applied optics for non-specialists is to be held from June 8th to 19th at Imperial College, London S.W.7. The course fee is £35 and further information and application forms may be obtained from the Registrar.

"Hybrid Computer Techniques" is the title of a course of six evening lectures to be held at Norwood Technical College, Knight's Hill, London S.E.27, commencing April 14th. Fee 15s.

Marconi Marine has received orders from three Japanese shipyards for the supply of **communications equipment, navigational aids** and dual radar installations for each of four new ore/oil carriers. The company is also supplying the communications and navigational equipment for *Esso Northumbria*, the largest ship ever to be built in the United Kingdom.

S.T.C. have been awarded a £350,000 contract by the Ministry of Technology for the development and construction of two functional models of a fully electronic access exchange for the Mallard project.

The Solartron Electronic Group Ltd, of Farnborough, Hants, has received an order from the Australian Government worth £2m to design, manufacture and install a combined action information and **tactical trainer** for the Royal Australian Navy.

An agreement has been signed between **Siemens** of West Germany and **Ferranti Ltd,** Edinburgh, according to which these two companies will collaborate on the design, development and production of laser systems for the Multi-role Combat Aircraft (M.R.C.A.) project.

The Channel Electronic Division of LRW Electronics Ltd, Cheltenham, has been awarded a £60,000 contract for the supply of **'Safetylink' marine radio telephones** by Channel Marine Commercial Ltd.

Link Electronics Ltd, has received a contract from the Post Office, valued at just under £20,000, for the supply of 40 **portable waveform generators** to be used in conjunction with differential gain and phase testing equipment.

The Aeronautical Division of Marconi has received an order worth nearly £100,000 from Air New Zealand for additional **Marconi Doppler equipment** to be fitted to their DC8 fleet.

GEC-AEI (Electronics), Leicester, have been awarded a **share of a £10m contract** for work on the Singapore Government's 'Bloodhound' missile defence system.

GEC-AEI Telecommunications Ltd has received orders worth £750,000 from the Post Office for **microwave radio equipment** to expand three routes in the P.O. network of high-capacity-radio trunk transmission routes.

Microwave Associates Ltd, of Cradock Road, Luton, Beds, have received an order, valued in the region of £40,000, from Sveriges Radio of Stockholm, for mobile all solid-state **television relay systems** for outside broadcast use.

H. Tinsley & Company Ltd, Werndee Hall, South Norwood, London S.E.25, will in future manufacture and market the range of air-spaced variable capacitors and trimmers previously made under the **"Cyldon"** name by Sydney S. Bird & Sons Ltd.

Highgate Acoustics, 184 Great Portland Street, London W.1, have been appointed distributors in the United Kingdom and Eire for the **Pickering** range of cartridges previously handled by Auriema.

A new division of Amphenol has been set up to manufacture components under licence from **Entrelec**, of Villeurbonne, France.

Electroustic Ltd, of 73b North Street, Guildford, Surrey, have been appointed the sole U.K. agent for the **'Silec' range of semiconductors.**

Tranchant Electronics (U.K.) Ltd, 17 Charing Cross Road, London W.C.2, have been appointed exclusive agents in Great Britain for the **Intersil** semiconductor range.

Intertechnique Ltd, Victoria Road, Portslade, Sussex BN4 1XQ, have been appointed sole representatives for the U.K. and other territories for the complete range of equipment manufactured by IGAB of Sweden.

Cole Electronics Ltd, Lansdowne Road, Croydon CR9 2HB, have been appointed sole U.K. agents for the range of **contactless solid-state switches** manufactured by Rafi Electronic, of Ravensburg, W. Germany.

The professional one

Here it is, Solartron's outstanding 1240.

The multimeter that's not just a toy but a real step forward in instrument technology.

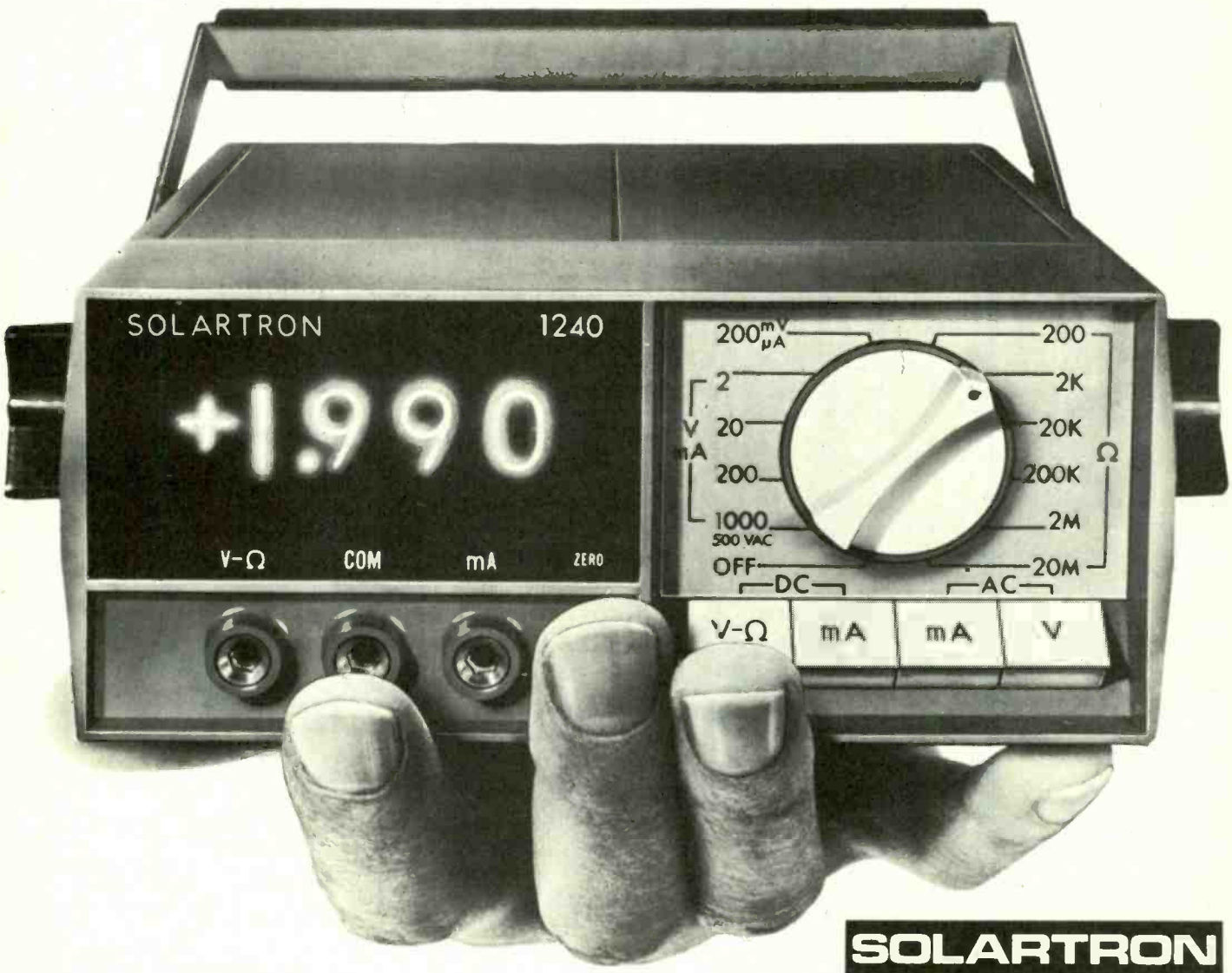
Now everyone can go digital!

You get Amps, Volts, Ohms – a.c. and d.c. – down to 100 microvolts and dual slope integration for noise rejection.

Technology apart, the 1240 has automatic polarity indication and a straightforward control layout including a single range selector and fingertip function switches. It's the easy-to-handle go-anywhere portable multimeter.

Go digital with the new 1240. From Solartron, European leaders in digital instrumentation.

Post the magazine's reply-paid card and we'll send you our data sheet of full details.

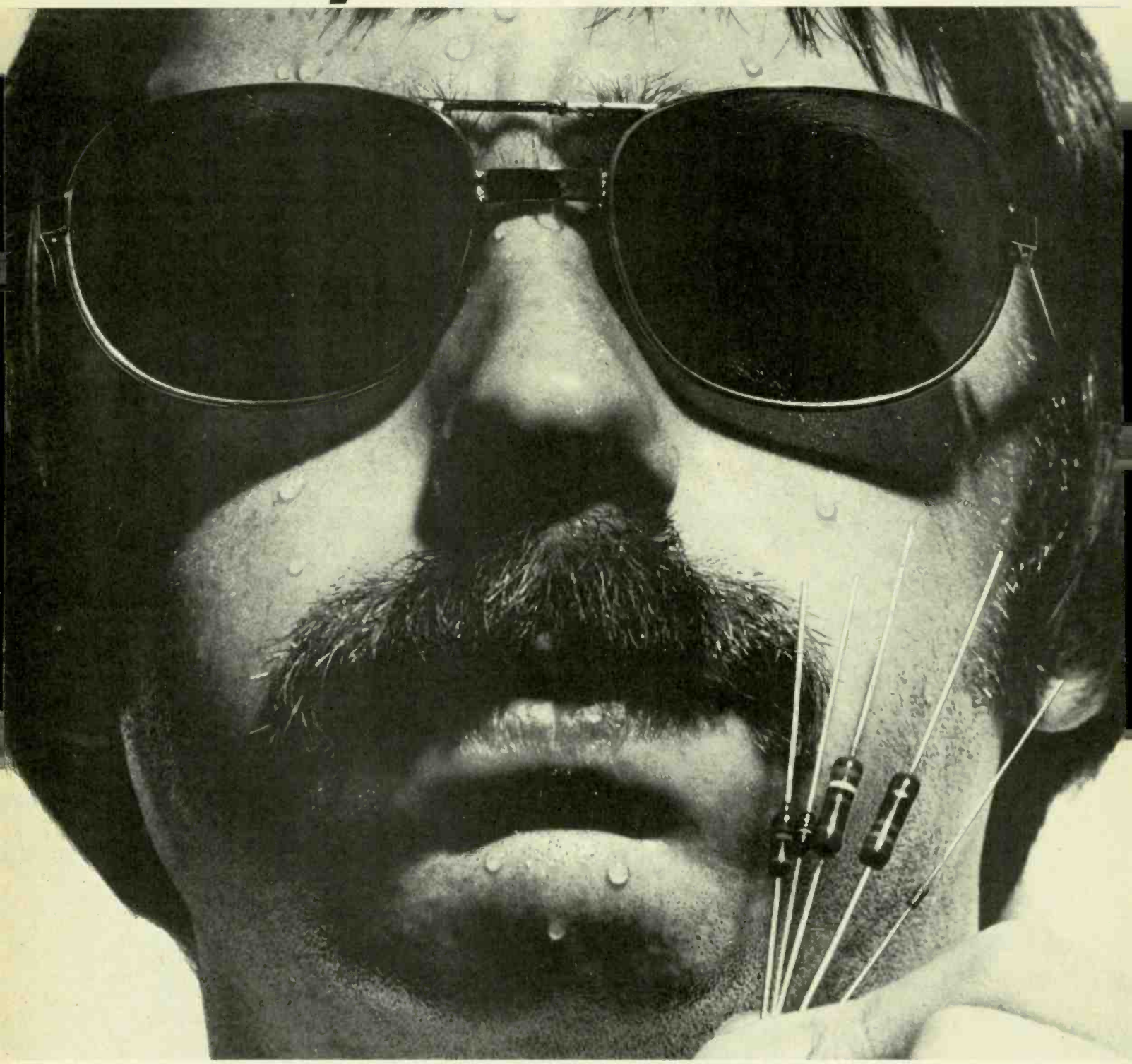


SOLARTRON
Schlumberger

The Solartron Electronic Group Ltd Farnborough Hampshire England Telephone 44433

WW—096 FOR FURTHER DETAILS

We're the first ones to blow hot and cold about our resistors. So that you never will



Just be faithful to Electrosil resistors and they'll be constant, too! Because we demand consistent performance from them before we'll let you have them. Maybe they're in aircraft flying at 50,000 ft. which later land in equatorial heat. Maybe they're in Antarctic equipment. They're indifferent. They've already had, from us, as savage thermal jolts as they're ever likely to get. They're glass-tin-oxide, of course, so you expect a much higher degree of stability and dependability.

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

If you're looking for this kind of performance in a small size, high stability resistor, have a look at the TR4. ¼W rating and only 0.281" long. Available in 1%, 2% or 5% tolerance.
Remember—leave the hot and cold treatment to us—that's how we achieve unwavering reliability.

ELR13

Electrosil LIMITED have the experience

WW—097 FOR FURTHER DETAILS

News of the Month

Parliamentary affairs committee

The Council of Engineering Institutions has formed a committee which will keep chartered engineers in Parliament informed of developments and opinion within the engineering profession. The committee is made up of representatives from the fourteen member institutions of the Council and members from both Houses of Parliament.

The parliamentary members are: Mr. E. Lubbock, Sir Ian Orr-Ewing, and Mr. A. Palmer. The chairman of the committee will be the present chairman of C.E.I., Sir Eric Mensforth, and the electrical, electronics and radio representative will be Sir Harold Bishop.

P.C.M. for B.B.C. stereo distribution?

It is now well known that the B.B.C. is experimenting with p.c.m. for distribution of high-quality sound—the advantages being, of course, the inherently stable characteristics of the system and immunity from noise and distortion in the sound transmission links. In fact, the Corporation has just finished a series of trials of the "sound-in-syncs" system using p.c.m. for television sound (*Wireless World* January 1969, page 38) between London and Kirk O'Shotts and this is expected to come into service within a year.

Writing in the first issue of *B.B.C. Engineering* (a journal replacing the Engineering Monographs), D.E.L. Shorter of the B.B.C. Research Department outlines what might be done in applying p.c.m. to monophonic and stereo sound signal distribution. If the stereo signal were applied to the p.c.m. system in the coded multiplex form in which it is required at the transmitter input, he says, it would be unnecessary to have a stereo coder at each transmitter. In the pilot-tone system used by the B.B.C., however, the spectrum of the multiplex stereophonic signals extends to 53 kHz and it would be a formidable task to design a system to accept the composite signal while meeting the requirements for signal-to-noise ratio. Even if this were done such an arrangement would not allow the information capacity of the channel to be fully utilised, if necessary, for other purposes. A more flexible arrangement could be achieved by transmitting the left- and right-hand signals over separate p.c.m. channels, each of which could then be used independently when required. This would also make more economical use of the capacity of the transmission circuit.

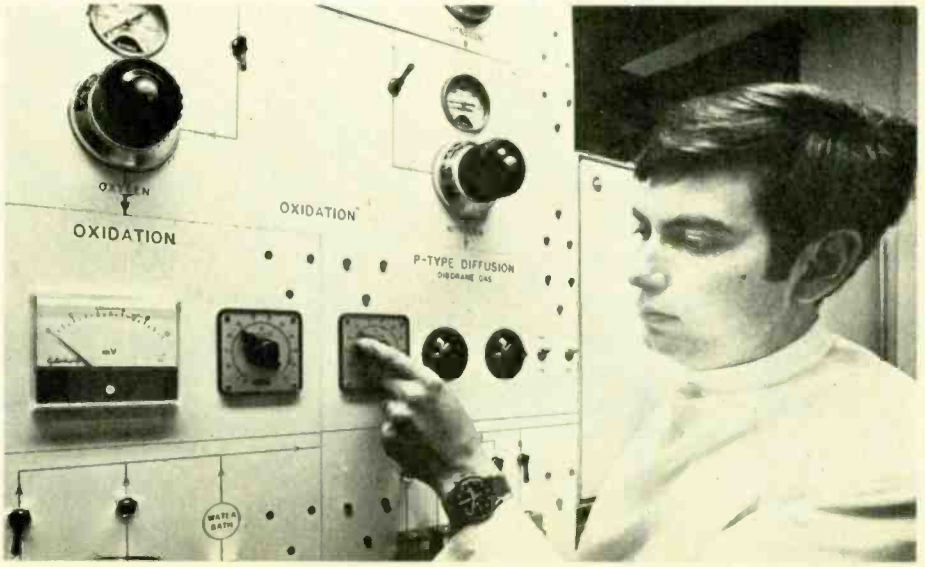
By using separate p.c.m. channels for the left- and right-hand signals, it would be possible to provide stereo coding in a rugged and simple way at the transmitter if the sampling frequency of the p.c.m. system were 38 kHz. The left-right switching, which is part of the stereo coding operation, could be done on the audio frequency signals appearing in sample-held form at the output of the digital-analogue converters. The signal resulting from this switching would then need only the addition of the 19-kHz pilot tone and filtration in a simple low-pass filter to remove components above 53 kHz in order to form the standard stereo signal. This artifice would avoid the need for a conventional analogue stereo coder at each transmitter and would be more economical in circuit capacity than digital distribution of the fully coded stereo signal. However, the use of a 38 kHz sampling frequency would still need some 12% greater capacity in the distribution system than the otherwise satisfactory sampling rate of 33.5 kHz. The higher sampling rate and novel stereo coder are thus of doubtful value.

In the same article, Mr. Shorter discusses the general problem of maintaining the high quality of sound (stereo or mono) in the coding and decoding processes involved in digital distribution. The main problems, it seems, are quantizing noise and distortion from the low level signals. Investigations have shown, however, that the required performance on both counts can be obtained from a 13-bit p.c.m. code using a process of interpolation between quantizing levels. Thus a p.c.m. system is in principle capable of satisfying all the requirements of a high-quality sound signal distribution network which would be able to cope with monophonic and stereophonic signals.

What, not who, is calling

For many people the telephone is the only means of directly communicating with someone else. At the present time a subscriber to the telephone system has at his disposal a vast switching network and he can set selectors clicking in this country, in Europe or in America merely by dialling; a direct pair of wires can be established between one telephone and any other—it does not matter if this

A fully equipped laboratory for the design and manufacture of bipolar micro-circuits has just been completed at Enfield College of Technology. The centre occupies only 750 square feet of floor space and cost about £40,000. The main idea seems to be to involve as many students as possible, in as many process steps as possible, and in projects of industrial value. Courses will be provided at all levels, from technician to post-graduate. Special courses can also be devised to meet particular needs, such as those of company managers and salesmen. Details of the three two-week practical courses to be held this year can be obtained from J. B. Butcher, Director, Microelectronics Centre, Enfield College of Technology, Queensway, Enfield, Middx.



connection be over land-lines, submarine cable, satellite or microwave link.

Computers now chatter to one another over the telephone and many firms send picture facsimiles to and from equipment associated with a telephone. However, for the majority of users the telephone is only a means of voice communication; a fact which means that the telephone system is largely being wasted at the present time.

Perhaps the most important additional use of a telephone would be as a computer terminal. This opens up a vast number of possibilities, too many to go into here, that could place at the disposal of subscribers huge amounts of information. Such a system could hit the printing industry hard, and who knows, in years to come you may receive your *Wireless World* on a c.r.t. display associated with a telephone—with optional line printer of course!

You may wish to switch on your central heating or cooker when you are away from home, this could easily be done by dialling a code on your telephone after connection has been established; and so on and so forth.

The present method of dialling, the Strowger system, does not lend itself to being used in any of the above ways. Before additional services could be provided it would be necessary to go over to the push button method of dialling using tones instead of pulses. The main advantage of the touch-tone system is not a question of novelty or aesthetics it lies in the fact that the push-buttons can be used to send codes after the appropriate number has been dialled.

Unfortunately push-button telephones require special exchange equipment. The Post Office say that this equipment will be installed over the next few years, in fact the Post Office already use push-button telephones in some of their buildings.

The telephone can be used as a means of sending huge amounts of information to a household, it can also be used as a means of extracting data from that household. In fact Bell Labs in America are running a pilot scheme at Holmdel, New Jersey, which reads domestic gas and electricity meters by computer over telephone lines. The computer "dials" the consumer's telephone number and is connected via special exchange equipment, which prevents the telephone bell from ringing, to transducers attached to the meters. The computer, on receiving the readings, carries out all the necessary accounting and recording. The process does not interfere with the normal operation of the telephone in any way.

Although all the above is technically feasible, and the main problem is one of economics, one is bound to ask if the meter reading system is socially acceptable. Apart from possible "big brother" implications many consumers rely on a chat with the "meter man" to gain some idea of what their bill is likely to be. In many areas, with modern high-speed computer processing, there is a gap of about a month between the meter being read and the bill arriving. This gives consumers time to prepare; with the proposed system there would be no early warning.

Tracking vehicle movements

An experimental computer control system designed to simplify and improve the operation of large vehicle fleets has just been demonstrated by Marconi to senior representatives of the London Transport Executive. Centred on a Myriad computer, the system is capable of continuously locating and identifying every vehicle throughout a network, presenting this information on a display screen, and immediately detecting any variations from schedule. This is done automatically without any involvement on the part of the vehicle driver. Additionally, it provides voice communication between the control centre and driver so that fresh instructions may be passed as and when necessary.

Each vehicle is fitted with a distance digitizer which counts the revolutions of its wheels, and therefore measures, digitally, the elapsed distance along a particular fixed route. Vehicles are also fitted with a radio telephone, adapted for two-channel operation, and a telemetry unit.

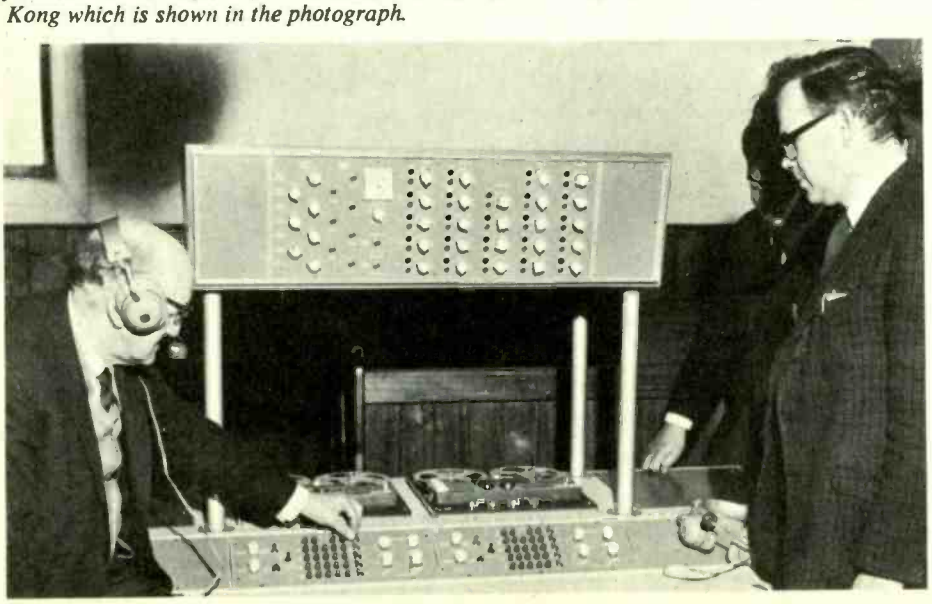
Digital information from each digitizer is passed into a register and is continuously updated at a prescribed rate—typically this might be every 25 feet of elapsed distance. The control room computer can interrogate any register, via the telemetry channel of the radio telephone, and the total elapsed distance count currently held in it will be passed over the link. This data is processed by the computer and displayed on the screen of a cathode-ray tube controlled by it. The display can take one of two basic forms. The route can be represented by a pair of straight lines, one for each direction, with prominent features such as fare stages identified. A vehicle is then continuously represented by a symbol at its current position on the route.

Alternatively, a second method of display allows all the vehicles in a particular area, a city centre for example, to be shown on a map electronically drawn on the screen.

The control room computer can be programmed to provide a number of other facilities. It can compare actual running times with those scheduled, and warn the operator if significant discrepancies are occurring. It can also generate a typewritten log of a day's operation, highlighting any 'out of schedule' running, and can provide this sort of 'history' for longer periods as well. Additional information such as crew meal break schedules may also be held on disc.

Finally, the radio telephone can easily be switched from the telemetry to a speech channel, to allow fresh instructions to be passed to drivers, or to allow emergency calls from them to base.

Sykes-Robertson (Electronics) Ltd. came into being in February 1968, mainly as a result of proposals made to Mr. J. Sykes, an electronics engineering consultant, who went to Sanday (Orkney) to escape the hurly-burly of the South of England. The idea was to find interesting work, mainly for youths and girls who otherwise would have to leave their homes and families to seek employment in the South. The scheme has been a success and the firm, working in a former school and school-house, is currently manufacturing and exporting electronic equipment mainly in the civil and military fields. A recent despatch from Sanday is a high-quality language laboratory for Hong Kong which is shown in the photograph.



University to industry, bridging the gap

A new four-phase sandwich course, lasting one year, is to be introduced by Birmingham University in October 1970. The first in a new series, this course has been developed on the principle that industrially related M.Sc. courses should be designed to bridge the gap between university and industry. It has been designed by several of the leading electronics companies in close collabora-

tion with the University and is sponsored by the Conference of the Electronics Industry, with the support of the Ministry of Technology, the Engineering Industry Training Board, the Science Research Council and the Electronic Engineering Association.

The electronics industry has been concerned for some time over the difficulty of training high-grade systems engineers in the fields of radio communications and radar technology. Normally, each student will be sponsored by a firm in the electronics industry, which, with the assistance of the Science Research Council and the Engineering Industry Training Board will provide his salary and pay all his fees.

Features of the course are that a high proportion of the lectures will be given by people from industry and that the lecture periods have been designed in the form of "modules", each of about three to four weeks' duration which will be available to industry to use as short up-dating courses.

This presents a unique opportunity to graduates to enjoy an intensive course of study and training in industrial research and development while receiving the salary of a full-time staff member of the company by which they are sponsored. The two industry centres for the first year of the course are to be at the Marconi Company in Chelmsford and the Plessey Company at Ilford.

The normal entry qualifications are a first or second class honours degree in electronics, electrical engineering, physics or mathematics or an equivalent qualification "with experience". For further information contact the Post-Graduate Admission Tutor, Department of Electronic and Electrical Engineering, University of Birmingham, P.O. Box 363, Birmingham, 15.

NEW COMPUTER TYPEFACE

A new computer typeface, shown above, has been chosen as the in-house style of Marconi-Elliott Computer Systems Ltd. The typeface, which is based on a square and has no curves or diagonals, makes the design of automatic readers a simpler task; it can also be easily read, even by the untrained eye, and it is not difficult to print by hand.

Keeping passengers informed

Nelson Tansley, in co-operation with Southern Rail's signal and telecommunications engineers, have developed a public address system which has been installed along the fifty miles of line between Woking and Southampton airport. In this system there are three control points; taking the one at the signal box at Basingstoke as an example, the signalman can address any of the five Basingstoke platforms and/or the "up" or "down" platforms at any of the four other stations under his control (Hook, Winchfield, Fleet and Farnborough).

The system employs two pairs of audio cable that already existed along the line. A signalman presses a button corresponding to the particular platform, at the required station, he wishes to address. All four wires are used to send a parallel digital address code which selects the p.a. equipment at the required platform. If the p.a. equipment is not already in use a cable pair is released from the addressing task and is used to inform the control point that this is so. The signalman can then make his announcement. The communication system employs a 20kHz f.m. carrier which is amplified at each remote point and then passed on to the next point.

The circuit is arranged to automatically provide a warning should any part of the transmission path be interrupted.

Post-doctoral research fellowships

The Science Research Council has announced a new scheme of post-doctoral fellowships for outstanding young British research workers to enable them to devote the whole of their time to original and independent research. Under this scheme, starting in October, there will be about 25 awards of much higher value than the 40 awards made last year.

Selection will be based on ability and independent achievement. Graduates in the U.K. may, with the approval of their head of department, apply to S.R.C. for research grants. The new fellowships, which will normally be held for a period of two years and which will be worth between £1,450 and £1,800, will be tenable at institutions in the U.K. or abroad acceptable to the Council—these include universities, colleges and government or industrial laboratories—which can provide the facilities necessary for the proposed research.

Component distributors association formed

With the primary objective of "defining clearly the role that the distributor plays in the chain of events from the creation and production of a product to bringing it to the market place", nineteen companies have formed the Association of Franchised Distributors of Electronic Components (AFDEC). Prime mover was Waldo Thorn, of Celdis Ltd, who called a meeting in February attended by 48 representatives of electronic component distributors. Following the election of a preliminary council with Mr. Thorn as chairman, objectives of AFDEC were discussed including its relationship with the Ministry of Technology and other associations such as the Radio and Electronic Manufacturers' Federation.

Domestic receiver deliveries

The British Radio Equipment Manufacturers' Association has released details of the total disposals of receivers to the trade during 1969. In the list below the 1969 figure is followed by the 1968 figure in brackets and the percentage change. Totals given should be multiplied by 1,000.

Radio receivers 737 (1,025) −28%; car radios 340 (388) −12%; radiograms 201 (226) −11%; monochrome television receivers 1,673 (1,753) −5%; colour television receivers 154 (121) +27%.

The highlight during 1969 was, without a doubt, the colour television disposals which showed a large increase, particularly in the last four months of the year.

The Electronic Industries Association of America has also produced results for 1969; these are presented as above, however a multiplication factor of one million should be applied.

Radio receivers 9.7 (11.8) −17.7%; car radios 10.1 (10.7) −5.4%; monochrome television receivers 5 (5.55) −10.4%; colour television receivers 5.5 (5.8) −7.7%.

It is interesting to note that of the 39.4M radio receivers sold in America in 1969 only 4.7M were home produced.

Wildlife tape recording competition

The European Broadcasting Union felt that the European Conservation Year 1970 was an ideal time to recognize the importance of wildlife sound recording, so, at the suggestion of the B.B.C., it decided to sponsor a wildlife tape recording contest. The competition is open to all living in Europe and Iceland.

There will be four categories and the winner in each will receive a "silver nightingale trophy" and the runner up a "bronze nightingale trophy". An outright winner will be chosen from the category winners who will be presented with a "golden nightingale award". Enquiries for entry forms and rules should be addressed to the Wildlife Sound Librarian, B.B.C. Natural History Unit, Broadcasting House, Whiteladies Rd, Bristol BS8 2LR.

Travelling award

The Royal Television Society invites applications for the 1970 John Logie Baird Travelling Award which has been increased this year to £500.

What they say

"It wasn't until I joined the B.B.C. that I learned that the Heaviside layer was not the top brass at Broadcasting House!"—Lord Hill, chairman, B.B.C., speaking at the I.E.E. annual dinner.

Letter from America

Sales of recorded stereo tapes accounted for approximately 26% of all recorded music sold in America during 1969 and should increase to 35% in 1970, according to Donald Hall, vice-president of Ampex. He went on to forecast that tape sales would equal sales of discs by 1972 or 1973.

At the moment, 8-track cartridges are still more than holding their own with 74% of the sales, followed by 15% for cassettes. There is no doubt that cassettes will gain in popularity and eventually overtake the 8-track cartridges which are mainly used in car-players. North American Philips confirm the rapid increase in popularity of cassettes and a spokesman said "Cassette equipment represents the fastest growing segment of the home entertainment industry—and it will gain a further impetus when cassette players are fitted to the new 1971 cars". Incidentally, nearly 10 million car radios are sold in the U.S.A. every year—more than the sales of domestic radios!

Before leaving the subject of sales—a few words about television. Last year colour sets sold just over 5 million—about 10% more than black-and-white. RCA have just announced plans to build a 20,000-ft plant in Mexico for the manufacture of colour tubes, and a larger one in Puerto Rico which will concentrate on shadow masks. One of the new RCA portables features a remote control unit which "gives instant shut off without need to turn down the volume control first". This is accomplished with a "computer-tested integrated circuit amplifier". The automatic fine tuning is also "computer designed"!

Meanwhile, that flat television screen is still just around the corner and the latest contender in the race is International Devices Ltd., of Fort Erie in Canada, who say they will have a flat-screen receiver in production by the end of the year. An electro-luminescent coated screen is used with vertical and horizontal potentials applied by an XY grid. It is claimed that picture brightness has been achieved up to 25% better than on standard colour TV sets now on the market. According to the company president they are only working with colour because "black and white is more difficult" and he is reported as saying that screen sizes up to 36 by 50 inches would present no problems.

Much work is going on behind the scenes with video cassette recorders and Capitol announced recently that they had one on the drawing board awaiting the establishment of industry standards. They stated that "a cassette television programme of a half hour or full hour would probably sell for about $30" (£12 10s.) and they also forecast a TV programme rental library system. The Capitol unit is simply wired to the aerial input of the home television set, and then all the user has to do is to insert a cassette and he can watch his favourite programme as many times as he likes.

Big news in the Hi-Fi world is the introduction of 4-channel stereo sound, or Quadrasonics. With present techniques this involves the use of two broadcasting stations but stations in Boston, New York and in other parts of the country have been pairing up to broadcast live concerts and tapes (made by Vanguard) and so have created considerable interest. True, there was some (predictable) criticism from a few sceptics who believe the whole idea is a gimmick thought up by speaker manufacturers or tape companies, but the majority of people who have heard 4-channel sound have been most impressed. How are the microphones placed? Well, for the initial Boston experiments (with the Boston Symphony Orchestra) two microphones were in the the usual stereo positions and two more were placed at the rear. One station carried the signals from the left front and left rear and the other from the right front and right rear. This unusual arrangement was in the interests of compatibility but recently the organizers had second thoughts and now one station transmits the signals from the front pair and the other station from the rear two. Not compatible at all; but I wonder how many complaints were received?

It is claimed that 4-channel stereo is much more *immediate*, more exciting than 2-channel (you could not use it as background music) and some enthusiasts are even saying "the difference between 4-channel and conventional stereo sound is greater than between 2-channel stereo and monophonic reproduction". It is certainly true that room acoustics become less important and there is a greater feeling of being at the actual performance. Some of the demonstrations feature large orchestral works where the rear channels supply most of the reverberation and this does help to give that 'you are there' feeling. However, I believe opera and drama will gain the most from the extra dimension. On the other hand, many contemporary composers are very enthusiastic about the possibilities and Henry Brant finds it ideal for his "space music". In a recent recording session at the large Eastman theatre, no less than five different groups of performers were used, on stage, in the balconies and in the aisles.

If Quadrasonics becomes popular, what are the record companies going to do about it? You may be sure they are not ignoring it and several companies are busily working on 4-channel discs using multiplex systems and it is rumoured that some will be demonstrated at a meeting of the Audio Engineering Society in New York very soon. It is obvious that it is not *really* feasible to use two separate broadcasting stations (except for experimental purposes) and so various schemes have been proposed that will allow 4-channel transmissions from one station. One of the most practical involves a multiplex arrangement and it is described by L. Feldman in *Audio* for January 1970. The only disadvantage is a slight loss in bandwidth of the rear channels but this may have to be accepted. Tapes, of course, present no problems and several recorders are now available with stacked heads. Scott brought out a Quadrasonic receiver in December but the majority of manufacturers are waiting to see what happens before they commit themselves. Among them curiously enough is Acoustic Research (AR) who have played a large part in organizing the Boston experiments.

G. W. TILLET

Our contributor **George Tillett** *has been appointed editor of* "Audio". *Since going to the U.S.A. five years ago he has successively been director of engineering in the Pennsylvania plant of Fisher Radio Corp. and executive vice-president of Audio Dynamics Corp. Prior to leaving this country he had been with Daystrom, as chief engineer, and latterly with Wharfedale as technical director.*

SONEX 70

Exhibitors at the forthcoming London Hi-Fi Show

With the transfer of the annual London Audio Festival & Fair from a hotel setting to Olympia and from the spring to the autumn there has apparently been agitation by some manufacturers for a spring show similar to those run first at the Waldorf Hotel (under the auspices of the defunct British Sound Recording Association) and latterly at the Hotel Russell. As a result the Federation of British Audio formed a company—British Audio Promotions Ltd—to organize a specialist hi-fi exhibition. The first of what is planned as an annual event, is to be held for four days (April 23rd-26th) at the Skyway Hotel, near London Airport, Heathrow. Each of the 50 manufacturers taking space at 'Sonex 70', as the exhibition is called, will have an individual hotel room for demonstrations. One advantage of the Skyway Hotel is that, because of its proximity to the airport, all the rooms are sound proof. The list of manufacturers exhibiting is given below.

It is encouraging to note that although the show is sponsored by the Federation of *British* Audio, there are a number of overseas names among the exhibitors.

The show will be open from 11.00 to 21.00 on each of the first three days. On the last day (Sunday) it will open at 11.00 but close at 18.00. Admission on the first day is restricted to the trade. Tickets for the other days are obtainable free from exhibitors, audio dealers or the exhibition organizers British Audio Promotions Ltd., 49 Russell Square, London W.C.1.

In our June issue we plan to include a more detailed account of some of the new products a few of which are illustrated here.

Manufacturers at the Show

Acoustic Research
Akai
Arena
Armstrong
Audiotechnica

BIB Multicore Solders
Brenell

Cambridge Audio
Cosmocord

Daystrom
Decca
Dynatron

Goldring
Goodmans
Grampian

I.M.F.

Jordan Watts

KEF

Leak
Lowther
Lugton
Lux

Metrosound
Modular Audio Components
Mullard

Ortofon

Peak Sound
Pickering
Pioneer

Quad

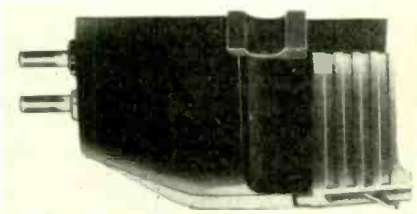
Radon
Rank Wharfedale
Revox
Richard Allan
Rogers
Rola-Celestion
Rotel

Sansui
Shure
Sinclair Radionics
Sugden, A. R.
Sugden, J. E.

Tape Recorder Spares
Teleton
Thorens
Toshiba

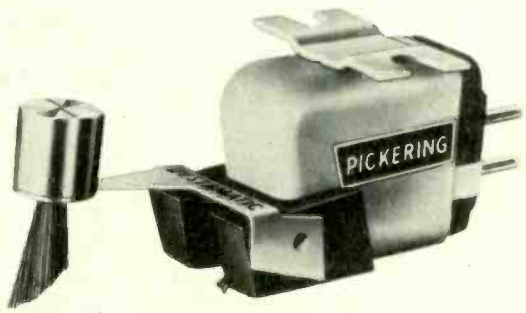
Vortexion

Williman Export



Goldring's G.850 stereo magnetic cartridge costs £6 10s and is designed to operate at a playing weight of between 2 and 3½ gm. The stylus has a 0.0007in diamond tip.

The XV-15 series of Pickering magnetic cartridges range in price from £15 15s (XV-15/100) to £39 (XV-15/750E). Some units have spherical and others eliptical styli. A groove-cleaning brush is fitted to each cartridge.



A reverberation amplifier, the SR202, from Pioneer enables controlled reverberation effects to be added to recordings that are judged to be too dry or dead. The system employs two time-delay circuits and the output is claimed to be free from peaks. The price is £45 9s 11d.

Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

Measuring crossover distortion

Even by allowing Mr. J. F. Golding his margin of decibels by calculating-out the noise up to a level 3dB above that of the t.h.d. ("Letters" March 1970 issue), his 57dB s/n ratio amplifier turned down from maximum power to 10mW by means of the volume control would—based on 10W maximum power—permit easy measurement of little less than 0.5% t.h.d. Not easily down to 0.1% as stated by Mr. Golding in his letter. The reason for this, of course, is that the noise of the power amplifier although relatively small is significant. The full-power s/n ratio would not be retained at the low power, for this implies that the ratio of noise relative to full power is enhanced in exactly the same ratio as the power is diminished. In reality, while the output power is reduced from maximum by, say, 30dB by turning down the volume control, the noise yield at the output rarely falls by more than 10 to 15dB over the same volume control range. Obviously, the noise of the pre-amplifier section passed by the volume control adds to the noise of the power amplifier by a square law.

I initially test at maximum setting of the volume control because some pre-amplifiers tend to veer towards non-linearity more easily than may be appreciated. Moreover, the control might affect the frequency response either unintentionally or purposely (e.g., fixed 'loudness' action lifting treble and/or bass as the control is turned down), and the maximum setting ensures that an established test datum level can be quickly repeated, not always as simple as it may seem, by using the amplifier's volume control. Nevertheless, subsequent to exploratory tests there may be merit in rechecking at low volume-control settings and when so warranted I do this. It is also noteworthy that the noise decrease at the output, on turning the volume control right down to minimum from maximum, can be quite small, depending on the nature of the volume control circuit and the noise performance of the circuits either side.

Mr. Golding fails to specify the wave analyser which provides the 3,000:1 input noise bandwidth to filter bandwidth, but I am sure he will agree that the readout of such low-level distortion components as implied by his dB values relative to a low impedance output load is not exactly an 'easy' matter. I have found that an s/n ratio improvement of about 30dB based on a 10-W 8-ohm 80dB s/n ratio amplifier running at 0.1mW allows a threshold readout little better than 0.1% selected harmonic. For ultimate measurements deep into noise one has to adopt phase detection and correlation techniques, the latter allowing useful signal indication up to 60dB deep in noise.

T.H.D. is a popular way of amplifier distortion appraisal in spite of all the other more sophisticated methods. It is less costly and less time consuming than analysis of individual waves. It is ideal for speedy distortion comparisons, and with a 'scope attached to the readout the knowledgeable operator can quickly glean useful information about the nature of the distortion and observe crossover artifacts if they exist. Treble-end performance can also be highlighted and the presence of odd-numbered high-order harmonics is revealed to the owners of both sensitive and cloth ears.

GORDON J. KING,
Brixham,
Devon.

V.H.F. services

I was touched to notice in his March contribution that "Vector" has been studying the wisdom of the ages. Now that my friendly neighbourhood tower crane has moved away I think I was probably right in 1947 to urge a more detailed study of pulse modulation. But after all, was it in 1933 that the quite successful tests of single sideband and carrier were made from Daventry? And where did they lead us?

Two other articles of the period still have some interest. The f.m.-a.m. controversy was bedevilled by the statement in the House of Commons by the P.M.G. of the day that no discussion could fruitfully take place until he had considered an entirely new system of modulation. He did not tell the Post Office engineers what it was. He did not tell the BBC engineers what it was. But it was entirely new and there was a change of Government and when his party came back they didn't make him P.M.G. So we shall never know.

Another topical article followed, I think, my discovery that at Copenhagen the British contingent regarded engineers and foreign office staff as Falstaff saw bread and wine.

Without going into details we can split music into three classes: pop, palm court and proper. Land-lines need not be rationed, so that by using synchronized carrier only a small number of m.f. channels need be locked up to provide three European music programmes. The remaining channels are available for speech programmes, which are essentially national or local. Any country getting two or three national channels then would offer a choice of five or six programmes, even though its share of the production costs of the three common programmes would be small. The only trouble is that this solution provides the most listening, not the most jobs.

A final memory is of a letter, circa 1946, urging that television services should not be resumed. As an engineering problem the transmission of moving pictures was worth doing, because it was there. But there would never be the talent to produce 30 or 40 hours of programmes a week. How right I was.

THOMAS RODDAM

Theoretical and measured response

While musing on the operation of the tone circuitry in the pre-amplifier designed by Dr. Bailey, I did a few mental calculations, and was interested to note an apparently large discrepancy between the measured and theoretical treble response curve.

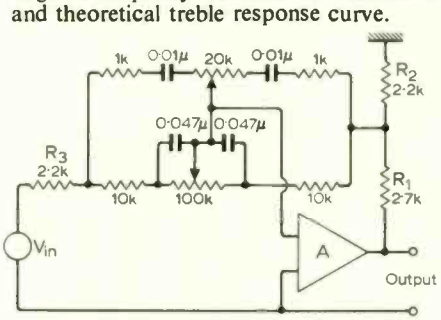


Fig. 1. Circuit of tone control.

Consider Fig. 1. At high frequencies all capacitors can be assumed low impedance, and in the limiting case, zero impedance. So for maximum treble-setting the high-frequency gain asymptote can be calculated if it is assumed that the two arms of the network are acting operationally. The limiting high-frequency equivalent circuit of Fig. 1 is shown in Fig. 2.

So the high-frequency gain asymptote is given as below:

$$G = \frac{1.2 + \dfrac{21 \times 10}{21 + 10}}{2.2 + \dfrac{1 \times 10}{1 + 10}}$$

$$= \frac{8}{3.1}$$

So $20 \log G = 8.2$ dB.

This value of G is about 10dB less than the apparent high-frequency asymptote given by Dr. Bailey. I would like, with

respect, to suggest that perhaps the frequency response curves given were measured before the output attenuator R_1, R_2 and the input resistor R_3, were added. These are respectively included to increase the overall gain of the circuit to about 2, and as load impedance to match the treble filter which feeds directly into this stage.

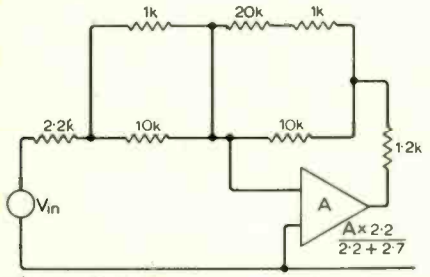


Fig. 2. High-frequency equivalent circuit.

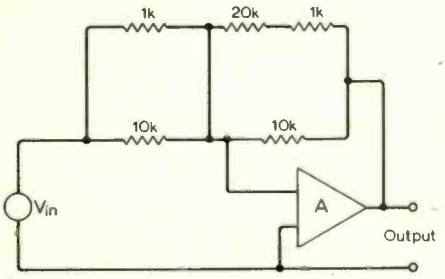


Fig. 3. Unity-gain version of Fig. 2 omitting R_1, R_2 and R_3.

The equivalent circuit at high frequencies for maximum treble lift can now be drawn as in Fig. 3 with R_1, R_2 and R_3 removed.

Now

$$G = \frac{21 \times 10}{21 + 10} \Big/ \frac{1 \times 10}{1 + 10}$$

$$= \frac{6.8}{0.91}$$

So $20 \log G = 17.5$ dB

This value agrees with Dr. Bailey's and is a reasonable figure.

It should be noted, therefore, that, so as not to restrict the range of the controls R_3 should be as small as possible.

It is also apparent that R_3 should equal the parallel combination of R_1 and R_2 otherwise the input and feedback portions of the network will not balance correctly with the controls centred.

P. M. QUILTER,
University of Sussex,
Brighton.

The author replies:

I was very interested in the letter from Mr. Quilter and his comments on the performance of the tone-control circuit. He is perfectly correct in his deductions and I must confess that the original curves were obtained with the treble filter circuit omitted. For this reason it is better to use the modified circuit where the filter components are bypassed with the filter out.

Personally, I have found that with speaker systems of low resonance (and similar performance pickups), treble filters are unnecessary unless a particularly dreadful recording is being played. 'Edginess' in reproduction is nearly always due to defects in speaker and/or pickup transient response—assuming that there is no crossover distortion trouble in the amplifier in use.

Similarly my treble controls are nearly always 'flat' and I use only a small amount of bass boost to make up for dynamic levels in playback. For my part I cannot see the need for ±20dB variation in controls, but I must agree that it looks better on a specification than say ±12dB.

Perhaps this is the reason why only one or two people have queried the performance (and then only h.f. boost). However it becomes obvious from Mr. Quilter's deductions that the two end-stop resistors of 1kΩ on the treble control are redundant. Also the 2.2kΩ resistor R_3 should be 1.2 kΩ for accurately balanced controls.

All this goes to show how simple modifications for one purpose can seriously modify the performance of a circuit in other directions. Many thanks Mr. Quilter, for a very useful lesson in the value of fully analysing the effects of modifications.

ARTHUR R. BAILEY

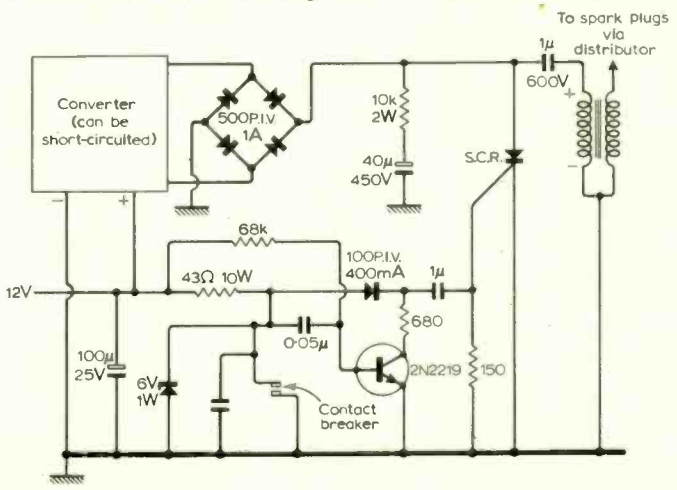
Capacitor-discharge ignition

During the last five years I have been interested in electronic ignition systems and after seeing Mr. Marston's article in the January issue of *Wireless World* I am prompted to write offering several comments on my own experiences.

In winter sub-zero conditions, the battery may drop to as low as 7V with a big engine and can rise to 15.5V under alternator charging. These limits are very severe on any ignition circuit, and accordingly in this continent [America] nearly standard ignition systems consist of a 1.5Ω ignition coil and a 1.5Ω series ballast resistor. While starting the ballast resistor is shorted out and the system gives fantastically good cold-weather starting. I doubted whether Mr. Marston's self-regulating converter would regulate well over a 2 to 1 voltage range, so I set about constructing his converter with a 17V 2A transformer that I happened to have brought back to Canada from a recent two-year stay in Cambridge. It has 210-, 220- and 240-volt primary taps. After rewinding two times 65 turns (the original had 136 turns) the converter put out about 500V in an ignition circuit with identical high-voltage components to Mr. Marston's circuit! There were rather large spikes at the transistor collectors and even at a very low sparking rate (induced manually) the voltage went down to 400V quickly. It seems the spikes do not have much energy to charge the 1μF discharge capacitor. At 10V d.c. input, the output was still 400V unloaded but this dropped to 300V at a low sparking rate. At 7V d.c. input the spark was inadequate. Mr. Marston's circuit may have regulated better (no two transformers are alike) but I feel such circuit action is not desirable where reliability is necessary. My friends and I have solved low starting voltage problems in several ways. One friend designed his system for 500V with 15V d.c. input, and this suffices until the battery falls below about 8V. Another friend uses a relay to switch in extra secondary turns on the converter transformer only during starting. My own solution is to add across the s.c.r. a large electrolytic capacitor in series with a 10-Ω 2-W resistor. The converter is a high-frequency unit (~1kHz) with no spikes, which supplies 400V with 15V input. When the ignition key is first turned on, the capacitor (~40μF) charges in a fraction of a second to ~400V, and the first 30 sparks are good and hot, no matter what the battery voltage.

Another serious problem is caused by the ballast resistor. After an ignition pulse, the converter again charges the discharge capacitor, causing typically several volts drop in the resistor. When charging ceases, the increasing voltage applied to the s.c.r. firing circuit could initiate a trigger. This has happened to some of my designs in the past and to combat any spurious triggering a 6-V 1-W zener diode was placed across the contact breaker. Any noise on the battery line produced by an erratic regulator will also be squelched by this zener. In Mr. Marston's circuit, transistor Tr_1 has an emitter-base breakdown voltage of about 7V, and the zener will also prevent very large base reverse currents which must flow when the contact breaker closes in the circuit as drawn. I do admire the trigger circuit for its positive ability to remove harmful effects of point bounce, and have already adopted it in my own unit.

The last point which I should mention as a purist is that a spark plug fires with lower voltage when the central electrode is negative, due to thermionic electron emission



Mr. Vanderkooy's circuit. The converter is an h.f. near-perfect square-wave unit using a nickel-tape-wound toroid.

from the hot electrode. All ignition systems, positive or negative earth, operate this way, and this feature should be preserved in an electronic system. A little analysis will show that in a standard ignition coil designed for a positive earth system (many British cars) the SW terminal should be grounded. (Fig. 6 in Mr. Marston's article.)

In conclusion perhaps readers would like to see my final circuit.

JOHN VANDERKOOY,
University of Waterloo,
Ontario.

The author replies:

From his letter, it seems that Mr. Vanderkooy has failed to grasp the operating principles of the converter circuitry, and does not appreciate the electrical requirements of an ignition system under cold start conditions.

I can assure Mr. Vanderkooy that the design of the converter section is such that it is virtually impossible for its output to exceed 414V ±5%. If higher voltages are obtained, it can only be because T_1 has been given a turns ratio greater than 15:1, or because ZD_1 and ZD_2 are not 27V ±5% types. If output voltages rise appreciably above the designed value, the s.c.r. (a 400V type) may be destroyed.

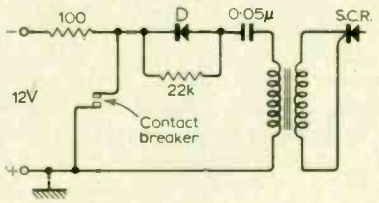
The ignition system has been specifically designed to give good cold-start characteristics; overshoot regulation is utilized to this end. While it is true that the overshoot (what Mr. Vanderkooy calls 'rather large spikes') contains very little energy, this energy is sufficient to meet cold start needs. Typically, a starter motor will turn an engine over at a 'brisk' rate of about 300 r.p.m. under 10-V cold start conditions, and at a 'sluggish' rate of only 150 r.p.m. at 8V. The table below shows the measured performance of the circuit under these conditions, and also at 7V cold start; I consider the performance to be adequate under all conditions, and I feel sure that Mr. Vanderkooy will agree with me if he carries out a little practical research into the subject.

No. of cylinders	C_1 charge voltage		
	7V, 150 r.p.m.	8V, 150 r.p.m.	10V, 300 r.p.m.
4	260	290	325
6	250	280	322
8	240	270	310
12	237	265	300

Finally, I suggest that if Mr. Vanderkooy's battery potential does in fact fall as low as 7V under cold start conditions, there is something seriously wrong with either his battery, his starter motor, or his choice of lubricating oil; battery potential should in fact never fall below 8 volts, even under the most severe cold start conditions.

R. M. MARSTON

Having done some work on this system of ignition may I bring out a few points which may be of interest to readers? The converter transformer can conveniently be one of the centre tapped l.t. types which are on the market. Working backwards a 9–0–9 volt secondary is about right for square-wave working at 12V d.c. and gives a frequency of a few hundred Hz. The capacitor C_1 does need to be a low-loss type, a paper capacitor was found to become very warm at spark rates of 300 per second corresponding to 6000 revolutions per minute with a six-cylinder engine and 9000 with four cylinders. It is worthwhile to include a recovery diode across the s.c.r.: nearly 20% of the energy can be recovered from the leakage reactance on the backswing. Best results are usually obtained with a 6V 'sports' type coil which has a low primary inductance and resistance, the rated voltage of the coil does not matter much with this type of circuit. Putting a



'crowbar' across the inverter output at each spark seems rather brutal and I have always used choke charging with an inductance of 3 to 5 henries between the inverter and C_1. The circuit can be simplified by using a small differentiating transformer to produce the s.c.r. firing pulse.

Diode D and the 22kΩ resistor give a delayed recovery to avoid misfiring as a result of contact bounce. The normal ignition capacitor is removed when using this circuit.

I have had an ignition system of this type in use now for some 6 years and 70,000 miles with complete success.

H. HARPER,
Fleet,
Hants.

The author replies:

When designing the original circuit I tried to find a standard l.t. transformer that could be used in the system; I considered the possibility of using a 9–0–9 volt one, but found that they were generally available in 2- and 4-amp ratings only. Unfortunately the 4-amp type (which is essential for operation up to c.b. frequencies of 660Hz) was found to be physically too large to fit inside the standard chassis in which I built the unit. The 2-amp type was found to give a reasonable performance when used on a four-cylinder engine at speeds up to 6000 r.p.m., but to be inadequate when used on engines with six or more cylinders (the reasons for this should be self evident).

Regarding the use of a diode to give energy recovery on the backswing; D_3-D_6 already perform this function in the original circuit!

Regarding the use of a 6V 'sports' coil and the removal of the normal c.b. capacitor; the original system was designed to use the existing coil and c.b. components, thus keeping building cost to a minimum and enabling the ignition to be changed from C-D to normal, and vice versa, with great ease. Mr. Harper's mods nullify these features!

R. M. MARSTON

I have been developing a capacitor-discharge ignition system for some time and I think you may be interested to know how I have attempted to overcome some of the problems mentioned by correspondents.

I have positively prevented s.c.r. latching by doing two things. I have arranged a feedback system to provide the gate drive. This consists of a monostable with a feedback connection from the s.c.r. anode which causes the drive pulse to be switched off as the s.c.r. switches on. This prevents gate drive from latching the s.c.r. I have also used a driver h.t. converter. In this the pulses from the driver circuit are fed through a gating circuit before being fed to the output transistors, driving the transformer. So by using the gating circuit to switch the converter on and off, very fast and reliable turn on, and turn off may be obtained. This facility may also be used to regulate the voltage to which the capacitor is charged by using a comparator to measure this voltage and switch the converter off when the capacitor is suitably charged.

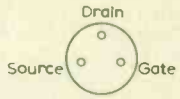
Finally I would like to make a few comments about the e.h.t. coil and the contact breaker points. Standard coils are not the best for use with capacitor-discharge systems. A far better coil would be a low-inductance primary, closed-iron type. These offer higher efficiency, higher operating speeds and less need for energy retrieval to recharge the capacitor (that is using the coil's back e.m.f. to charge the capacitor).

Also I believe it would be worthwhile for the more ambitious constructor to try to replace the points with a photo-electric magnetic or reed switch pick-up as points can be quite troublesome when lightly loaded.

D. J. WHITE,
Harborne,
Birmingham.

Modular pre-amplifier design

Some users of this design (*W.W.* July 1969) have found a somewhat higher level of background 'hiss' than had been expected at very low settings of the volume control. Where this has occurred it is usually due to the f.e.t. used as Tr_5 in the tone control circuit.



A much improved performance in this respect can be obtained by the use of an Amelco 2N4302 or 4303. In the former case it may be necessary to modify the biasing of the f.e.t. to ensure that the drain current is at a suitable level. (The voltage measured at the emitter of Tr_6, which is a convenient point, should be somewhere in the range 6-11 volts.)

The adjustment of the f.e.t. bias can be done either by alteration to the 33-kΩ source resistor, or by connecting a resistor of about 3.3MΩ between the emitter of Tr_4 and the gate of the f.e.t.

J. L. LINSLEY HOOD,
Taunton,
Som.

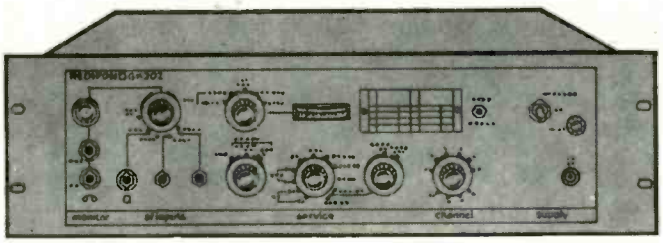
17 ways to drive

-all the signals needed for HF traffic

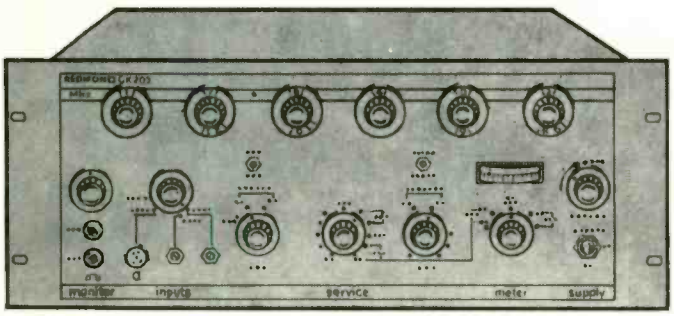
A new flexibility for your HF transmitters is yours immediately you install one of Redifon's three new HF drive units. Each generates up to 17 different modes of transmission covering telegraphy and telephony —CW, DSB, SSB and ISB —at the frequency of radiation. Each is a completely self-contained unit with its own power supply and a 19-inch rack-mounting front panel to fit neatly into linear amplifier housings.

Units are available with spot tuning or full frequency synthesis, 1.5 to 30 MHz.

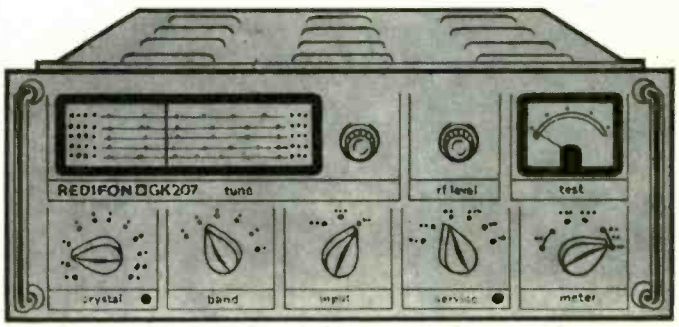
Automatic volume compression for extra talk power and voice-operated Transmit switching, both selectable.



GK 202: 10 spot channels, set by a single switch



GK 203: Frequency synthesis in 100 Hz increments to provide maximum frequency flexibility



GK 207: 10 spot channels; manually tunable output circuits allow allocated channel frequencies to be changed rapidly by plugging in new crystals, without having to realign any pre-set circuits

Find out more about how flexible and economical your HF drive arrangements can be, by writing to:

The Sales Manager,
Redifon Limited, Communications Division,
Broomhill Road, Wandsworth, London, S.W.18.

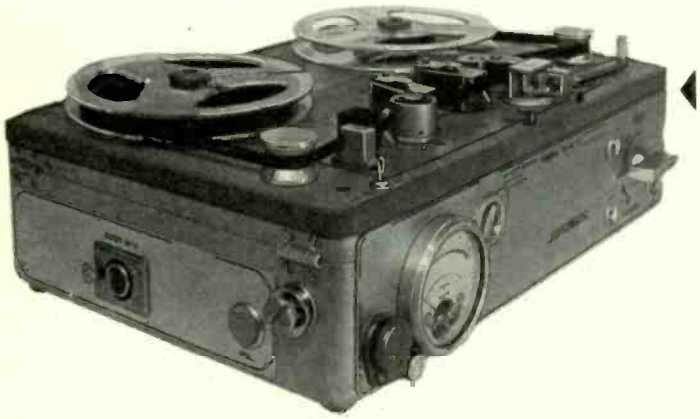
REDIFON

A Member Company of the Rediffusion Organisation

WW—098 FOR FURTHER DETAILS

NAGRA

The world's best portable professional audio tape recorder



MODEL IVA Automatic, single speed

MODEL IVB Manual, single speed

MODEL IVD Automatic/Manual, three speeds

MODEL IVL Neopilot, three speeds, Automatic/Manual

* *Lids of transparent, shock resistant plastic, have been removed for clarity of illustration.*

These models plus eight variants give the professional user a choice of twelve basic Nagra IV tape recorders. Modular plug-in electronic circuit boards, available for each machine, allow unique flexibility in the choice of recording functions.

Study the Nagra IV brochure and see how you can select precisely the facilities you need, built in to one compact machine of outstanding performance and reliability.

Write or telephone for technical information.

HAYDEN LABORATORIES LIMITED,

East House, Chiltern Avenue, Amersham, Bucks., England

Tel: 02403 5511 Telex: 83251 Cables: Haylab Amersham.

HAYDEN

WW—099 FOR FURTHER DETAILS

Digital Remote Control System

Up to fifteen circuits may be controlled from a remote point with this system

*by H. N. Griffiths**

Up to fifteen circuits can be remotely controlled using this system, the block diagram of which is given in Fig. 1. As can be seen the system consists of two units, a coder and a decoder, connected by some form of data link; this could be a pair of wires or a radio transmitter and receiver.

The coder is a pulse generator which can generate a train of between one and fifteen pulses under the control of the switches S_1 to S_{15}.

Initially the stop and set zero lines in the coder are UP (positive) so that the multivibrator is stopped and the counter is set to zero. Operation of any control switch (S_1 to S_{15}) earths the stop and set zero lines and the counter starts to count pulses from the multivibrator which will have started. When the counter reaches a preselected state, as determined by the logic network and the operated switch, the inhibit line goes UP and the multivibrator stops.

The decoder counter also counts the pulses from the multivibrator which are sent over the data link. When the multivibrator is inhibited the two counters will hold the same number. The logic network in the decoder now actuates the required control.

It is arranged that when the input to the decoder is UP (no signal) the decoder set zero line is also UP, resetting the counter. On receipt of the first negative edge the set zero line of the decoder goes down and is held down by capacitor C_S so that the counter can accept the incoming pulses.

On release of the control switch in the coder the stop and set zero lines in the coder go UP returning the coder to its initial state and the input to the decoder also goes UP (and stays there) so that the decoder counter also resets. The operated control is now released.

When fewer than fifteen controls are required, the decoder logic network can be simplified. Indeed, if relays are used to operate the controls it is possible to eliminate the logic network by using the relay contacts to perform the decoding logic functions. In such a system (Fig. 2) the relay coils are controlled directly by each stage of the binary counter via the transistor switches (see inset Fig. 3). Fewer relays are required to perform a given number of on-off control functions than is the case when a separate relay is used for each control. The overall reliability of the system is degraded, however, because each control is operated through a group of contacts in series and failure of any one of these will cause at least one control (and possibly half the total number of controls, depending on the position of the fault) to fail. However, the saving in circuitry and the increased simplicity of the system will, in many cases, offset the risk of simultaneous failure of more than one control.

Communication Channel

The simplest form of data link is two wires between coder and decoder. In

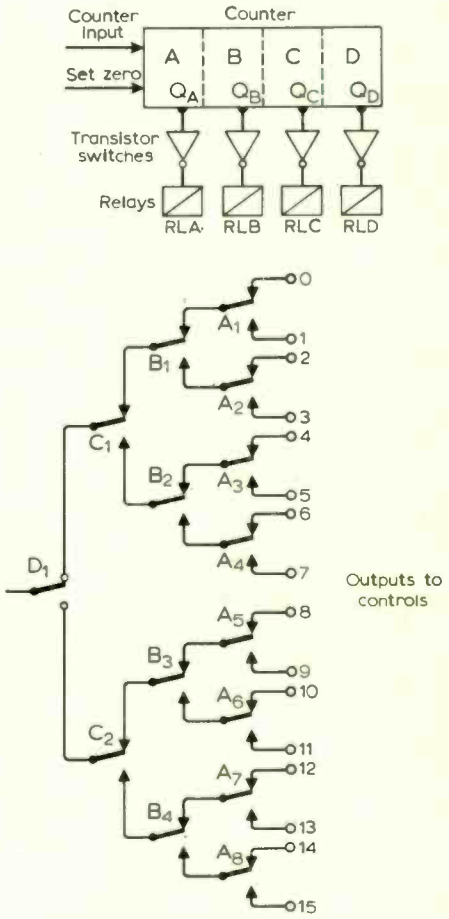


Fig. 2. (Above) Showing how the decoding can be performed with relays.

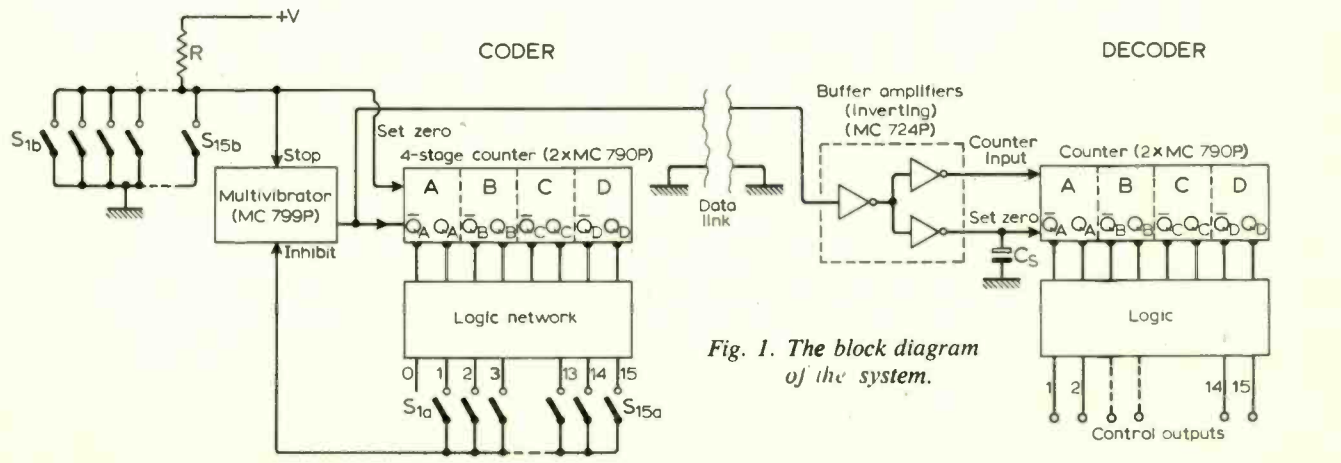


Fig. 1. The block diagram of the system.

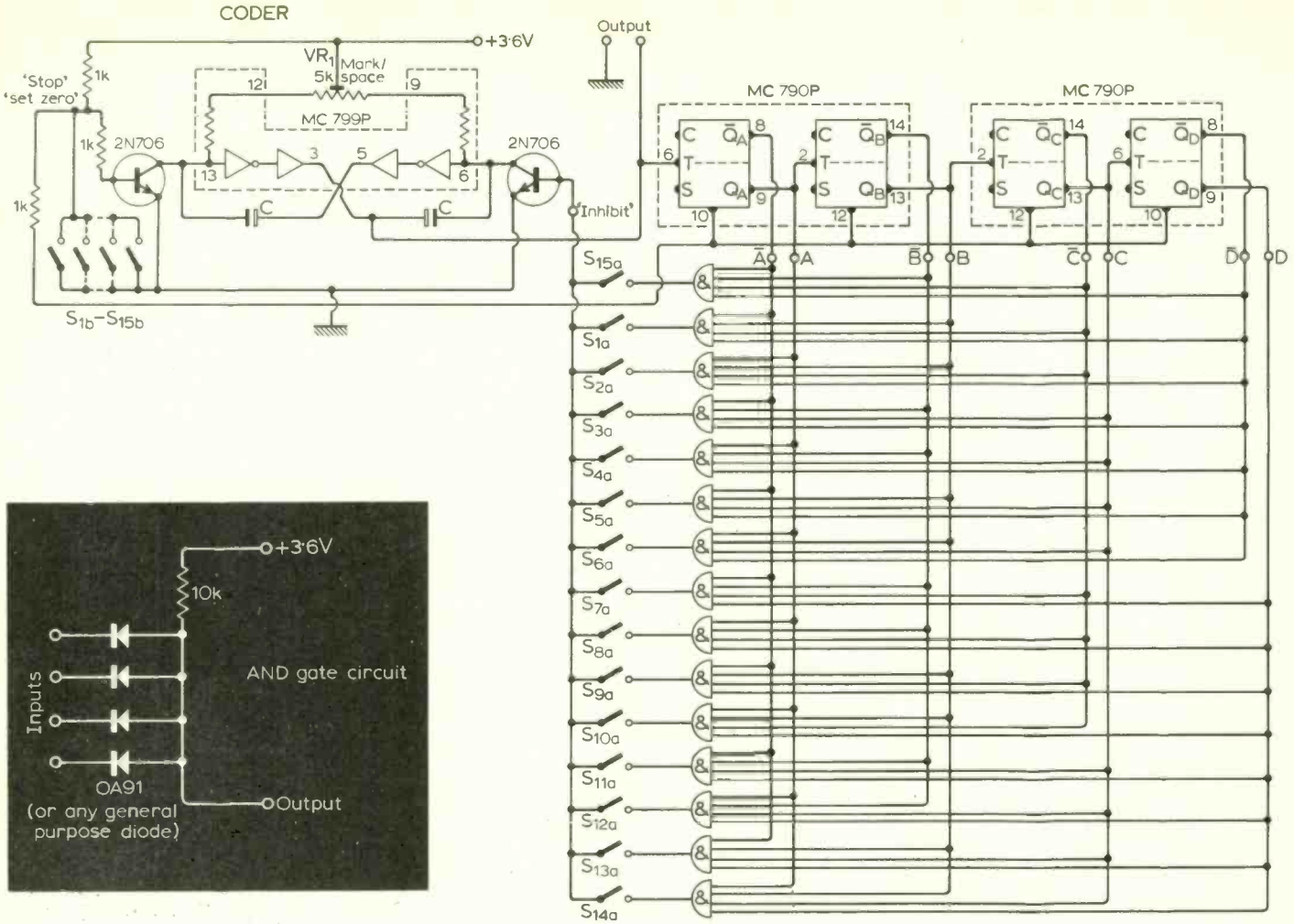
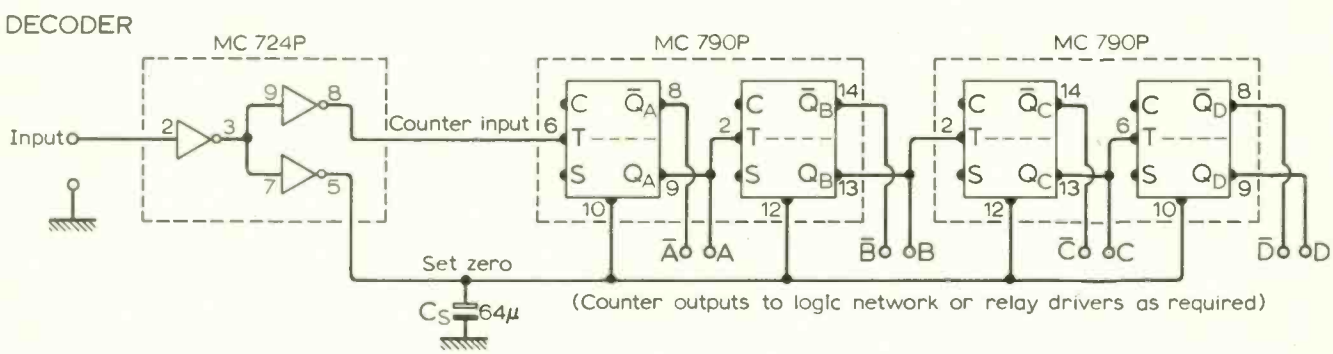
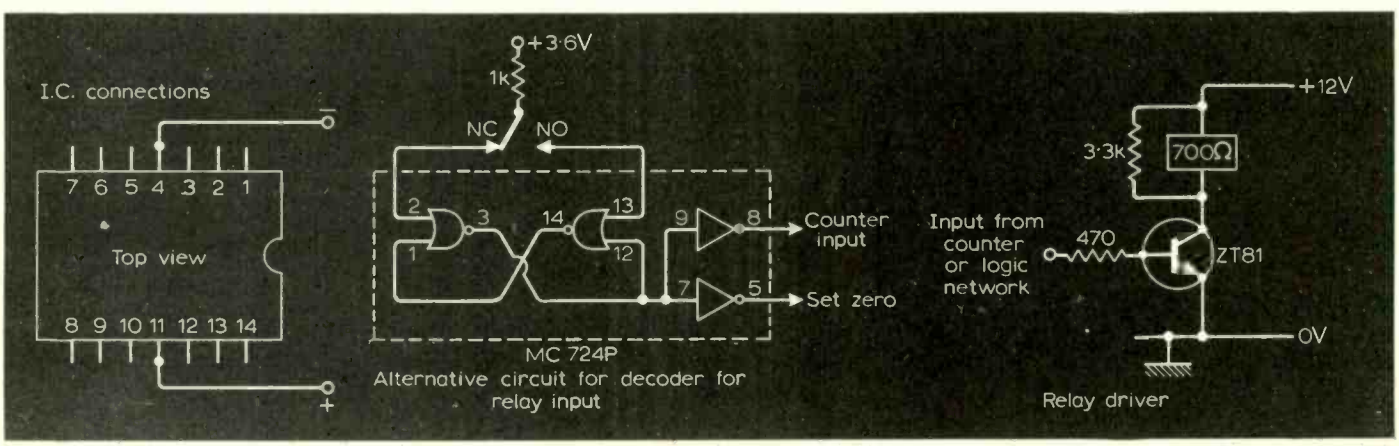


Fig. 3. The circuit of the coder (Above) and decoder (Below). If wished the decoder may be used with the relay decoding system of Fig. 2 or with the same AND gate networks as the coder. The inset above gives the circuit for the AND gates. A relay drive circuit for use with relay decoding and an alternative decoder input circuit for use with a relay input are given in the lower inset.





cases where complete freedom of movement of the remote unit is required a radio communication channel can be used to carry the control information. In fact, the original system was conceived as a means for the remote control of a model via a 27MHz radio link. Since amplitude modulation is used in the prototype, the system is susceptible to impulse interference which may be generated, for example, by the electric motors being controlled. It is therefore essential, in such a case, to incorporate a device which rejects impulsive spikes of short duration and allows the decoder to respond only to the relatively slow rate of the signal pulses.

Erratic operation may also occur if the supply voltages to the integrated circuits are allowed to drop too far below the nominal value of 3.6V. Since the decoder input is controlled by a relay in the radio control receiver, special precautions are taken to eliminate faulty triggering due to contact bounce. A 'set-reset' bistable is therefore interposed between the relay contacts and the counter input (see inset Fig. 3).

Transient operation of intermediate controls may occur when the counter in the decoder is stepping to its final state. One method of eliminating this is to connect a suitable capacitor in parallel with each relay.

The pulse rate in the prototype is chosen to be 20Hz. This is high enough to permit rapid selection of controls but sufficiently low to ensure reliable operation of the relay in the radio control receiver. This relay also provides a measure of impulse interference rejection since it responds to the signal pulses but rejects impulsive 'spikes' of short duration.

Circuitry

The circuit is given in Fig. 3. Simple diode AND gates are employed in the logic network. If used with a radio control receiver which employs a relay the alternative decoder input circuit should be used. The decoder may be built with the relay decoding circuit of Fig. 2 or with the same logic circuit as the coder, in this case the outputs of the AND gates are used to actuate the required controls.

Adjustment is confined to setting the pre-set potentiometer in the coder for satisfactory operation. It will be found that a mark-space ratio of 1:2 is about right.

In order to simplify the electronic design and improve reliability integrated circuits have been employed in both the coder and decoder. The coder uses three dual-in-line packages: a dual buffer (multivibrator) and two dual J-K flip-flops (counter). The decoder also uses three dual-in-line packages: a quad two-input gate and two dual J-K flip-flops (counter). The dual buffer (MC799P), quad two-input gate (MC724P) and dual J-K flip-flops (MC790P) are all from the Motorola range of r.t.l. circuits.

The prototype uses printed circuit construction but it is suggested that the first attempt at construction be made by mounting the packages on unclad 0.1-inch matrix Veroboard and interconnecting by direct wiring. Any mistakes are more easily rectified when the direct wiring technique is employed.

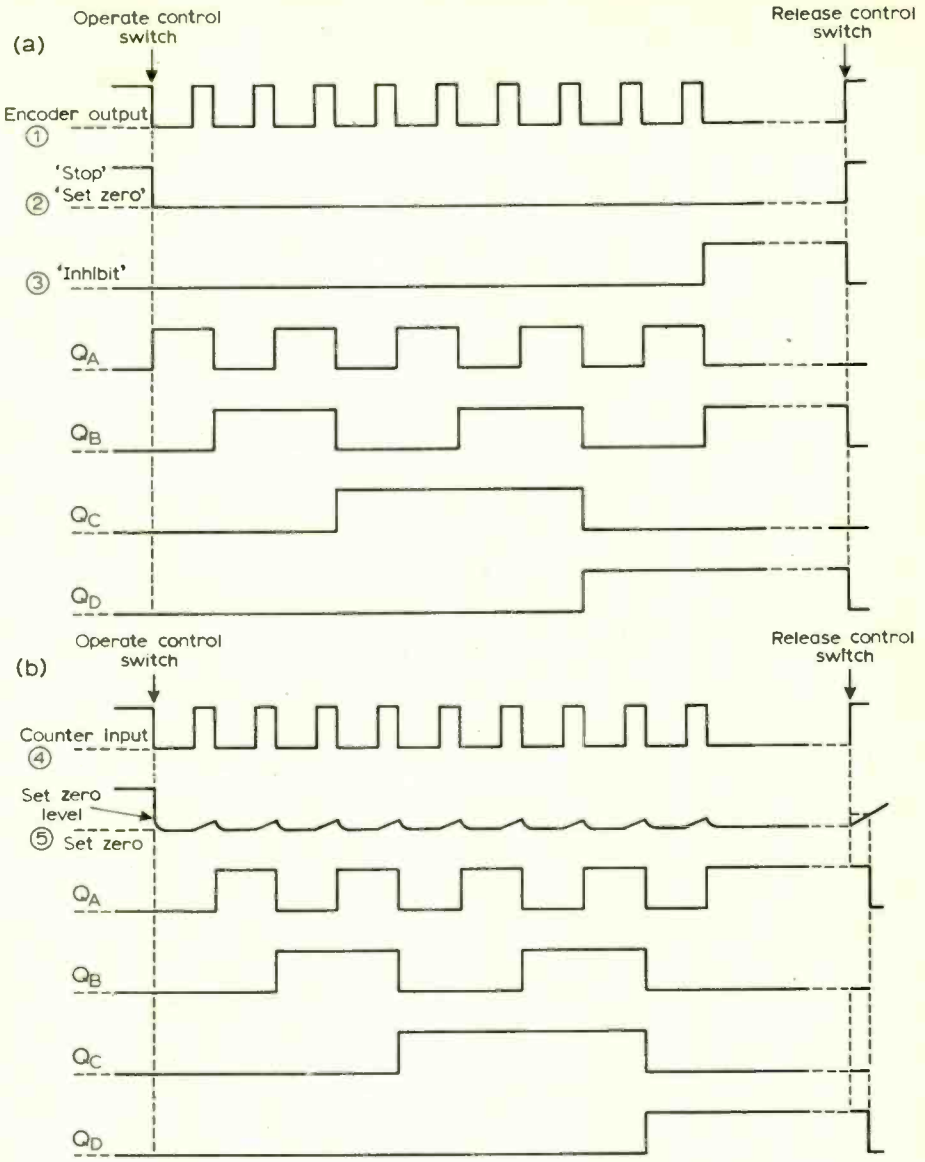


Fig. 4. (a) Coder and (b) decoder waveforms.

Transients

What happens to an LCR circuit when it's shocked

by Thomas Roddam

Two articles (*W.W.* February and March) have been devoted to considering the "natural" behaviour of simple circuits containing at most one inductance, one capacitance and one resistance. Even so, only one form of the *LCR* circuit has been considered, the form in which the same current appears at the terminals of each element. The same kind of result will be obtained for the other form, in which the same voltage appears at the terminals of each element. I do not propose to prove this: the actual solution can be obtained in an easier way and there is a limit to the amount of detailed examination which the editor, the reader and the author will stand.

Natural behaviour is the term used for the current which flows in a circuit when, having managed to get some energy in one of the energy stores, either as current in an inductance or charge in a capacitance, or both, the circuit is left isolated while the energy is being dissipated in the resistance element. We have seen that, as a general conclusion, we obtain a characteristic time for each storage type element in the circuit. If we have an *LR* or a *CR* circuit we get the current following the simple decay function

$$\exp(-t/\tau)$$

in which $\tau = CR$ or L/R, which we call the time constant. For the *LCR* circuit the general form depends on

$$\exp(-t \cdot R/2L) \exp jt\left(\frac{1}{LC}-\left(\frac{R}{2L}\right)^2\right)^{\frac{1}{2}}$$

in which we must take both positive and negative signs for the square root term. The interesting case at the moment is when $L/C > R^2/4$, which leads to the form

$$\exp(-tR/2L)\cos(\omega t)$$

It is usual to take, not $\tau = 2L/R$, but $\alpha = R/2L$, the damping constant. Then we have

$$\exp(-\alpha t)\cos(\omega t)$$

Fig. 1 shows the shape of this behaviour. As we increase R, keeping L and C constant, the decay envelope has a shorter time constant, a tighter time scale. In addition, ω, the square root term, becomes smaller, thus increasing the time scale of the oscillatory wave. If the decay envelope is falling faster than the oscillatory wave it will dominate the situation. This is rather dull, in waveform terms, and will not be discussed until we get to the complex plane. I had, indeed, intended to devote this article to the idea of complex frequency, but when I came to sort out the basic facts I found that transients must come first.

The great problem with the study of the transient behaviour of circuits is that it is complicated and tedious, rather than difficult. There are basically two kinds of transient behaviour. In one, the circuit is given an instantaneous shock, by closing a switch or some other equivalent means, but essentially just hit with a package of energy. We have already the sort of solution we shall expect, although whether it is to be $\cos \omega t$ or $\sin \omega t$ or $\cos(\omega t + \theta)$ depends on how the shock is delivered. The other kind of behaviour arises when we apply an energy source which can produce a continued action. The natural kind of source, which will go on indefinitely, is given by the function the circuit itself has defined, but with an infinite value for the decay time, $1/\alpha$. This means simply the common cosine wave, $\cos \omega t$. We set up the circuit of Fig. 2. After a good few times, the time $1/\alpha$ (for the *LCR* circuit), any energy involved in the starting process will have been dissipated and the system will have settled to the steady state.

The voltage across the capacitor will be

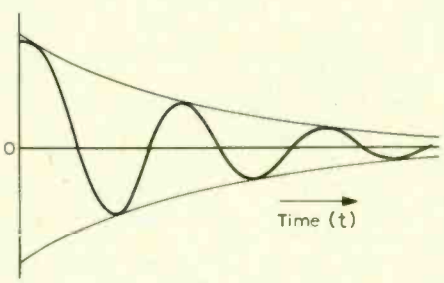


Fig. 1. The shape of exp $(-\alpha t)$ cos (ωt) enclosed in the decay curve exp $(-\alpha t)$.

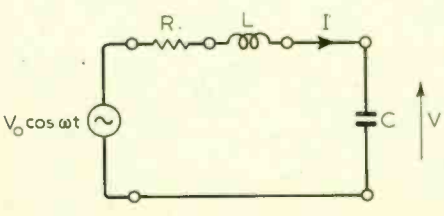


Fig. 2. The driven circuit.

given by the equation

$$V_C = \frac{1}{C}\int I\,dt = V_0 \exp(j\omega t) - L\frac{dI}{dt} - RI$$

The point of writing $V_0 \exp(j\omega t)$, with the implied operation of taking real parts later, is to make the mathematics have a simpler pattern. The equation is rearranged to the standard form

$$L\frac{dI}{dt} + RI + \frac{1}{C}\int I\,dt = V_0 \exp(j\omega t)$$

We are going on for ever, so the current will have the same shape as the voltage, or so we guess.

$$I = I_0 \exp(j\omega t)$$

If so:

$$\left(j\omega L + R + \frac{1}{j\omega C}\right) I_0 \exp(j\omega t) = V_0 \exp(j\omega t)$$

or $$I_0 = V_0 \Big/ \left(R + j\omega L + \frac{1}{j\omega C}\right)$$

$$\frac{V_0}{I_0} = R + j\left(\omega L - \frac{1}{\omega C}\right) = R + jX$$

This general form of Ohm's Law is one we use every day. X is the reactance and, if $\omega L > 1/\omega C$, X is of an inductive kind: if $\omega L < 1/\omega C$, X is of a capacitive kind.

Because $I = I_0 \exp(j\omega t)$, we can write

$$I = V_0 \cdot \left(\frac{\cos \omega t + j \sin \omega t}{R + jX}\right)$$

$$= \frac{V_0}{R^2 + X^2} \cdot (R - jX)(\cos \omega t + j \sin \omega t)$$

$$= \frac{V_0}{R^2 + X^2} \cdot (R \cos \omega t + X \sin \omega t) + \text{terms in } j$$

We take the real part of this, giving

$$I = \frac{V_0}{R^2 + X^2}(R \cos \omega t + X \sin \omega t)$$

If $X/R = \tan \theta$

$$R/(R^2 + X^2)^{\frac{1}{2}} = \cos \theta$$

$$X/(R^2 + X^2)^{\frac{1}{2}} = \sin \theta$$

and then $$I = \left|\frac{V_0}{Z}\right| \cos(\omega t - \theta)$$

in which $Z^2 = (R^2 + X^2)$

The voltage on the capacitance, V_C, is

$$V_C = \frac{1}{C}\int I\,dt = \left|\frac{V_0}{Z}\right| \cdot \frac{1}{\omega C} \cdot \sin(\omega t - \theta)$$

The voltage across the inductance is

$$V_L = L\frac{dI}{dt} = -\left|\frac{V_0}{Z}\right| \cdot \omega L \cdot \sin(\omega t - \theta)$$

Notice how, if $\omega L = 1/\omega C$, $V_C + V_L$ becomes zero. In a study of transient conditions we shall see that I_L and V_C are the terms we want.

The usual method of studying what happens when the oscillator signal is switched on is a straightforward affair of formal mathematics, followed by the consideration of a number of particular cases. The variety arises from the fact that we have the natural frequency of the circuit itself, $\omega_0 = 1/(LC)^{\frac{1}{2}}$ (leaving out the damping correction), the damping correction, the frequency of the supply. The drive may be at, $\omega = \omega_0$, near, or well above or below the natural frequency. The actual switching instant may be when the generator voltage is a maximum, or zero, or somewhere in between. There may even be some current flowing in the inductor, some charge in the capacitor. So, find the general solution and put in the boundary conditions.

When I came to do this I found it was totally incomprehensible. At the end of the process one emerges with an answer, for the specific conditions, but on the way one had no contact with any sort of physical reality. In more advanced circuit work this is normal, and the more advanced the theory the more likely you are to have a large amount of "reality" wrapped up in a single symbol. With tears pouring down my cheeks I scrapped the elegant analysis and began to look for a more direct way of determining the transient behaviour of the circuit. The approach I chose is not in any of the books I looked at, although that is probably my bad luck.

The key to all transient behaviour is the way the free circuit settles down to the rest stage. When we looked at its behaviour before we found that the current was of the form

$$I = \exp(-\alpha t)\cos(\omega t)$$

This form does not contain any constants of integration. The voltage on the capacitance is best worked out from scratch. If we start with the capacitor charged, to correspond with the way we started with current flowing in the inductor, we get again

$$V = \exp(-\alpha t)\cos\omega t$$

By working through the analysis for the two cases in which we consider either fixed current starting and capacitor voltage or fixed voltage starting and inductor current we get expressions of the form

$$\exp(-\alpha t)\sin\omega t$$

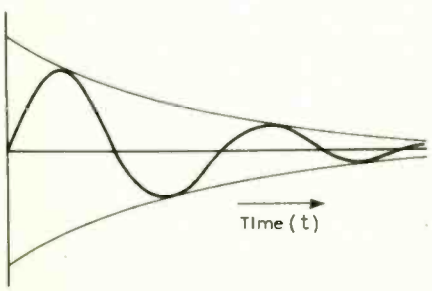


Fig. 3. The shape of exp $(-\alpha t)$ sin ωt.

In general, whatever the starting condition may be, we would expect the function to be of the form

$A \exp(-\alpha t)\cos(\omega t + \theta)$ [or $\sin(\omega t + \theta)$, whichever we choose, provided we adjust θ]. We have two constants of integration, which can be chosen to fit the initial current and voltage. Apart from the actual size of these functions, we can always write

$$\cos(\omega t + \theta) = \cos\omega t \cdot \cos\theta - \sin\omega t \sin\theta,$$

So that any value of θ can be realized if we take the right mix of the two curves, Fig. 1 and Fig. 3.

Let us adopt some low trickery. We set our circuit off with a current I_1 and a voltage V_1. I_1 is flowing into the capacitor, so that it will tend to increase V_1. Obviously V_1 is opposing the flow of I_1 and will tend to reduce it. We assume, since this is a fairly normal assumption among the more theoretical treatments, that α is small compared with ω. There is not much difference between successive cycles.

We began with a total energy of

$$\tfrac{1}{2}LI_1^2 + \tfrac{1}{2}CV_1^2$$

After a short time, all the energy will be in the capacitance and the current will have fallen to zero. The capacitance voltage will then be V_{max}, given by

$$\tfrac{1}{2}CV_{max}^2 = \tfrac{1}{2}CV_1^2 + \tfrac{1}{2}LI_1^2$$

Thus we can find V_{max}.

All this is on paper, so negative time is quite an acceptable thing. At a small value of t, with t negative, the curves show all the energy in the inductance, and $V = 0$. At this time

$$\tfrac{1}{2}LI_{max}^2 = \tfrac{1}{2}CV_1^2 + \tfrac{1}{2}LI_1^2$$

As we have decided that we will take the case of $\alpha \ll \omega$, then two quantities, V_{max} and I_{max}, are very close to the correct values for the envelopes $(V, I)_{max} \exp(-\alpha t)$.

At this point I begin drawing Fig. 4. I mark in V_{max} and $-V_{max}$, I_{max} and $-I_{max}$, and then V_1 and I_1. I also draw the exponential envelopes.

Now if $V_1/V_{max} = \sin\omega t_0$, the voltage wave must have crossed the zero axis at $-t_0$. We can measure along from here in angle units of $\pi/2$, or time units of $\pi/2\omega$ $(= 1/4f)$. Now we sketch in the waveform. The error in this is always less than

$$\exp(-\alpha\pi/2\omega)$$

Because α is small compared with ω it is tempting to take $\omega = \omega_0$, that is to use the frequency fixed by LC. Guillemin seems to do this, but it would appear to me that it leaves a nasty ambiguity in one of the cases we are now going to study.

The really tricky problem is that of switching on a sine-wave generator in the circuit. We are allowed to simplify it by assuming that the circuit had not recently been disturbed, so that it contains no stored energy. As it happens, the method we are now going to use makes it relatively easy to take account of any stored energy. The applied waveform is shown in Fig. 5, where the switch has been closed at a quite arbitrary point in the cycle. "Typical cases" in the textbooks usually amount to the choice of either switching at cross-over or switching

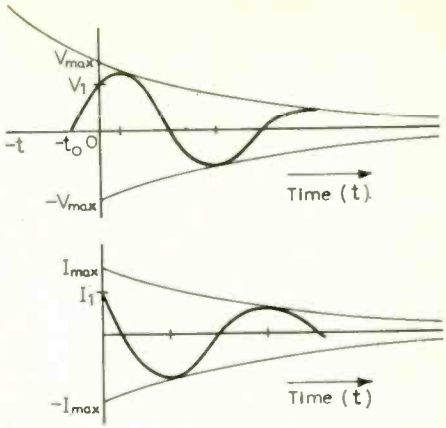


Fig. 4.

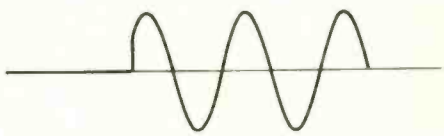


Fig. 5. Harmonic excitation applied at arbitrary phase.

at the peak. A typical case means one which is fairly easy to calculate, and I am not sure if these are, in fact, the easiest. Wait and see.

I am determined to do no more thinking than I need. I know that if I look for the steady state, the current in an RLC circuit from a voltage $V_0 \sin\omega t$ will be given by

$$V_0 \sin\omega t = I(R + j\omega L + 1/j\omega C)$$

To make the expressions look simpler we write

$$R + j\omega L + 1/j\omega C = R + j(\omega L - 1/\omega C)$$

$$= R + j\omega_0 L\left(\frac{\omega}{\omega_0} - \frac{1}{\omega\omega_0 LC}\right)$$

Now choose $\omega_0^2 = 1/LC$, giving

$$R + j\omega_0 L\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)$$

If we now write $\omega_0\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right) = \Omega$, we have

$$I = V_0 \sin\omega t/(R + j\Omega L)$$

or $$I = \frac{V_0}{(R^2 + \Omega^2 L^2)^{\frac{1}{2}}} \cdot \sin(\omega t - \theta)$$

where $\tan\theta = \Omega L/R$. Although this looks like an LR circuit only, we can now have Ω negative for positive values of ω, whenever $\omega < \omega_0$ in fact. So that this way of writing the result involves a range

for ω =	0		ω_0		∞
Ω =	$-\infty$	−ve	0	+ve	∞

The voltage across the capacitor is given by

$$V_C = \frac{1}{C}\int I\,dt$$

$$= \frac{V_0}{(R^2 + \Omega^2 L^2)^{\frac{1}{2}}} \cdot \frac{1}{C}\int \sin(\omega t - \theta)dt$$

$$= -\frac{V_0}{(R^2 + \Omega^2 L^2)^{\frac{1}{2}}} \cdot \frac{1}{\omega C}\cos(\omega t - \theta)$$

Now we know the two important terms in the steady state solution. Let us adopt a

simple trick. We use two voltage generators,

$$V_0 \sin \omega t \quad \text{and}$$

$$V_0 \sin (\omega t + \pi)$$

For one we get some current I_1, given by the equation above, and a capacitor voltage of V_{C1}. The other produces a current $I_2 = -I_1$, and a voltage $V_{C2} = -V_{C1}$. They might just as well not be there. Let us now, however, switch off the second generator. This is indicated in Fig. 6. The current produced by

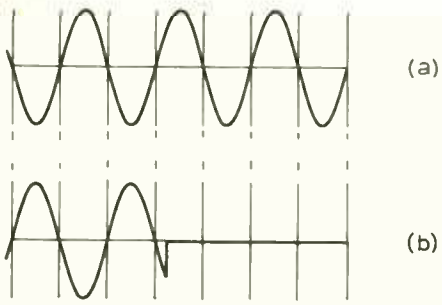


Fig. 6. Instead of switching on, *as shown in Fig. 5, one signal is switched* off.

the first generator continues to flow quite unperturbed. The stored energy associated with the second generator is the transient energy, and this sets up the decaying oscillation which we discussed earlier in the article. The formal justification for this method is that the equations are all linear.

If I were writing a rather grand textbook I should at this point begin to calculate a vast variety of examples. One simple way of doing this used to be to invite a selected group of students to lunch, flatter them by asking for unspecified help and then dole out the drudgery. Advances in modern technology make it possible to get one student to do it all on the department computer, and buy his own lunch into the bargain. But let us be realistic. In transient problems with a switched sine wave we normally have one of two situations. Either we don't know the switching phase, as in the ordinary switch-on situation, or the phase may vary systematically over a wide range, as in a phase-controlled rectifier circuit. We need a picture of the kind of behaviour we can expect. I am well aware that there are occasions when a detailed study of a special situation is required. Such problems can be solved by working out I_1 and V_{C1}, using the equations just given, and then using these in determining the ring shown in Fig. 4. This is just added to the steady state solution. What sort of an answer do we expect.

First of all, notice that we are concerned with two frequencies, for which I shall use the letter f. We have the generator frequency, f_g, and the frequency of the transient ring, f_r. With f_r goes the damping coefficient, which is $\alpha = R/2L$ and which modifies the undamped frequency slightly. For a lightly damped circuit we want $\alpha \ll 2\pi f_r$. This does not necessarily mean that $\alpha \ll 2\pi f_g$. A circuit with a very low Q, or very high damping, at the working frequency may ring vigorously at its natural frequency. Notice that this is likely when $f_r \gg f_g$.

Now we may proceed to pick out a few special situations. Suppose that f_r is very much less than f_g. When the circuit is being driven by the two opposing generators, the quantity Ω will be

$$2\pi f_r\left(\frac{f_g}{f_r} - \frac{f_r}{f_g}\right) = 2\pi\left(f_g - \frac{f_r^2}{f_g}\right)$$

This is very close to $2\pi f_g$, the value we should get if we made $f_r = 0$. The current is virtually that we should get in an RL circuit. It is quite easy to sketch out Fig. 7, which shows the current in the circuit. The switched-off generator leaves current flowing, and this decays exponentially. If we have a low value of α, i.e. $\alpha \ll 2\pi f_r$, this exponential would be replaced by a long, slow, oscillation. The two generator sine waves shown represent the currents, not the voltages: we can job back to the voltage from the $\tan\theta = \omega L/R$ equation. Obviously the most important case is when the current is a maximum. It should be noted that one very important feature of this circuit is that the current must follow a continuous curve. The inductance will always prevent a sharp step in current. Similarly the capacitance will always prevent a sharp step in voltage.

The second example is for the case when f_r and f_g are fairly close together. This is a rather tedious one to draw, because a good drawing needs about $5f_r/(f_g - f_r)$ cycles to show the pattern. We set about it as before, though now for $t > 0$ we have an exponentially decaying sine wave which does not necessarily have its peak at $t = 0$. To draw it properly we must work out the peak from the total stored energy equation and for this we need to draw the capacitance voltage curve too. Physically what happens is this. When the transient situation occurs, the stored energy appears as a damped sine wave of frequency f_r. The generator produces an undamped sine wave of frequency f_g. The two current waves beat together at $|f_g - f_r|$ to produce the modulation effect shown more clearly in the sketch of Fig. 8(b). As the ring dies away the current settles to the steady state value. The detail at the beginning depends on the phase of the switch operation. It makes little difference to the kind of response whether $f_g > f_r$ or $f_g < f_r$. What is important is that the current may reach double its normal peak value. It is logical to guess that it is also possible for the capacitor voltage to reach double its normal peak value. Practical circuits in which this kind of transient condition can arise need tougher components than you thought.

At the desk one considers $f_r = f_g$. The analysis then finds that there are some small terms to throw away, and in the whole process I rather lose track of whether f_g is the damped or undamped frequency. Anyway, I do not believe in this sort of equality. If we go back to the nearly equal frequency problem, and then say that the beats are so slow that they have died away before the first maximum is reached, we get a normal "soft-keying" growth in a straightforward sine wave. Rather roughly, this means that we consider the case where

$$\alpha > (f_g - f_r), \text{ even though}$$
$$\alpha \ll f_g$$

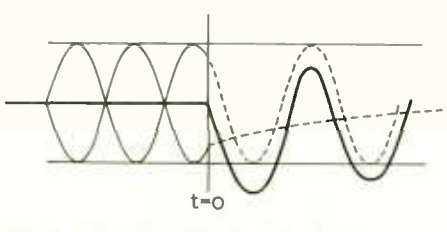


Fig. 7. Response of $f_r \ll f_g$. The decay curve at $t > 0$ is the transient component, to which the steady state solution is added to give the overall behaviour.

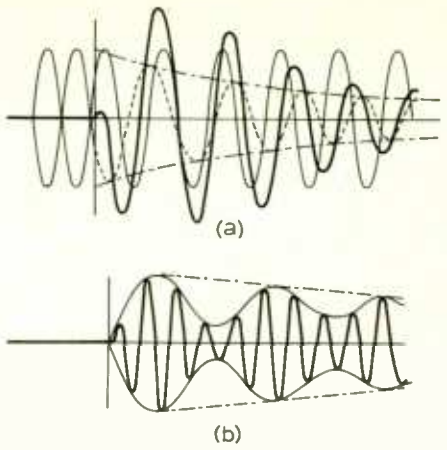


Fig. 8. Situation for $f_r < f_g$ but $f_g - f_r$ small.

Since α will always exist, we never need to consider $f_g = f_r$: we just take them near enough together. In this way we avoid any awkward questions about roots of an equation coinciding.

Finally we come to the very interesting case when $f_g \ll f_r$: the ring frequency is high compared with the frequency of the drive. This is the kind of situation which is encountered when a mains transformer is switched on or off and the leakage inductance and stray capacitance form the ringing circuit. A feature of this situation is that if it is treated by purely analytical methods the result which emerges is totally unexpected in form. The conscientious student goes back over the analysis to find out just what went wrong. The method we adopt here gives us a direct feeling of the nature of the solution, with no surprises, or perhaps more appropriately, no unexpected shocks.

At the low drive frequency we can more or less ignore the circuit inductance. If the damping coefficient is low enough, we can even ignore the resistance. For this extreme case, the full generator voltage appears across the capacitance. If the resistance is not as low as all that, the voltage is split between capacitance and resistance and it is very easy to calculate the peak value of capacitance voltage. It is

$$V_C = V_0/[1 + (\omega CR)^2]^{\frac{1}{2}}$$

Let us consider the extreme case. Let us also assume that the switching instant is when V_C is a maximum. The energy stored in the capacitance is $\frac{1}{2}(CV_C^2)$. For the transient waveform we have an exchange of energy between capacitance and inductance, and, as we have assumed that α is very small, the

first current maximum, I_L, must satisfy the equation:

$$\tfrac{1}{2}I_L^2 L = \tfrac{1}{2}CV_C^2$$

Thus $$I_L = V_C(C/L)^{\frac{1}{2}}$$

But if $\omega_r = 2\pi f_r$, we know that $\omega_r^2 LC = 1$

Then $$C/L = \omega_r^2 C^2$$ and so

$$I_L = V_C \cdot \omega_r C$$

The steady state current through the inductance is limited by the capacitance, and is $I_{L,s} = V_0 \cdot \omega_\theta C$. Taking $V_C = V_0$

$$I_{L,t} = \frac{f_r}{f_\theta} \cdot I_{L,s}$$

It will be seen that the transient current is very large indeed compared with the normal current (Fig. 9). We could have chosen a different switching phase. Had we done so we should have found a smaller value of transient current, which we can work out for any phase by the energy equations. Worst case solutions are, however, the ones which normally interest us.

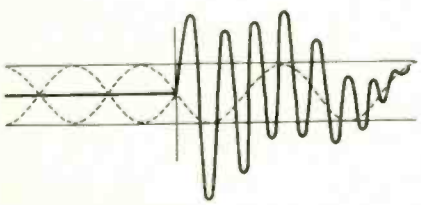


Fig. 9. For $f_r \gg f_\theta$ the current ring is very much larger than the steady state current.

Very much the same pattern of results is obtained when we study the way a parallel tuned circuit behaves with the switching of a current source. The commonest form here, numerically, is the line transformer of a television set. Here, as indeed in all the variations, we would study the voltage across the capacitance and we know, in the similar but more general form of a transistor with an inductive load, it is energy associated with volts which we must watch. Energy associated with volts, because second breakdown is not a linear phenomenon.

More complex circuits can be handled on a piece by piece basis, but the labour involved is often prohibitive. Transients are not normally central to the main problem, and the main problem takes most of our effort. A knowledge of the sort of transient behaviour to expect, together with a quick calculation of the stored energy which has easy access to the danger points, will normally be sufficient. Then, if the situation is potentially dangerous, wheel out the oscilloscope.

Nowhere in this article is there any mention of musical transients in amplifiers. This is, of course, a topic of great importance. There are two aspects which make it unsuitable for treatment here and now. Musical transients are not produced by a click-on mechanism, but have finite rise and fall times; they pass through circuits, feedback amplifiers, with a much sharper phase shift characteristic than our single tuned circuit. Anyway, this article is quite long enough.

Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Apr. 8–15 — Earls Court
Electrex '70
(Electrical Engineers A.S.E.E. Exhibition, Museum St., London W.C.1)

Apr. 13–16 — University College
Atomic and Molecular Physics
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Apr. 23–26 — Skyway Hotel
Sonex '70 HiFi Exhibition
(Federation of British Audio, 49 Russell Sq., London W.C.1)

Apr. 28 & 29 — Royal Garden Hotel
Microelectronics Conference
(Business Conferences & Exhibitions, Mercury House, Waterloo Rd., London S.E.1)

BIRMINGHAM

Apr. 14–17 — The University
Automatic Test Systems
(I.E.R.E., 8-9 Bedford Sq., London W.C.1)

HARWELL

Apr. 2–3 — A.E.R.E.
High Voltage Electron Microscopy
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

OXFORD

Apr. 6–11 — The University
Biological Engineering Conference
(J. Gasking, Dept. of Pharmacology, St. Bartholomew's Hospital Medical School, Charterhouse Sq., London E.C.1.)

READING

Apr. 6–8 — The University
Thin Films Conference
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Apr. 15–17 — The University
Defects in Semiconductors
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

UXBRIDGE

Apr. 14–16 — Brunel University
Computer Graphics International Symposium
(R. Elliot Green, Brunel University, Uxbridge, Middx.)

OVERSEAS

Mar. 31–Apr. 2 — New York
Submillimetre Waves
(Polytechnic Inst. of Brooklyn, 333 Jay St., Brooklyn, New York 11201)

Mar. 31–Apr. 3 — Paris
Electrical-Electronic Engineering Seminar
(E.E.E. Seminar, 80 rue Jouffroy 75-Paris 17e)

Apr. 3–8 — Paris
Electronic Components Show
(Fed. Nat. des Ind. Electroniques, 16 rue de Presles, Paris 15e

Apr. 5–9 — Berlin
Cybernetics Congress
(Deutsche Gesellschaft für Kybernetik, 21 Stresemann Allee, 6 Frankfurt/Main 70)

Apr. 6–10 — Paris
Advanced Microelectronics Conference
(Fed. Nat. des Ind. Electroniques, 16 rue de Presles, Paris 15e)

Apr. 7–9 — Las Vegas
Reliability Physics Symposium
(K. H. Zaininger, RCA Labs, Princeton, N.J. 08540)

Apr. 10–20 — Tokyo
Japan Electronics Show
(Japan Elec. Show Assoc., Tokyo Chamber of Commerce Bldg., 2-2 Marunouchi 3-chome, Chiyoda-ku, Tokyo)

Apr. 14–17 — Washington
Geoscience Electronics Symposium
(I.E.E.E., 345 East 47th St., New York, N.Y. 10017)

Apr. 14–19 — Frankfurt
Hi-Fi Show
(U.S. Trade Centre, Frankfurt/Main)

Apr. 21–24 — Washington
International Magnetics Conference (INTERMAG)
(D. S. Shull, Bell Telephone Labs, 3300 Lexington Ave, Winston-Salem, N.C. 27102)

Apr. 21–24 — Budapest
Microwave Communication Colloquium
(Microcoll—Technica Háza Budapest, V. Szabadsag tér 17, Hungary)

Apr. 22–24 — Dallas
Southwestern I.E.E.E. Conference
(A. P. Sage, Inst. of Tech., S.M.U., Dallas, Texas 75222)

Apr. 27–29 — Atlantic City
Frequency Control Symposium
(Electronic Components Lab., U.S. Army Electronics Command, Fort Monmouth, New Jersey 07703)

Apr. 27–30 — Los Angeles
National Telemetering Conference
(A. V. Balakrishnan, UCLA, Rm. 3531, 405 Hilgard Ave, Los Angeles, Calif. 90024)

Circuit Ideas

H. F. Predictions—April

High-gain f.e.t. tuned amplifier

The reverse transfer capacitance of a field-effect transistor can be employed as a very stable Q multiplier with inherent automatic bandwidth control. Essentials are (Fig. 1) resistive drain and source loads and selection of C, which is smaller in value than a bypass capacitor. C determines the no-signal Q: decreasing the value moves the stage towards oscillation; increasing it has the reverse effect. This circuit, with no additional components, will replace two double-tuned 470-kHz i.f. stages. With a constant current supply it is reproduceable using wide-tolerance f.e.ts. The response of Fig. 2, after optimum adjustment of C, is a shallow curve, peaking reasonably close to oscillation over the middle third of each band. The detector stage assists in bandwidth control (varying the impedance of D_1), and even on weak signals accurate tuning is indicated by wideband quality. For operation at frequencies higher than 2MHz the drain load must be progressively reduced.

K. W. MAWSON,
Bradford,
Yorks.

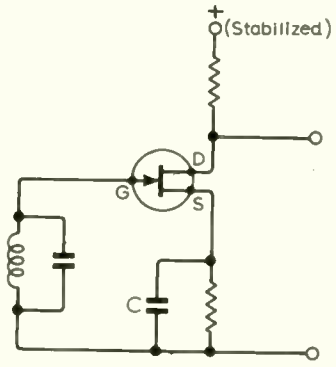


Fig. 1. F.E.T. as Q multiplier.

Logic circuit gates astable multibrator

When Tr_4—the output transistor of a d.t.l. logic stage—is switched off, the current in R_1 is very slight and Tr_3 is effectively off: R_2 is chosen so that when Tr_4 saturates, Tr_3 saturates thus permitting the multi to function. D_1 and D_2 are included to prevent base-emitter breakdown in Tr_1 and Tr_2 for a large voltage at the collector of Tr_3. C_1 is a small capacitor (100pF) included to make the collector circuits of Tr_1 and Tr_2 dissimilar: this ensures that the multi will not block. Conventional design theory governs the choice of C R_L, R_B. The circuit functions just as well if R_2 is omitted and the base of Tr_3 is driven from a high impedance source, e.g. the collector of a current-mode switch. For a 5V rail suitable values of R_1 and R_2 are $R_1 = 1k\Omega$ and $R_2 = 2.2k\Omega$, for current in R_L up to 16mA. Typical low-cost devices which are suitable are: diode IN4148 (G.E.); transistors (Ferranti plastic 'E' line) ZTX 500.

B. L. HART,
West Ham College of Technology,
London E.15.

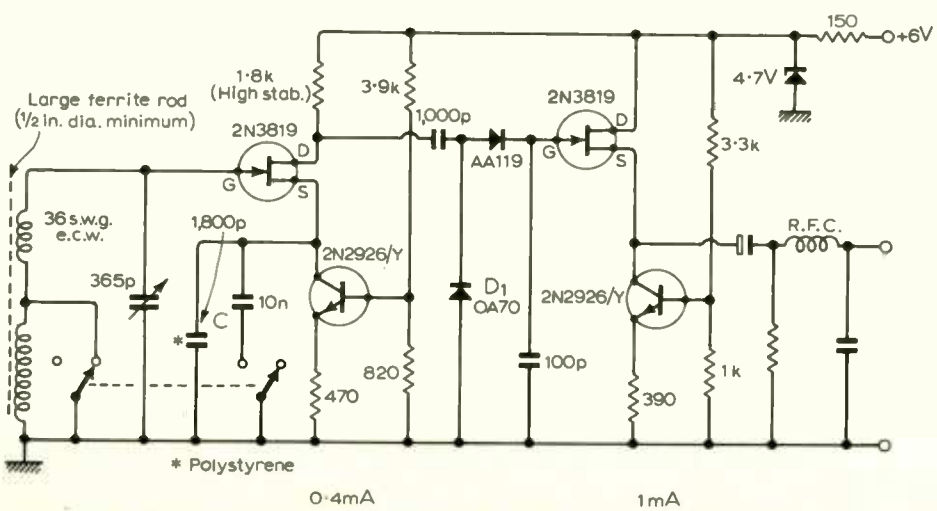
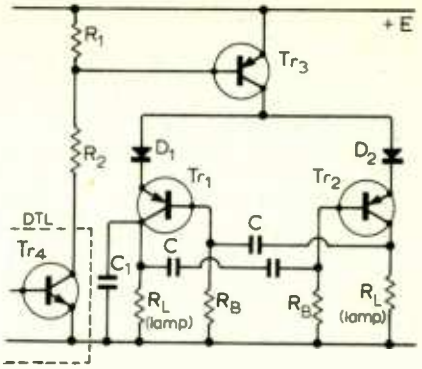


Fig. 2. M.W./L.W. tuner employing Q multiplier.



F.E.T. push-pull oscillator

Wide frequency range LC oscillators are usually Colpitts or Hartley configurations. Higher output can be obtained using a push-pull arrangement. Many thermionic valve circuits have been evolved and n-channel field-effect devices can be substituted without significant modifications. The use of p-channel enhancement devices can however simplify the bias arrangement using no components other than the active devices and the tuning components is shown in Fig. 1. The tap on the coil can be omitted if a pair of chokes or resistors are used to feed f.e.t. drain connections.

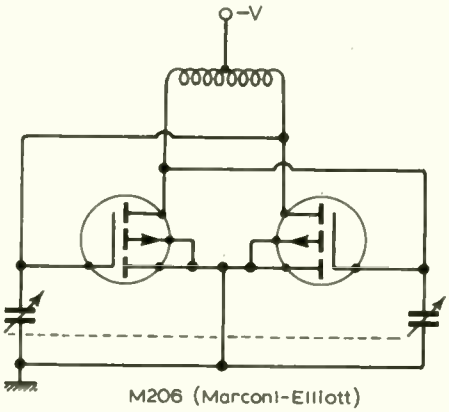


Fig. 1. Oscillator operating up to 300MHz.

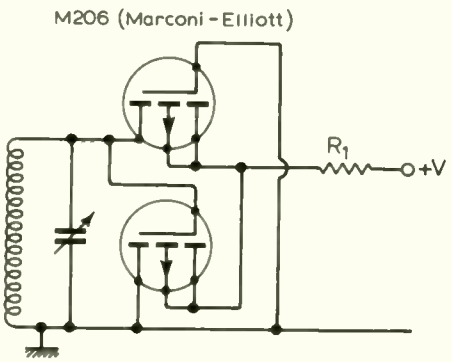
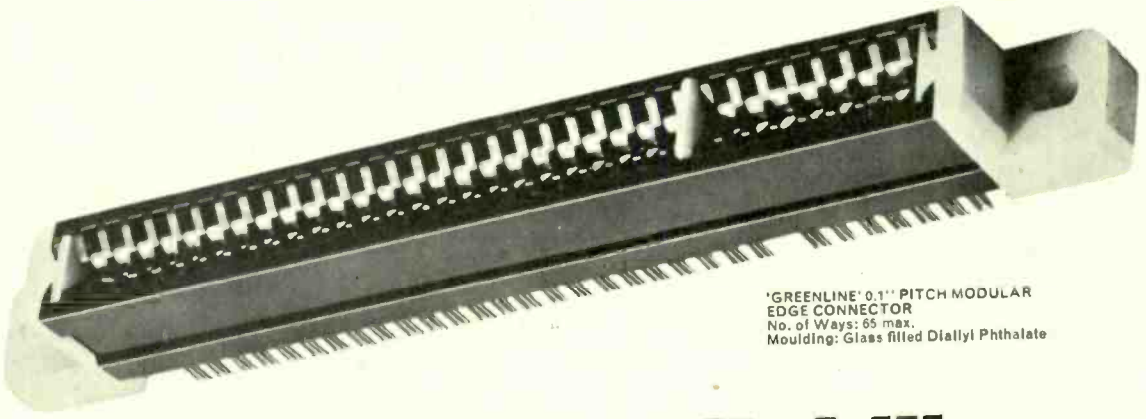


Fig. 2. Arrangement for operation between 50 kHz and 350MHz.

The unusual re-arrangement shown in Fig. 2 allows the tuning components to be at ground potential. The circuit is no longer balanced and a resistor (R_1) or choke is required.

J. A. ROBERTS,
University College of Swansea.

the Pacemaker



'GREENLINE' 0.1" PITCH MODULAR EDGE CONNECTOR
No. of Ways: 65 max.
Moulding: Glass filled Diallyl Phthalate

in optimum-reliability electronic components

In the continually-evolving technology of the electronics industry, Carr design and research keep pace with, and often ahead of, the ever-changing demands for increasingly sophisticated components.

But whilst designs may change from week to week, Carr quality and reliability remain constant, ensuring that complex high-precision specifications are met with absolute and consistent accuracy.

'GREENLINE' 0.150" PITCH MOULDED EDGE CONNECTOR
No. of Ways: 4, 8, 12, 16, 24, 32 and 40.
Moulding: Glass filled Diallyl Phthalate

REED ELECTRONIC EXCHANGE CONNECTOR Mk.10 0.2" PITCH
No. of Ways: 12+12 and 18+18
Moulding: Glass filled Polycarbonate

The connectors illustrated here are typical examples from our ranges. We have, of course, many other components of special interest to the computer and communications industries, with rapid, reliable deliveries in bulk quantities assured.

Ask for data, or for a visit from one of our Technical Sales Staff. The application of his wide experience to your problems can help you towards easier, more advanced assembly techniques, with the collateral benefits of worthwhile savings on time and costs.

PERMACON MOULDED EDGE CONNECTOR. Maximum No. of Contact Positions and Pitches:
40 for 0.100" Pitch 20 for 0.200" Pitch
26 for 0.150" Pitch
Moulding: Polypropylene

SUB-MINIATURE CONNECTORS
No. of Ways: 9, 15, 25, 37 and 50
Light alloy shell and base

CINCH

RADIO AND ELECTRONIC CONNECTORS

OPTIMUM-RELIABILITY COMPONENTS FOR HIGH-PRECISION ELECTRONIC APPLICATIONS

CARR FASTENER

CARR FASTENER CO. LTD. STAPLEFORD NOTTINGHAM Telephone 0602-39-2661 Telex 37637

the firm with the best connections

C50

WW—100 FOR FURTHER DETAILS

spot check or 100% inspection?

There is nothing random about quality control with BRIMAR data display tubes. Every single tube is subjected to an exacting test at every stage of production, from the raw materials used, through the various complex stages of manufacture, to the finished product.

A typical example of BRIMAR'S advanced inspection methods is the use of Spatial Frequency measuring equipment, built to their own uncompromising standards, and used for the measurement of final spot size and focus uniformity in such tubes.

And in addition to this, an unparalleled capability in chemistry, electron optics and vacuum physics enables Brimar to offer the widest design diversity backed by a *personalised customer service*. This service, provided by engineers with extensive experience of the electronics industry, covers advice on tube characteristics, operating conditions and associated components.

Tailored packaging, and reliable delivery to meet production schedules are also part of the BRIMAR Service.

Want to know more about BRIMAR Industrial Cathode Ray Tubes? - ask to see our latest catalogue.

BRIMAR

Thorn Radio Valves and Tubes Limited

THORN

7 Soho Square, London, W1V 6DN.
Telephone: 01-437 5233

WW—101 FOR FURTHER DETAILS

Active Filters

9. Synthesis by factors

by F. E. J. Girling and E. F. Good**

It is shown how a filter may be synthesized as a product of factors, and a number of numerical examples are given.

So far in this series we have dealt mainly with principles. In this article, although some important methods of realization still remain to be described, it is shown how some of the circuits already described can be put to use. The method is that of synthesizing the complete filter as a cascade of 1st- and 2nd-order sections, each with output impedance low enough for its response to be unaffected by the connection to it of the following section. Thus the response of the whole filter is the product of the responses of the individual sections. It is a practical method of design for specifications of moderate stringency, and also throws light on the nature of filters of higher order and their transfer functions.

It is not possible in this series to say very much about the design of filters as such, but an attempt is made in this Part to help the non-specialist reader—partly by calculation, and partly by the use of reference works—to make a start on the design of filters to a variety of specifications.

5th-order low-pass filter with Darlington response

In a conventional wave filter the important characteristic is the steady-state amplitude (or gain-versus-frequency) response. This can be specified, Fig. 1, by three parameters: A_p the maximum deviation from level response in the pass band; A_s the minimum attenuation in the stop band; $(\Omega_s - 1)$ the relative width of the transition band, Ω_s being the start of the stop band in the normalized characteristic ($\omega_p = 1$). And if any two are specified, the work of Darlington shows how to proportion the elements of a given structure to give the best value of the third. The nature of the relationship between the three is that, if for constant A_s a smaller value of Ω_s is required, then either a greater ripple in the pass band (A_p) must be accepted or a structure of greater complexity must be adopted. The steady-state amplitude response of a filter of Darlington design (sometimes called an elliptic-function filter) is of equal-ripple type in pass band and stop band, as indicated in Fig. 1.

* Royal Radar Establishment.

Thus we may quote from Reference 1 as a representative optimum set of values for the structure shown in Fig. 2: $A_p = 0{\cdot}1$ dB, $A_s = 40$ dB, $\Omega_s = 1{\cdot}44$; and the "ladder coefficients", i.e. the element values for the normalized filter, are given in Table 1, ω_p being used as the reference frequency, not ω_B as in the paper referred to

TABLE 1

Normalized component values for 5th-order Darlington filter, Fig. 2.

$A_p = 0{\cdot}1$ dB, $A_s = 40$ dB, $\Omega_s = 1{\cdot}44$
$\omega_p = 1$ radian/second, $R_S = R_L = 1$ ohm

C_1	1·016	C_2	0·175
L_2	1·197	C_4	0·521
C_3	1·596	T_2	0·4576
L_4	0·882	T_4	0·6780
C_5	0·773		

Although of symmetrical topology the filter is not symmetrical, since $C_1 \neq C_5$, $L_2 \neq L_4$, etc. This is always the case in an efficient filter of order higher than three; one reason is that the rejector circuits (L_2C_2 and L_4C_4) are tuned to different frequencies.

The five elements in the left-hand column of the table, by themselves, form a 5th-order simple ladder filter and give the transfer function a 5th-order denominator. The addition of the capacitances C_2 and C_4 does not change this order (although it does change the coefficients of the terms), but the numerator becomes 4th-order. Because $R_L = R_S$ and the reactances are assumed to be without loss, the voltage ratio at zero frequency is one half. Consequently the transfer function may be written

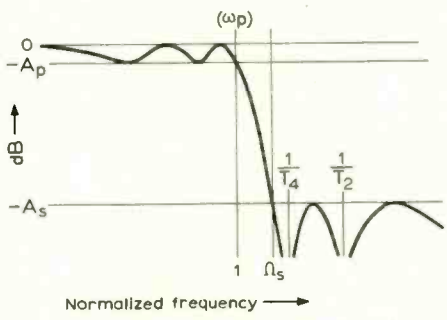


Fig. 1. Diagrammatic representation of 5th-order Darlington response.

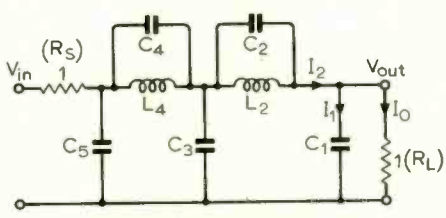


Fig. 2. Standard passive realization of 5th-order Darlington low-pass filter.

$$G(p) = \frac{V_{out}}{V_{in}} = \frac{1}{2}\cdot\frac{N(p)}{D(p)}$$

$$= \frac{1+ap+bp^2+cp^3+dp^4}{2(1+Ap+Bp^2+Cp^3+Dp^4+Ep^5)} \quad (1)$$

The industrious may find the coefficients by analyzing the network:

$$I_0 = V_{out}/R_L$$

$$I_1 = V_{out}\,pC_1$$

$$I_2 = I_0 + I_1$$

$$V_2 = I_2Z_2 = \frac{(I_0+I_1)pL_2}{1+p^2L_2C_2}$$

$$V_3 = V_2 + V_0$$

$$I_3 = V_3pC_3$$

and so on. It is only fair to give warning, however, that over forty products have to be formed in working out the denominator. The numerator, however, is easily obtained. It is

$$1+p^2(L_2C_2+L_4C_4)+p^4L_2C_2L_4C_4$$

and so depends only on the components of the two infinite-rejection circuits. For the chosen example the numerical values of the denominator coefficients are: $A = 2{\cdot}73$, $B = 4{\cdot}19$, $C = 4{\cdot}68$, $D = 2{\cdot}85$, $E = 1{\cdot}38$.

For our present purpose the transfer function is required factorised. This may be regarded as the mathematical excercise of finding the roots of the equations $N(p) = 0$ and $D(p) = 0$. These roots are the z_1, z_2, etc., and p_1, p_2, etc. of the identities

$$N(p) \equiv d(p-z_1)(p-z_2)(p-z_3)(p-z_4), \quad (2)$$

$$D(p) \equiv E(p-p_1)(p-p_2)(p-p_3)(p-p_4)(p-p_5), \quad (3)$$

and are referred to as the zeroes and poles of $G(p)$, since if $p =$ any of z_1, etc. $G(p) = 0$, while if $p =$ any of p_1, etc. $G(p) = \infty$. The numerator of the chosen example can be treated generally as it factorizes into

$$N(p) = (1+p^2L_2C_2)(1+p^2L_4C_4); \quad (4)$$

but p_1, p_2, etc. can be expressed only as particular numerical values:

$$p_1, p_2 = -0{\cdot}1080 \pm j1{\cdot}065$$

$$p_3, p_4 = -0{\cdot}413 \pm j0{\cdot}784$$

$$p_5 = -0{\cdot}667.$$

By multiplying together the denominator factors containing the complex conjugates p_1 and p_2 a 2nd-order factor with real coefficients is formed,

$$(p^2+\alpha_1\omega_1 p+\omega_1^2);$$

and by writing $p_1, p_2 = -a \pm jb$, it is seen that

$$\omega_1^2 = a^2+b^2, \quad (5)$$

$$\alpha_1\omega_1 = 2a, \quad (6)$$

i.e. $$\alpha_1 = 2a/(a^2+b^2)^{\frac{1}{2}} \quad (7)$$

If the factor is now divided by ω_1^2, which gives

$$\frac{p^2}{\omega_1^2}+\frac{\alpha_1 p}{\omega_1}+1,$$

it is easily compared with the preferred form

$$1+pT/q+p^2T^2,$$

whence $T = 1/\omega_1 = (a^2+b^2)^{-\frac{1}{2}}$ (8)

and $q = 1/\alpha_1 = (a^2+b^2)^{\frac{1}{2}}/2a$

$$= \left(1+\frac{b^2}{a^2}\right)^{\frac{1}{2}}\Big/2. \quad (9)$$

Or, by reference to Fig. 3,

$$T = \frac{1}{OP}, \quad q = \frac{OP}{2OA}. \quad (10),(11)$$

For the example then

$$T_1 = 0{\cdot}9357, \quad q_1 = 4{\cdot}94$$

$$T_3 = 1{\cdot}129, \quad q_3 = 1{\cdot}073$$

and for the real 1st-order factor

$$T_5 = -1/p_5 = 1{\cdot}499.$$

Thus the transfer function has been obtained in the form $N(p)/D(p)$

$$= \frac{(1+p^2T_2^2)}{(1+pT_1/q_1+p^2T_1^2)} \times \frac{(1+p^2T_4^2)}{(1+pT_3/q_3+p^2T_3^2)(1+pT_5)} \quad (12)$$

with parameters as given above, and $T_2 = \sqrt{L_2C_2} = 0{\cdot}4576$, $T_4 = \sqrt{L_4C_4} = 0{\cdot}6780$.

The 2nd-order numerator and denominator factors may now be paired arbitrarily to give sections with unsymmetrical notch response, Part 2, Fig. 19. As the highest Q factor is not very high, both sections may conveniently be realized by the Sallen-and-Key type of circuit with added parallel path, Part 6, Fig. 11(b).

Consider the transfer function

$$G(p) = \frac{1+p^2T_4^2}{1+(1/q)pT_1+p^2T_1^2} \quad (13)$$

and let it be identically equal to the standard form

$$\frac{1+ap^2T_1^2}{1+(1/q)pT_1+p^2T_1^2} \quad (14)$$

Then $a_1 = T_4^2/T_1^2 = 0{\cdot}523$. Similarly for the other 2nd-order section, $a_3 = T_2^2/T_3^2 = 0{\cdot}164$. Hence the schematic for the whole filter may be as in Fig. 4. This gives the relative component values for the case of ideal amplifiers, $K = 1$, $A = \infty$.

Equation (8) of Part 6, which becomes when $b = \frac{1}{2}$

$$\frac{1}{q} = \frac{1}{q_i}+\frac{2q_i}{A+1}, \quad (15)$$

shows that for $q_i = 5$ and $A = 1000$ the ideal component values would give an actual q approximately 5% low, and that if compensation is made by increasing the ratio C_x/C_y, the appropriate value of q_i is 5·28. If this method is used it should be remembered that for a good zero the equality

$$C_6R_6 = C_xR_1/4 \quad (16)$$

must be maintained. Hence C_6 may have to be changed. A more convenient method of compensation would perhaps be to increase K slightly by using less than 100% feedback as shown in Fig. 5 of Part 6. The calculation really shows, however, that for accurate design A should be high, say 10,000 minimum, for q of this value. Alternatively a two-integrator loop may be used (Part 7), or a parallel-T system (to be described in a following Part). For the other 2nd-order section, $q = 1{\cdot}073$, a moderate value of A is sufficient, although for practical convenience the same type of amplifier is likely to be used.

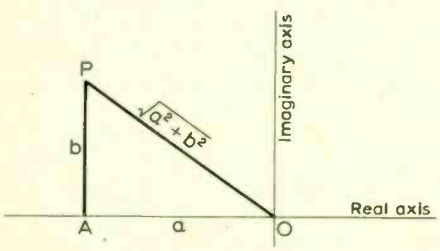


Fig. 3. P is the position of a pole, $p = -a+jb$.

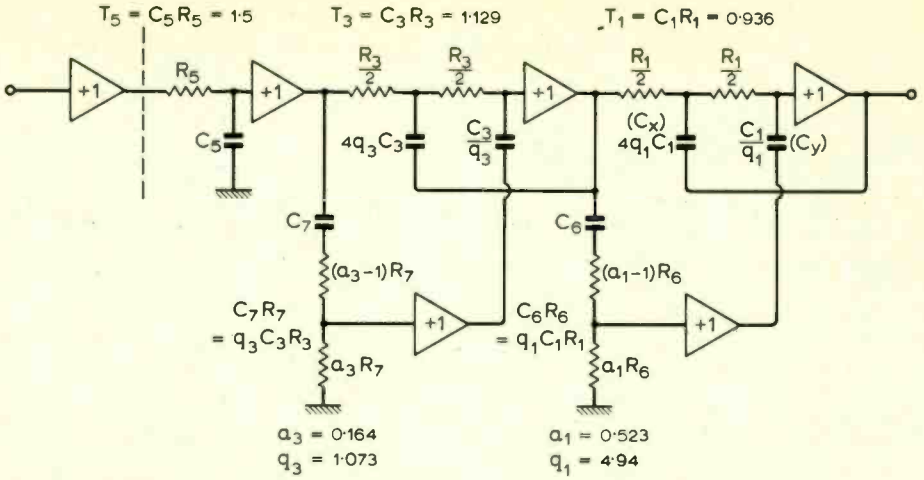


Fig. 4. Schematic for realization by factors of 5th-order Darlington response with 0·1 dB ripple in the pass band, 40 dB minimum attenuation in the stop band, and cut off at 1 radian/second.

Moving the cut-off frequency to the required value is a simple matter of scaling. So, to set the −3 dB frequency at 1000 radians/second (= 159 Hz) ω_p must be 923 radians/second and all time constants of the normalized filter must be divided by this figure. This gives (including small adjustments based on an accurate computation of the overall response) the values shown in Table 2 below.

TABLE 2

Component values for 5th-order Darlington filter, Fig. 4, scaled for −3 dB at 159 Hz.

Stage 1	Stage 2	Stage 3
T_5 = 1·623ms	q_3 = 1·073	q_1 = 5
R_5 = 16·2kΩ	T_3 = 1·222ms	T_1 = 1·018ms
C_5 = 0·1μF	T_7 = 1·313ms	T_6 = 5·09ms
	$R_3/2$ = 26·3kΩ	$R_1/2$ = 20·4kΩ
	$4q_3C_3$ = 0·1μF	$4q_1C_1$ = 0·5μF
	C_3/q_3 = 21,700pF	C_1/q_1 = 5000pF
	C_7 = 0·01pF	C_6 = 0·05μF
	$(a_3-1)R_7$ = 110kΩ	$(a_1-1)R_6$ = 48·6kΩ
	a_3R_7 = 21·5kΩ	a_1R_6 = 53·3kΩ

TABLE 3

Parameters for 5th-order Darlington response, normalized to cut-off frequency ω_p = 1 rad/s.

$$G(p) = \frac{(1+p^2T_2^2)(1+p^2T_4^2)}{(1+pT_1/q_1+p^2T_1^2)(1+pT_3/q_3+p^2T_3^2)(1+pT_5)}$$

A_s (dB)	$1/\Omega_s$	A_p (dB)	q_1	T_1	q_3	T_3	T_5	T_2	T_4
20	0·9	0·077	9·73	0·955	1·469	0·975	1·029	0·662	0·881
	0·95	0·38	17·38	0·988	2·017	1·065	1·380	0·746	0·937
30	0·7	0·009	4·262	0·850	0·962	0·871	0·900	0·456	0·676
	0·75	0·025	4·96	0·895	1·042	0·951	1·044	0·499	0·726
	0·8	0·071	5·724	0·935	1·167	1·033	1·238	0·546	0·776
	0·85	0·21	8·071	0·969	1·387	1·115	1·522	0·598	0·828
	0·9	0·72	12·60	0·994	1·857	1·187	2·02	0·663	0·881
	0·95	2·8							
40	0·6	0·012	3·554	0·842	0·885	0·927	1·043	0·378	0·576
	0·65	0·033	4·096	0·889	0·959	1·018	1·225	0·416	0·625
	0·70	0·09	4·902	0·932	1·070	1·108	1·460	0·456	0·675
	0·75	0·24	6·19	0·966	1·247	1·196	1·791	0·499	0·726
	0·80	0·66	8·489	0·992	1·560	1·270	2·295	0·546	0·777
	0·85	1·8	13·31	1·010	2·193	1·318	3·175	0·598	0·827
50	0·55	0·04	3·655	0·889	0·9188	1·073	1·364	0·342	0·527
	0·6	0·12	4·382	0·934	1·033	1·178	1·661	0·378	0·576
	0·65	0·32	5·405	0·971	1·213	1·274	2·078	0·416	0·626
	0·7	0·82	7·410	0·997	1·518	1·354	2·701	0·456	0·675
	0·75	2·0	10·886	1·015	2·076	1·407	3·710	0·499	0·726
	0·8	4·24							
60	0·45	0·039	3·331	0·881	0·884	1·096	1·424	0·274	0·430
	0·5	0·13	4·052	0·934	1·006	1·221	1·790	0·308	0·479
	0·55	0·38	5·162	0·975	1·203	1·334	2·311	0·342	0·527
	0·6	1·0	7·033	1·004	1·335	1·424	3·107	0·378	0·576
	0·65	2·4	10·367	1·022	2·145	1·479	4·397	0·416	0·626
	0·7	4·9							

In the pass band distortion from the theoretical curve is most likely to be caused by misalignment of the high-q section with respect to the other two. The greatest slope of the response of this section in the pass band is $\frac{1}{4}$ dB for a 1% change of frequency. For not more than $\frac{1}{10}$th dB error in the passband, therefore, an accuracy in the component values of $\pm 0{\cdot}4\%$ is indicated.

Points in favour of realization by factors are that requirements for amplifier gain and the effect of errors in component values are easily calculated, and hence amplifier gains and component tolerances are easily specified. A further convenience is that errors can be localized by measuring the responses of the individual section. These responses for the given example are shown in Fig. 5. The overall response was given in Part 1, Fig. 1.

An experimental filter of this design was shown by the Royal Radar Establishment on the Ministry of Aviation stand at the I.E.A. Exhibition, London, in 1964; and at the Physics Exhibition, London, in 1969 G.E.C., Ltd., (Hirst Research Centre, Wembley) showed some interesting developments of the same type of circuit.

The derivation of the factors of the transfer function from the element values of the passive filter serves to show the relationship between the several ways of specifying the filter and its responses. For accuracy, however, the qs and Ts of the factors are better computed directly from the Darlington theory as given in Ref. 1, Ref. 2, and elsewhere; and some sets of values so obtained are given in Table 3. The k of Ref. 1 $= 1/\Omega_s$. Tables of poles and zeroes for Darlington and some other types of filter are given in Ref. 3 and may be converted into real factors as shown above, Fig. 3 and equations (10) and (11).

3rd-order Darlington response

3rd-order Darlington is specified as in Fig. 1, though there is only one trough in the pass band, and one zero in the stop band. Such a specification is met by a structure as shown in Fig. 6. There is no longer any necessity to use an unsymmetrical structure, and in practice a symmetrical structure is used. This can be bisected into two equal halves, and hence a general expression for the transfer function found in factorized form,

$$G(p)=\frac{1+p^2T_2^2}{2(1+(1/q_1)pT_1+p^2T_1^2)(1+pT_3)} \quad (17)$$

The response may then be analyzed by simple algebraic methods. However, some ready-computed results are given here:

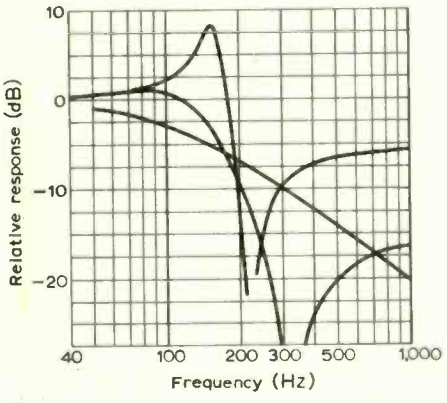


Fig. 5. Measured responses of the individual stages of a filter as Fig. 4, scaled to give −3 dB at 159 Hz.

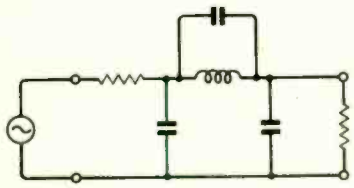


Fig. 6. Schematic for passive realization of 3rd-order Darlington response.

TABLE 4

Parameters for 3rd-order Darlington response, normalized to cut-off frequency $\omega_p = 1$ rad/s.

$$G(p)=\frac{1+p^2T_2^2}{(1+pT_1/q_1+p^2T_1^2)(1+pT_3)}$$

A_s (db)	$1/\Omega_s$	A_p	q_1	T_1	T_3	T_2
20	0·5	0·05	1·635	0·704	0·699	0·441
	0·6	0·15	1·929	0·826	0·928	0·533
	0·7	0·5	2·480	0·931	1·252	0·630
	0·8	1·5	3·731	1·007	1·778	0·731
30	0·4	0·1	1·515	0·766	0·919	0·351
	0·5	0·4	1·909	0·909	1·328	0·441
	0·6	1·3	2·685	1·010	1·959	0·533
	0·65	2·2	3·354	1·030	2·418	0·581
40	0·3	0·15	1·486	0·807	1·074	0·261
	0·4	0·8	2·080	0·978	1·778	0·350
	0·45	1·6	2·604	1·036	2·305	0·395
	0·5	2·9	3·373	1·074	3·012	0·441

Butterworth response

The occasional designer may like to have at command without resort to reference books a few design formulae suitable for meeting specifications of only moderate stringency such as might occur in the experimental laboratory in acoustical and vibrational work. In such applications the steep cut off given by a zero in the stop band may not be required, and the easily defined Butterworth (or maximally flat) response is often used:

$$|G(\omega)| = \frac{V_{out}}{V_{in}} = \frac{1}{(1+x^{2n})^{\frac{1}{2}}} \quad (18)$$

where $x = \omega/\omega_c$, ω_c is the -3 dB (or corner) frequency, n is the order of the response. The nature of this family of responses is shown in Fig. 7. Each for its own value of n is the best monotonic approximation to the two asymptotes, i.e. the closest-fitting curve with a slope continuously increasing in one direction, and all pass through -3 dB at $\omega = \omega_c$, i.e. at $x = 1$.

The first three we already know in factorized transfer-function form, Table 5.

TABLE 5

Amplitude and transfer functions for low-pass Butterworth filters, $n = 1$ to $n = 3$.

$\lvert G(\omega)\rvert$	$G(p)$
$\frac{1}{(1+x^2)^{1/2}}$	$\frac{1}{1+pT}$
$\frac{1}{(1+x^4)^{1/2}}$	$\frac{1}{1+\sqrt{2}pT+p^2T^2}$
$\frac{1}{(1+x^6)^{1/2}}$	$\frac{1}{(1+pT)(1+pT+p^2T^2)}$

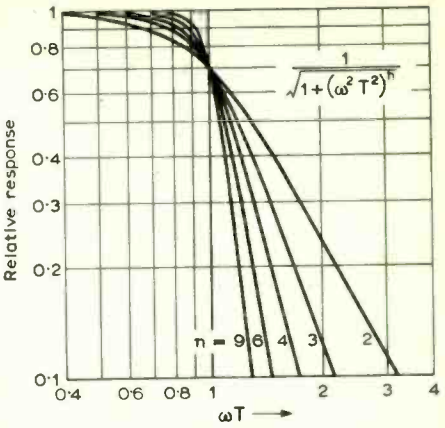


Fig. 7. Butterworth response, low-pass.

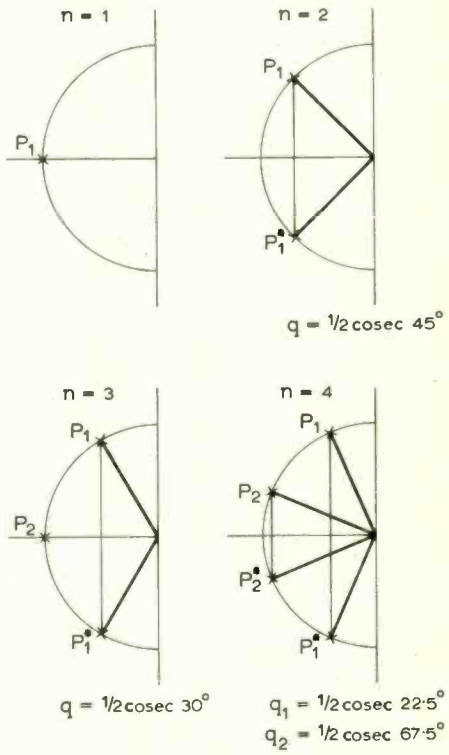


Fig. 8. Location of Butterworth poles.

To find the remainder the amplitude function $|G(\omega)|$ must be factorized. This involves finding the roots of the equation

$$x^{2n}+1 = 0 \quad (19)$$

i.e.

$$x^{2n} = -1, \quad (20)$$

and is, therefore, an exercise in complex algebra using the concept of the n nth roots of -1. (See, for example, Loney: Plane Trigonometry, Pt. 2, p. 141.) The complex conjugate factors so obtained are multiplied together, giving real 2nd-order factors in ω^2, with one real 1st-order factor when n is odd, and compared with the 2nd-order amplitude factor, equation (21) of Part 2, corresponding to the standard transfer-function factor

$$\frac{1}{1+(1/q)pT+p^2T^2}$$

The result is that the rth factor has

$$\frac{1}{q} = 2\sin\frac{(2r-1)\pi}{2n}, \quad (21)$$

and numerical results up to $n = 10$ are

given in Table 6. For all odd values of n there is also a 1st-order (simple-lag) factor; hence for odd orders the products of the qs is 1, and for even orders $1/\sqrt{2}$.

TABLE 6

n	q_1	q_2	q_3	q_4	q_5
2	0·707				
3	1·000				
4	1·306	0·541			
5	1·618	0·618			
6	1·932	0·707	0·518		
7	2·247	0·802	0·555		
8	2·563	0·900	0·601	0·510	
9	2·880	1·000	0·653	0·532	
10	3·196	1·101	0·707	0·561	0·506

The results of the analysis can also be given in memorable form as the positions of the poles of $G(p)$ in the complex plane. As all Ts are equal the poles lie on a circle, and they are evenly spaced as shown in Fig. 8. It is clear that the highest Q factor increases with increasing n, and the curves, Fig. 9, give an idea of how the opposing curvatures of the high-Q and low-Q factors go towards giving an approximation to a level response in the pass band and to a constant rate of fall above cutoff.

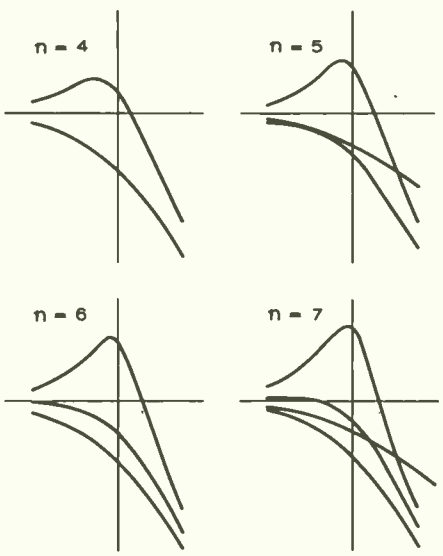


Fig. 9. Response of individual factors of Butterworth responses, $n = 4$ to $n = 7$.

It can also be seen that for n even and ≥ 4 the lowest Q factor is little greater than $\frac{1}{2}$. If it is divided by a factor x so that it is made equal to $\frac{1}{2}$, the gain at ω_c can be returned to -3 dB by multiplying the highest Q factor by x. The overall response is hardly altered by the change, Fig. 10; and the Q factors for these approximate Butterworth filters are given in Table 7. The importance

TABLE 7

n	q_1	q_2	q_3
4	1·414	0·5	
6	2·0	0·707	0·5

of the modification is that the low-Q factor is now two buffered lags, and it may be possible to save an amplifier by incorporating them in some existing part of a system.

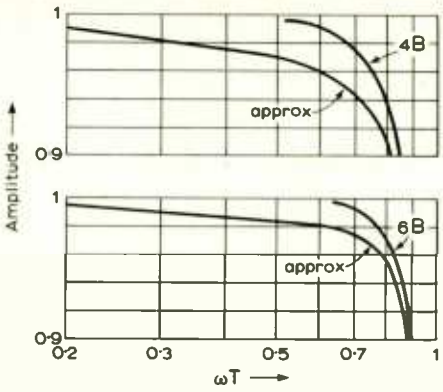


Fig. 10. Approximate Butterworth responses compared with exact responses.

3rd-order Chebyshev response

If some ripple is allowed in the pass band the corner can be sharper and the fall just beyond steeper. Consider the simple 3rd-order filter shown in Fig. 11. If it is equally terminated, $R_L = R_S = R$ (say), the network can be bisected into two halves, and the voltage transfer ratio easily found as

$$\frac{V_{out}}{V_{in}} = \frac{1}{2(1+pCR)(1+pL/R+p^2LC)} \quad (22)$$

$$= \frac{1}{2(1+qpT)(1+(1/q)pT+p^2T^2)} \quad (23)$$

where $T = 1/\omega_c = \sqrt{(LC)}$, (24)

$$q = \frac{R}{\omega_c L} = \omega_c CR \quad (25)$$

$$= R\sqrt{\frac{C}{L}} \quad (26)$$

This confirms that high R gives light damping (high q), and also shows that as q increases the corner frequency of the 1st-order factor, $1/qT$, moves down the frequency scale, giving increased attenuation at high frequency. This "corrects" the increased gain in the vicinity of ω_c contributed by the 2nd-order factor, and so is consistent with the fact that when $R_L = R_S$ no peak in the response can rise higher than the zero-frequency level (-6 dB), since this is the optimum match between equal resistances.

Ignoring the factor $\frac{1}{2}$, the normalized ($T = 1$) amplitude response is given by $|G(j\omega)|$

$$= [(1+q^2\omega^2)\{(1-\omega^2)^2+\omega^2/q^2\}]^{-\frac{1}{2}} \quad (27)$$

$$= [1+\omega^2\{(q-1/q)-q\omega^2\}^2]^{-\frac{1}{2}} \quad (28)$$

Consider

$$y = \omega\{(q-1/q)-q\omega^2\}. \quad (29)$$

If $q<1$, $(q-1/q)$ is negative and the slope $dy/d\omega$ is continuously negative; but if $q>1$, $(q-1/q)$ is positive and y is zero at a finite positive value of ω as well as at the origin, Fig. 12. Consequently when $q>1$, the normalized amplitude response, which is given by $(1+y^2)^{-\frac{1}{2}}$, has a trough and then returns to unity before descending towards zero. (See Fig. 13.) As Q increases the sharpness of the corner and the rate of attenuation just beyond the corner increase: so does the amplitude of ripple in the pass-band. This is a simple example of the general

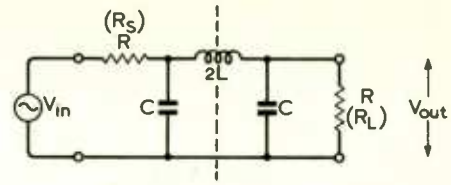


Fig. 11. Structure of simple (all-pole) passive 3rd-order low-pass filter.

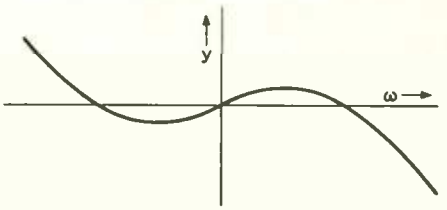


Fig. 12. Illustrating the mathematics of the production of a ripple.

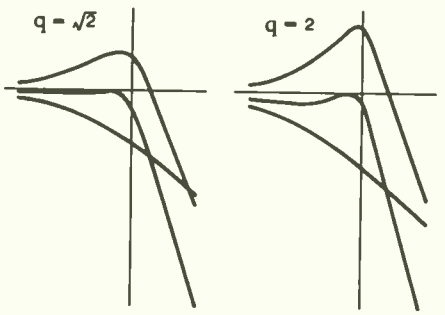


Fig. 13. Chebyshev responses, 3rd-order, and the responses of their factors.

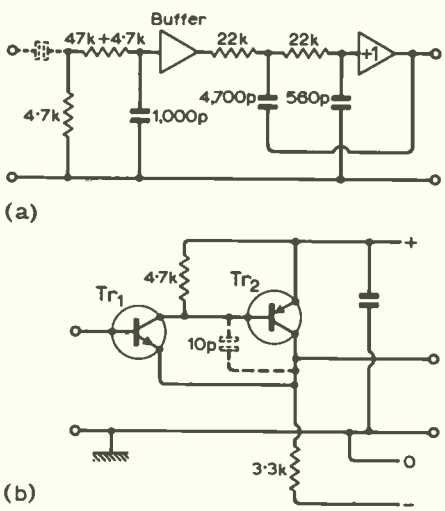


Fig. 14. (a) 3rd-order low-pass filter, -3 dB at 4·75 kHz. (b) Suggested amplifier. Tr_1: 2N3707, 2N3904, BC109C etc. Tr_2: 2N4058, 2N3906 etc.

nature of Chebyshev or equal-ripple response. The peak occurs where

$$\omega^2 = 1-\frac{1}{q^2}, \quad (30)$$

So as $q \to \infty$ the peak approaches ω_c, while for $q = 1$ it is at $\omega = 0$ (i.e. the ripple disappears). As shown in Part 1 this is maximally-flat-amplitude (Butterworth) response, and here the corner frequency of the 1st-order factor is equal to that of the 2nd-order factor. For $q<1$ the corner frequency of the 1st-order factor is at a higher frequency than that of the 2nd-order factor, and this adds to the greater roundness of the corner compared with the Butterworth.

The trough occurs at

$$\omega^2 = \frac{1}{3}\left(1-\frac{1}{q^2}\right), \qquad (31)$$

and the depth of the trough may be derived from the relationship

$$y_t^2 = \frac{4q^2}{27}\left(1-\frac{1}{q^2}\right)^3 \qquad (32)$$

For 1 dB depth, maximum, q must be ≥ 2 approx., Fig. 13.

As a compromise between low ripple and a sharper corner q may be chosen in the region 1·4 (0·15 dB ripple) to 1·5 (0·25 dB ripple); and Fig. 14(a) shows a schematic for an audio-frequency low-pass filter with $q = 1{\cdot}43$ approx. The ω_c of the 2nd-order factor is $10^6/36$ radians/second (= 4·4 kHz), and the −3 dB point for the whole filter is at 4·75 kHz approximately.

The amplifiers may be of a variety of types, and will probably be chosen for convenience and ready availability. The circuit shown in Fig. 14(b) is suitable, and although of only moderate internal gain (*c.* 500), gives enough loop gain to reduce distortion at (say) 1 V r.m.s. output to a very low level. An input buffer amplifier should be used if the output impedance of the previous stage is not negligible or cannot be incorporated into the first resistance of the filter. Provided Tr_1 maintains a high current gain at low I_C all impedances, and the two resistances in the amplifier, may be increased several times, giving economy in h.t. current and in the size of capacitors.

For higher-order Chebyshev filters the parameters must form a proper set, or the ripples will not be equal. Table 8 gives the Q factors and the relative magnitudes of the Ts for five 5th-order curves with depth of ripple from 0·02 dB to 0·8 dB. All these may be considered a better approximation to constant gain in the pass band, and the table shows that all but the first give more attentuation than 5th-order Butterworth, both at twice the cut-off frequency and at higher frequencies (Fig. 15).

Filters for pulse transmission

The high Q factor of at least one factor of a

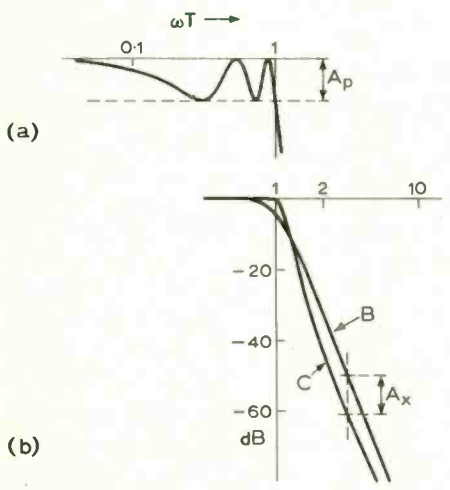


Fig. 15. Illustrating 5th-order Chebyshev response: (a) pass-band ripple, (b) increased attenuation compared with Butterworth 5th-order response, B.

TABLE 8

Parameters for 5th-order Chebyshev response

$$\frac{1}{(1+pT_0)(1+pT_1/q_1+p^2T_1^2)(1+pT_2/q_2+p^2T_2^2)}$$

$\frac{T_0}{T}$	$\frac{T_1}{T}$	q_1	$\frac{T_2}{T}$	q_2	A_p	A_x $\omega T=2$	A_x $\omega T=\infty$
1·337	1·051	0·786	0·827	2·618	0·02	−3	0
1·642	1·181	0·859	0·885	3·000	0·06	2	5
2·164	1·337	1·000	0·946	3·702	0·2	7	10
2·377	1·383	1·062	0·962	4·000	0·3	9	12
3·236	1·506	1·328	1·000	5·236	0·8	14	17

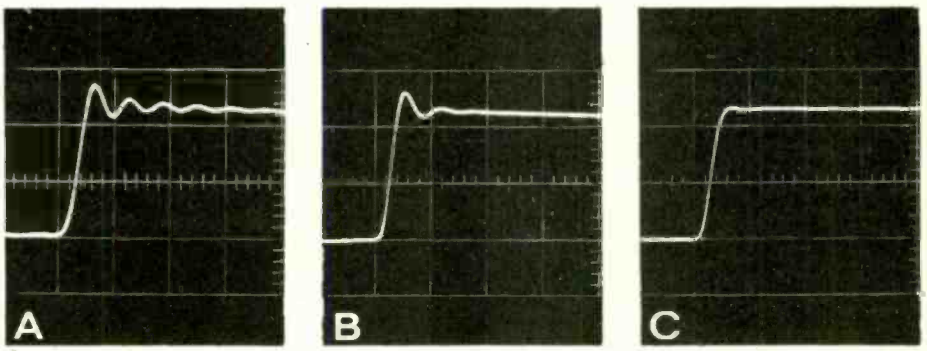


Fig. 16. Step responses of three filters: (a) a 5th-order Darlington, (b) a 5th-order Butterworth, (c) an approximate linear-phase filter.

filter with a sharp corner and rapid fall at the end of the pass band gives an oscillatory transient response. Thus for the Darlington filter described in the previous section the response to a step function, Fig. 16(a), shows an overshoot of about 15% and several subsequent oscillations of appreciable amplitude. To avoid such ringing it is not necessary for all factors to have $q \leqslant \frac{1}{2}$ ($q = \frac{1}{2}$ is critical damping), but it is necessary that all factors with corner frequencies falling within the passband should have low values of q. Thus the simple 5th-order filter with transfer function

$$G(p) = \frac{1}{(1+pT)^3(1+pT+p^2T^2)} \qquad (33)$$

has a step response, Fig. 16(c), quite suitable for pulse work; though the frequency response, Fig. 17(a), falls away considerably in the pass band and has a very rounded corner.

It is generally agreed that for good pulse response the phase lag should increase linearly with frequency through as much of the pass band as possible. If a high Q factor is present the slope of the phase curve is less near zero frequency but increases as the resonant frequency of the factor is approached. If the corner of the amplitude response curve is unnecessarily rounded, meaning that only very low Q factors are present, the slope of the phase curve is greater near zero frequency, but slowly decreases. The transient response then is not ringy, but the rise time is unnecessarily long. Note: a linear frequency scale is assumed.

The slope of the phase curve is associated with the idea of a group delay used in the wave theory of optics,

$$\tau_g = \frac{d\phi}{d\omega} \qquad (34)$$

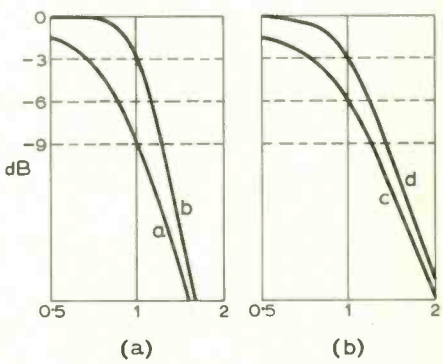


Fig. 17. Amplitude responses of Butterworth and approximately linear-phase filters.

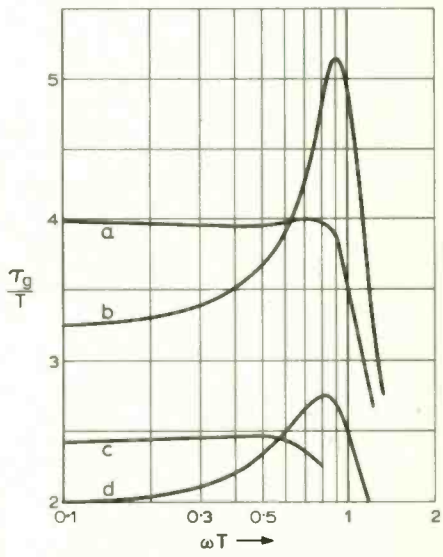


Fig. 18. Normalized group delay of Butterworth and approximately linear-phase filters.

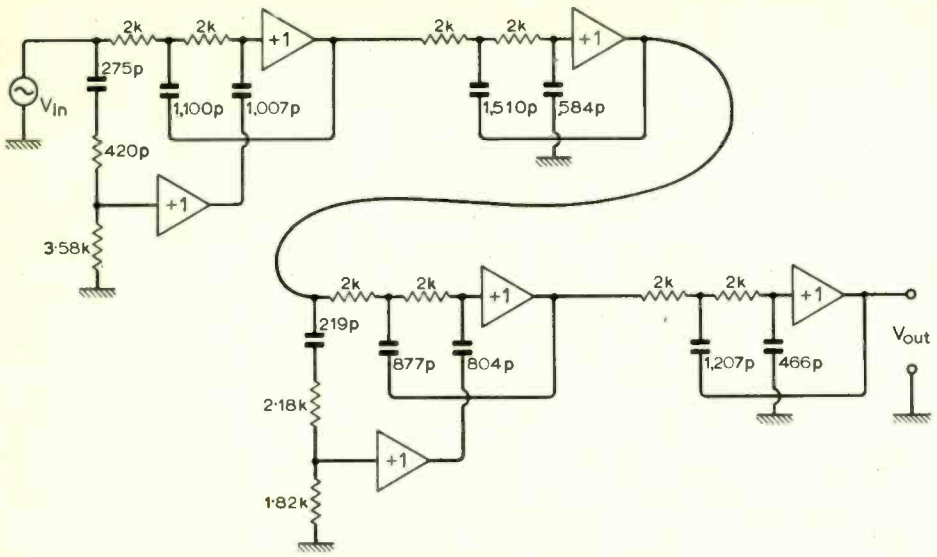


Fig. 19. Realization of the 8th-order Storey-and-Cullyer linear-phase characteristic. Resistors, Ω. Capacitors, pF.

This function for the filter just mentioned, equation (33), is shown in Fig. 18, curve *a* and for the 5th-order Butterworth filter in curve *b*. It can be seen that while the first is almost level up to 0·9 of the cut-off frequency, the second rises to a pronounced peak. Curves *c* and *d* give similar information for two 3rd-order filters: *d* Butterworth, *c* a similar filter with the *q* of the quadratic factor reduced to $1/\sqrt{2}$. The frequency responses are shown in Fig. 17(b).

An example of a linear-phase filter designed empirically is given in Ref. 4. It is an 8th-order filter with two frequencies of infinite attenuation, and the transfer function may therefore be resolved into two numerator factors,

$$(1+p^2T_a^2),\ (1+p^2T_b^2),$$

and four denominator factors,

$$(1+(1/q_1)pT_1+p^2T_1^2),\ \text{etc.}$$

The poles are given as

$$-4{\cdot}549\pm j1{\cdot}362,\ -3{\cdot}305\pm j4{\cdot}174,$$
$$-5{\cdot}687\pm j1{\cdot}703,\ -4{\cdot}131\pm j5{\cdot}218,$$

and the frequencies of inf. attenuation as

$$5{\cdot}027 \text{ and } 8{\cdot}796,$$

(all $\times 10^5$ radians/second). These give

$$\omega_1 = (4{\cdot}549^2+1{\cdot}362^2)^{\frac{1}{2}} = 4{\cdot}75\ (\times 10^5),$$

hence

$$T_1 = 1/0{\cdot}475 = 2{\cdot}105 \text{ microseconds},$$
$$q_1 = \tfrac{1}{2}(1+1{\cdot}362^2/4{\cdot}549^2)^{\frac{1}{2}} = 0{\cdot}5215,$$
$$T_a = 1/0{\cdot}5027 = 1{\cdot}991 \text{ microseconds},$$

and similarly for the other constants, giving Table 9.

If (a) is grouped with (1), and (b) with (3), two factors are obtained

$$\frac{1+a_1p^2T_1^2}{1+(1/q_1)pT_1+p^2T_1^2},\quad \frac{1+a_3p^2T_3^2}{1+(1/q_3)pT_3+p^2T_3^2}$$

with

$$a_1 = T_a^2/T_1^2 = 1{\cdot}991^2/2{\cdot}105^2 = 0{\cdot}895,$$

and

$$a_3 = T_b^2/T_3^2 = 1{\cdot}137^2/1{\cdot}685^2 = 0{\cdot}455;$$

and (2) and (4) are left as simple 2nd-order low-pass factors. These add up to give the overall response, which has a well rounded

TABLE 9

Parameters of linear-phase filter, Fig. 19.

Subscript	(1)	(2)	(3)	(4)	(a)	(b)
T	2·105	1·88	1·685	1·50	1·991	1·137
q	0·522	0·805	0·522	0·805	—	—

corner much as curve *a* of Fig. 17(a), but, because of the zeroes a much steeper fall after the corner. The stop band, where the minimum attenuation is 30 dB, starts at 75 kHz. The end of the passband may be taken to be the −10 dB point, which is at 50 kHz (314×10^3 rad/s, $T = 3{\cdot}18\ \mu$s); and rectangular pulses down to a width of 20 μs are transmitted with full amplitude, though reduced to a shape similar to a single cycle of a cosine wave.

By following the procedure used before, the filter may be realized as a cascade of four Sallen-and-Key sections, two of simple low-pass type and two with a parallel path giving a zero, Fig. 19. As all Q factors are low, the amplifiers do not need very high internal gain. Provided the filter is not required to pass zero-frequency signals with a tight specification on zero drift, pairs of transistors connected in the enhanced-emitter-follower arrangement would be satisfactory. In general a tolerance of ±2% on component values will be quite adequate, as none of the factors show rapid changes of attenuation in or near the pass band. For good zeroes, however, a somewhat closer match between the time constant of the side-chain network and the short-circuited-output time constant of the network in the main path is advisable.

REFERENCES

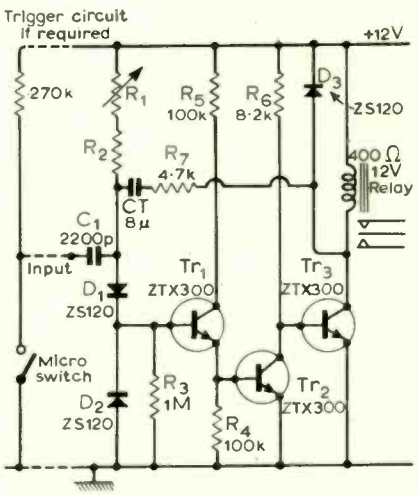
1. "Design Data for Symmetrical Darlington Filters", by J. K. Skwirzynski and J. Zdunek, Proc. I.E.E. Part C, Sept. 1957, Vol. 104C, No. 6, pp. 366–380.
2. "Design Theory and Data for Electrical Filters", by J. K. Skwirzynski, Van Nostrand, London (1965).
3. "Filter Design Tables and Graphs", by E. Christian and E. Eisenmann, John Wiley & Sons, New York (1966).
4. "Active Low-pass Linear-phase Filters for Pulse Transmission", by D. J. Storey and W. J. Cullyer, Proc. I.E.E., April 1965, Vol. 112, No. 4, pp. 661–668.

Application Notes

Circuitry selected from device manufacturers' literature

Process Timer

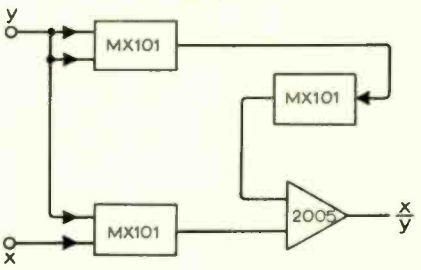
The circuit will hold the relay on for a period of between one and ten seconds (determined by R_1) when actuated by a negative input pulse. This pulse could



be provided by the switch and resistor shown. Extracted from the Ferranti "E-line Transistor Applications" handbook.

Four-Quadrant Division

The circuit produces X/Y using type MX101 multipliers from Fenlow elec-



tronics. The inputs X and Y can be of any sign. Use is made of the fact that $X \div Y = (XY)/Y^2$.

Dynamic Range versus Ambient Noise

A practical solution involving metal-cone loudspeakers and high-power amplifiers

by George Izzard O'Veering

The essential requirements for a high quality sound reproduction system are adequate power and adequate bandwidth. Since loudspeakers are inefficient, and the attainment of wide bandwidth systems is generally incompatible with high efficiency, the achievement of the desired acoustic spectrum from the subsonic to the ultrasonic makes heavy demands on amplifier output.

Moreover, it will be apparent on reflection that many of the musical and other instruments, the acoustic output of which it is desired to reproduce, are themselves both powerful and developed to a high degree of acoustic efficiency. It is clearly laughable to suppose that the majestic splendour of a full orchestral fortissimo or the lung power of a Wagnerian tenor in full cry can be represented adequately on an acoustic budget of a few hundred milliwatts. Inconvenient though it may be, there can be no doubt that to recreate the true dynamic range of much recorded sound over the required sonic spectrum makes demands on the output power of the audio amplifier/reproducer system which are well beyond the capabilities of most, if not all, of the equipment at present on the market.

Calculation of required power

The quietest sound which can be heard in a given environment depends entirely upon the background noise level of that environment. Unfortunately, most people live in close proximity to traffic, neighbours with television sets, dogs, and noisy children, and these things, together with the normal background sounds of the home, combine to give an ambient noise level of about 50dB. The minimum sound level which can be distinguished clearly above this background level is therefore 53dB. The dynamic range of orchestral music can be as much as 70dB, therefore in order to be able to hear the pianissimo as well as the fortissimo passages, a peak level of 123dB is required.

The acoustic power in watts required to produce a sound intensity level of 53dB is about 6μW for an average-size living room. Since a 10-dB increase in power output requires a tenfold increase in power, the 123-dB peak-power level will therefore require a maximum acoustic output of some 50W. If the loudspeaker efficiency is 5% (and this is significantly better than is obtained from most commercially available loudspeaker systems) a peak-power output of 1000W per stereo channel is obviously required if the total dynamic range of a symphony orchestra is to be heard in comfort.

It was clear from discussions both with manufacturers and distributors that no serious attempt had been made to meet the requirement for drive units capable of handling as little as 250W. Initial trials made with some of the more likely units, were generally unsatisfactory. In particular there was a tendency for the cone and speech coil to become detached, and for fraying of the surround. In addition, the failure was often made more serious by partial combustion of the inflammable materials within or in proximity to the speech-coil assembly.

When more substantial reproducer units had been evolved, this only brought to light the flimsy nature of the housings which had been supplied, and considerable annoyance was caused by a minor injury sustained when one of the cabinets burst during an orchestral transient and the room was filled with flying splinters. At this stage it was accepted that the cabinets used would require to be of comparable strength to the reproducers, and the assistance of the specialist who constructed the metal cone loudspeaker assemblies was sought to manufacture four sheet-steel column-loaded units, of a suitable type to take the 23in × 14in elliptical wide-band speakers. These are situated at the four corners of the listening room and the opposite units are connected in parallel but in antiphase. This has the effect of increasing the apparent dimensions of the listening room, in addition to reducing the I^2R losses in the speaker wires.

Each unit is rated at 500W, with a nominal 20Ω impedance. The required output from the amplifier is therefore 10A at 100V r.m.s. (282 volts pk-pk) per channel.

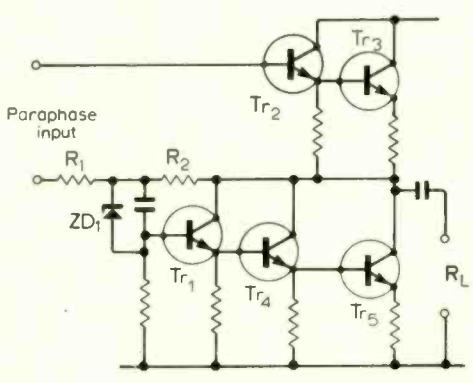


Fig. 1. Symmetrical output stage using only n-p-n transistors.

Power amplifier design

The use of a solid-state, transformerless amplifier to provide an output of 1kW into a 10-Ω load imposes certain limitations on the designer. In particular, the normal complementary or quasi-complementary output stage configurations are no longer practicable since the only useful and relatively cheap high-voltage transistors which are available are all of the n-p-n construction.

The basic output stage configuration employed, to provide a fully symmetrical push-pull class B output stage using only n-p-n transistors, is shown in Fig. 1. As shown, this would be satisfactory for power outputs up to about 50W.

In this circuit arrangement, Tr_2/Tr_3 and Tr_4/Tr_5 are Darlington pairs with Tr_2 and Tr_4 being normal small-power driver transistors. Tr_1, in combination with R_1 and R_2, provides the necessary signal level and amplitude transformation for the lower half of the output stage, and ZD_1 effectively stabilizes the voltage level at the power output point. This is chosen so that the largest symmetrical voltage swing is obtainable. The symmetry of this stage is maintained up to a frequency determined by the resistance of R_1 and R_2 and the input shunt capacitance of Tr_1. This will normally be well above the audible spectrum.

The final circuit employed is shown in Fig. 2. Although for simplicity only four parallel-connected output transistors are shown in each half of the output stage, this is only adequate for intermittent use at 1kW output. In practice six parallel connected transistors are required in each half of the output stage.

The paraphase input is obtained from two medium-power high-voltage transistors, Tr_3 and Tr_4, the h.t. supply for which is obtained from a separately smoothed 400-V line, because bootstrapping is not practicable with this type of driver stage.

The input is derived from a long-tailed pair of p-n-p transistors, of a type chosen for high voltage linearity, and freedom from avalanche or collector leakage (Early effect) distortion. Although 150V is applied to the end of the 'tail', the maximum collector-emitter voltage is limited to about 52V, because the base of Tr_2 is returned to the 50V tap on the zener diode chain. A variable resistor is included in the 'tail' to set the current through Tr_1 and Tr_2. This controls the current through Tr_3 and Tr_4, and, since the output d.c. level is determined by ZD_1, thereby controls the

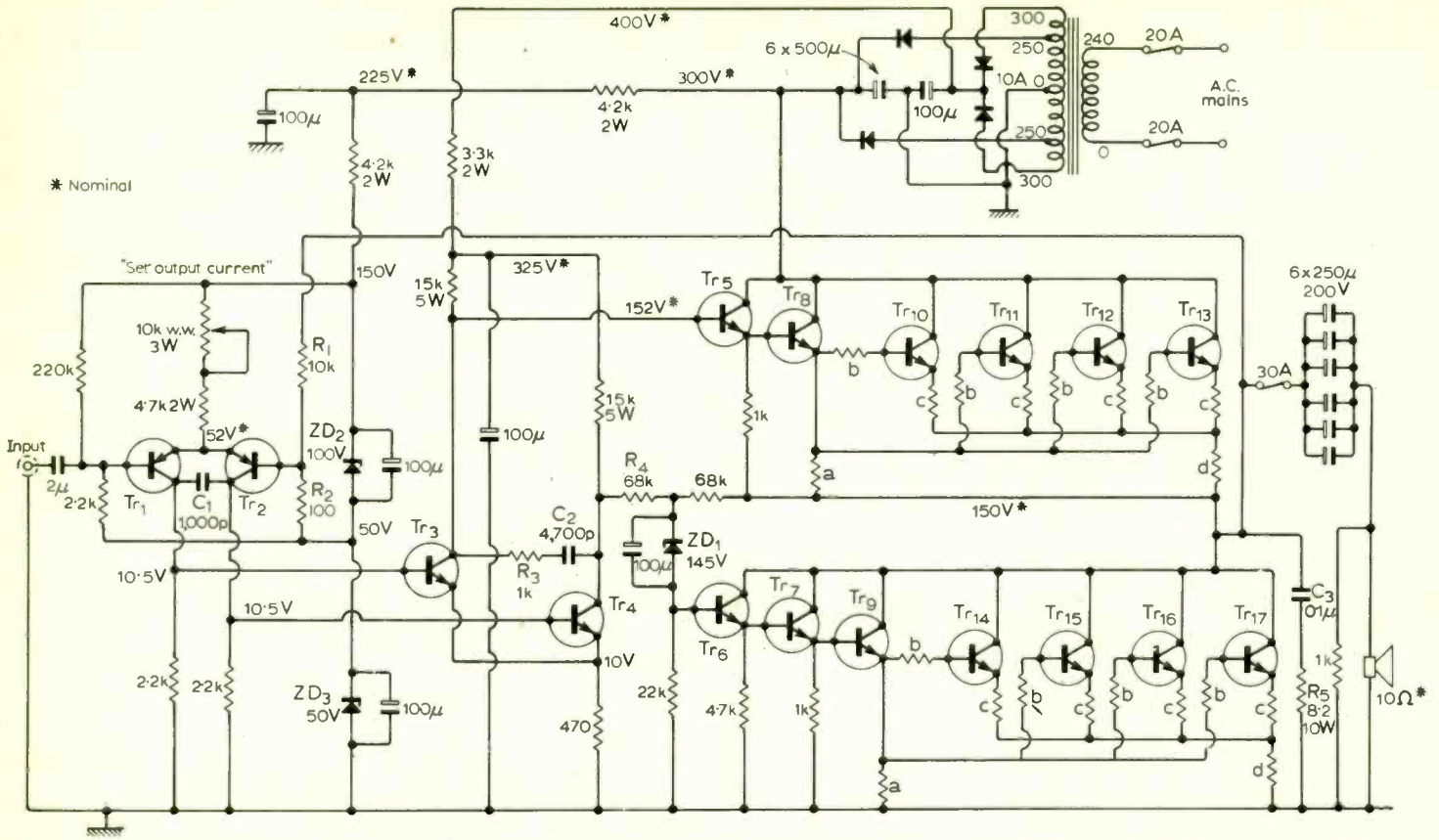


Fig. 2. Expanded version of Fig. 1 employing a Darlington triple as the output device. Tr_1, Tr_2—R.C.A. 38496; Tr_3 to Tr_7—MJE340; Tr_8 to Tr_{17}—MJ413. Lettered resistor values: $a = 22\Omega$, 2W; $b = 10\Omega$, 2W; $c = 0.5\Omega$, 5W; and $d = 0.1\Omega$, 5W.

quiescent current of the output stage. This should be set to about 200mA. Because of the absence of coupling or bootstrapping capacitors the gain of the circuit from the base of Tr_1 to the output of the power transistors is constant from the h.f. roll-off point down to d.c. The l.f. roll-off point is therefore determined solely by the 2-μF input capacitor and the output time constant.

The input impedance is 2kΩ in series with 2μF. The h.f. roll-off point and the phase stability margin is determined by C_1, (the input-lag capacitor) C_2 and R_3, and C_3 and R_5. The loop gain is determined by resistors R_1 and R_2 and is approximately 100. The full output is given by an input of 1V r.m.s., which can be obtained from any suitable high-quality pre-amplifier capable of operating into a 2-kΩ load.

Constructional details

The construction of the power amplifier unit follows conventional lines, and no unusual precautions are required apart from the need for generous heat sinks. Very satisfactory results were given in the prototype by the use of a pair of old cast-iron radiators, such as can be found second-hand for a few pounds in a builder's yard, to which the transistors can be individually attached by small bridges made from a suitably substantial gauge of copper sheet. The bottom and sides of an old copper preserving pan would be ideal. Care should, of course, be taken in drilling the attachment holes to make sure that the radiator shell is still capable of retaining water without leakage.

If such radiators cannot be found, a copper hot-water storage cylinder would serve admirably, but it would probably be more difficult to introduce such an item inconspicuously into the listening room. The siting of the output transistors should combine shortness of signal leads with the required thermal separation of the power transistors one from another. It should also be borne in mind that the circulating currents at full power are of the order of 30A. The leads to the loudspeaker terminal bosses—for which old car battery connectors are suggested—to the collector and emitter rails of the output transistors, and to the h.t. and earthy ends of the h.t. decoupling capacitor block must be substantial. A $\frac{1}{8}$in × $\frac{1}{4}$in bore copper pipe is preferable, but as an alternative, lengths of 12 s.w.g. copper wire may be plaited together.

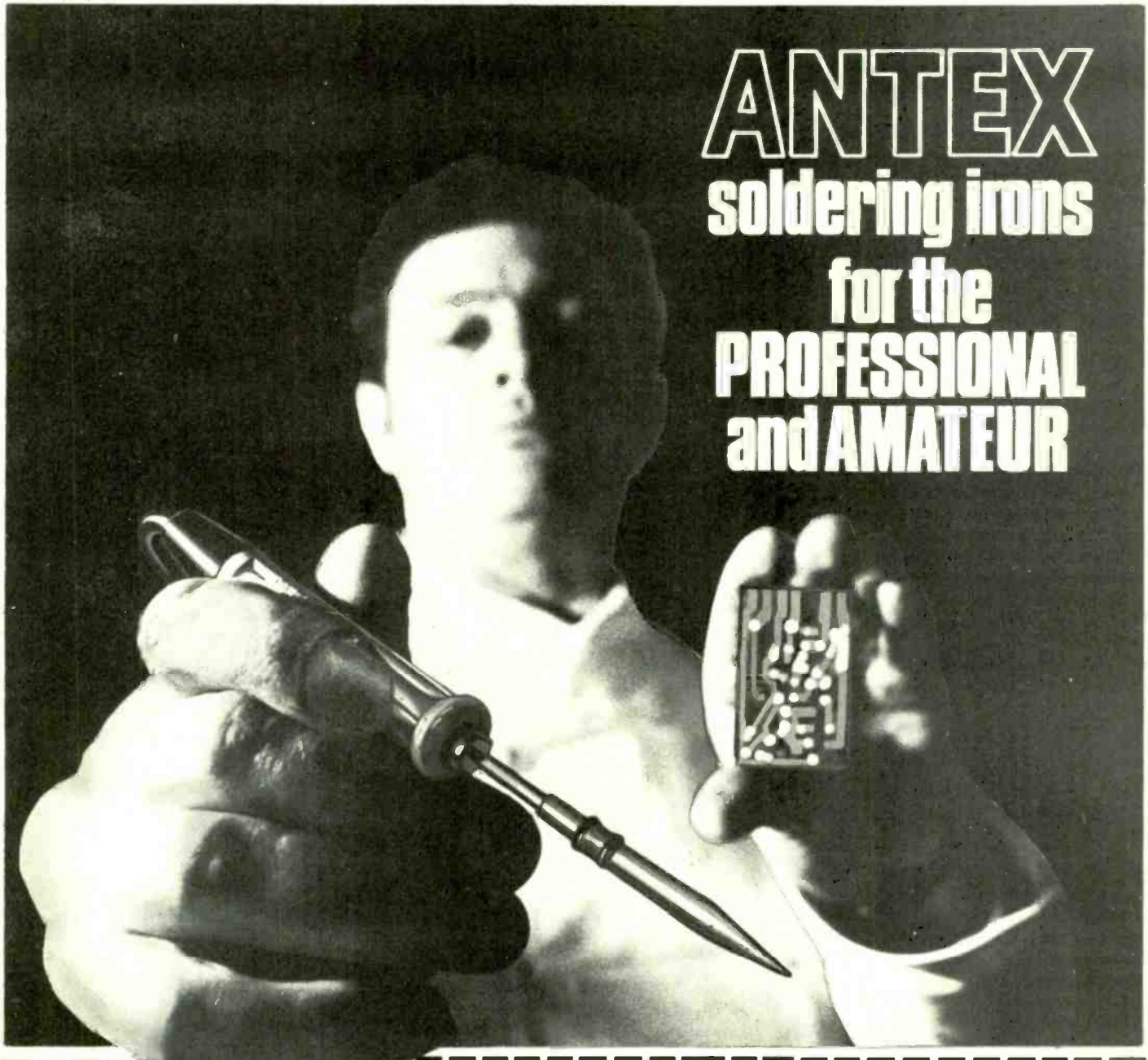
After assembly, it is recommended that the amplifier units be bench-tested on a dummy load before attachment to the speaker units, since quite trifling faults can lead to a surprising amount of energy being released. For example, in preliminary listening trials with the prototype, an intermittent o/c in the earth braiding on an input to the pre-amp, led to the necessity for the listening room ceiling to be substantially restored and replastered.

Listening arrangements

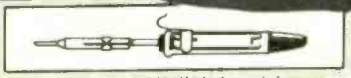
Although the results obtained with good quality gramophone recordings have been most astonishing, and have brought home to the author in the most vivid way the qualities of stamina and emotional detachment required of an instrumental player situated, as the fortunate listener, in the midst of a large orchestra, it is clear that there are a large number of residual problems in the life-like reproduction of disc recordings, of which the major one is the avoidance of acoustic feedback. As with many other of these problems, it is suspected that the manufacturers of the equipment have not really got down to serious thought on this matter, and the solution which the author feels most people must adopt, that of housing the record player unit is some detached building, such as a small garden shed, is inconvenient and prevents the listener from hearing the beginning of the recorded piece. Moreover, if in one's hurry to return to the audition room, the pickup cartridge is let fall too rapidly upon the record, extensive damage can be caused to windows and other glazing.

Summing up

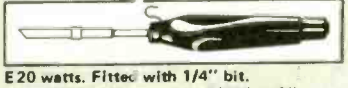
The performance of the equipment as installed is entirely satisfactory, and a wide variety of sound sources have been explored during the assessment of the scope of this system, and many sounds have been recaptured with a degree of realism not previously encountered. However, the development of this apparatus has not been without difficulty, scepticism and expense, and it has been suspected at times that unnecessary difficulties have been placed in the author's way. For these reasons, it is thought unlikely to appeal to those for whom high-fidelity reproduction is merely a passing interest. On the other hand, it has proved possible to purchase several of the adjoining properties at a very advantageous price, and this has undoubtedly offset a large part of the constructional costs.



ANTEX
soldering irons for the PROFESSIONAL and AMATEUR



G 18 watts. Fitted 3/32" bit for miniature work on production lines. Interchangeable spare bits, 1/8", 3/16" and 1/4" available. For 240, 220 or 110 volts. 32/6.

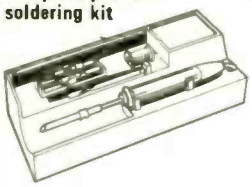


E 20 watts. Fitted with 1/4" bit. Interchangeable spare bits 3/32", 1/8", 3/16" available. For 240, 220, 110 volts. From 35/-

ES 25 watts. Fitted with 1/8" bit. Interchangeable bits 3/32", 3/16" and 1/4" available. Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. From 35/-

F 40 watts. Fitted 5/16" bit. Interchangeable bits 1/4", 3/16", 1/8", 3/32" available. Very high temperature iron. For 240, 220, 110, 24 or 20 volts. From 42/6 Spare bits and elements for all models and voltages immediately available from stock.

Complete precision soldering kit



This kit—in a rigid plastic "tool-box" — contains

- Model CN 15 watts miniature iron, fitted 1/8" bit. Interchangeable spare bits 1/4", 3/16".
- Reel of resin-cored solder
- Felt cleaning pad
- Stand for soldering iron

PLUS 36-page booklet on "How-to-Solder"—a mine of information for amateur and professional.

From Electrical and Radio Shops or send cash to Antex. **49/6**

Model CN 240/2
15 watts - 240 volts
Fitted with nickel plated bit (3/32") and in handy transparent pack. From Electrical and Radio Shops or send cash to Antex. **31/**

ANTEX

PRECISION MINIATURE SOLDERING IRONS

Antex, Mayflower House, Plymouth, Devon.
Telephone: Plymouth 67377/8.
Telex: 45296. Giro No. 2581000.

☐ Please send me the Antex colour catalogue

☐ Please send me the following irons

Quantity Model Bit Size Volts Price

....

....

....

I enclose cheque/P.O./cash value

.....

NAME .....

ADDRESS .....

..... WW.4

WW—102 FOR FURTHER DETAILS

World of Amateur Radio

Amateurs urged to tackle TV interference

As a result of renewed efforts by many British amateurs to overcome the problem of causing interference to local television receivers, the number of stations to be heard operating during television programme hours has risen appreciably during the past year. However, there are signs that the Ministry of Posts & Telecommunications is concerned at the number of requests being made to the Post Office by both amateurs and viewers for assistance in overcoming television interference (TVI). While the Ministry is responsible for all technical matters relating to the orderly use of the r.f. spectrum, interference investigation field work is now carried out by Post Office engineers under contract to the Ministry. Interference investigation costs the Ministry about £2 per hour.

Amateurs are being urged to acquaint themselves with the basic causes of TVI and to tackle interference problems without calling in the Post Office teams. Amateurs are also being encouraged to persuade manufacturers of commercially built amateur transmitters to pay more attention to design features likely to reduce the problem, including the choice of oscillator frequencies. It is being suggested that only when cases of TVI prove intractable or where the viewers concerned adopt an unco-operative attitude should the Post Office investigation officers be called in.

Australis Oscar 5 satellite

The Australian-built Oscar 5 satellite carrying 28- and 144-MHz beacon transmitters (see the March issue), launched on January 23rd, continued to function as planned until February 14th when, during the 273rd orbit, a commanding "on" of the h.f. beacon brought the battery voltage below that needed to operate the v.h.f. beacon. At the time of writing, the h.f. beacon continues in operation but is expected to have ceased by the time these notes appear.

Bill Browning, G2AOX, the European co-ordinator, has already received over 100 reports on the Oscar 5 telemetry signals, including many from Germany, Sweden and the U.K. The reports cover reception of the 144-MHz beacon since telemetry signals were not satisfactory on 28MHz, due to a modulator malfunction, although the carrier and "HI" identification signals were radiated. The simple stabilizing system also proved rather less satisfactory than had been expected resulting in deep fading of signals when the satellite was overhead. Many novel techniques were used by amateurs to read out the telemetry, including matching of incoming tones with a local generator by means of stereo headphones (giving accurate results at low signal/noise ratios). Almost all the reports showed close agreement in results.

Another highly satisfactory feature was the effective amateur communications links which brought masses of orbital predictions and other information to the London co-ordinator. These included radio-teleprinter links with Australia and the United States operated by Reg Wigg, G6JF in Devon and fed to London on 3.5MHz a.m. Direct London to U.S. links on s.s.b. were also used.

Many amateurs are hoping that the next Oscar will include (as in 1965) an active transposer, possibly 144MHz down and 432MHz up, to allow long-distance contacts to be made via the satellite. It is not known yet when the next amateur satellite is likely to be launched.

New group for the north east

A new North East England amateur radio group has been formed from within local clubs and societies to organize major amateur radio events, mainly evening "technical conventions". It is hoped that some five or six large meetings can be arranged each year to attract speakers from all over the country. Members of the group cover the whole of County Durham, Tyneside and Teesside as well as parts of Northumberland and the North Riding of Yorkshire. Members will be free from the commitments normally associated with regional and local radio clubs.

The first event takes place in Durham City on Friday, March 20th when F. J. U. Ritson, G5RI, of the University of Newcastle-upon-Tyne, is to give a lecture demonstration on aerials.

The secretary, J. Melvin, G3LIV, 5 Lancashire Drive, Belmont, Durham, will provide further details and a sample Newsletter to those interested. Peter Martin, G3PDM, is the interim chairman of what promises to be something new in the dissemination of technical information among amateurs.

Amateur microwave record?

An excellent contact was established during February between A. Wakeman, G3EEZ, operating portable on Clee Hill in the Midlands, and L. W. G. Sharrock, G3BNL, on Cleeve Common in the Cotswolds, on the 10-GHz (3-cm) band.

This is believed to be a new British record for amateur two-way operation on this band. A pulsed klystron transmitter was used at G3EEZ/P while frequency modulation was used at G3BNL/P.

A large number of v.h.f. and u.h.f. enthusiasts are expected to attend the 16th annual R.S.G.B. v.h.f./u.h.f. convention at the Winning Post hotel at Whitton on Saturday, April 25th. Technical lectures and an exhibition of equipment during the afternoon will be followed by a dinner. Tickets can be obtained from Frank Green, G3GMY, 48 Borough Way, Potters Bar, Hertfordshire.

In Brief: A change of address for the general secretary of the British Amateur Television Club: Ian Lever, G8CPJ, 65 Dynes Road, Kemsing, Sevenoaks, Kent, replaces the former Swanley address. . . . The first totally blind Irish amateur, Cathal O'Reilly, has recently been licensed as EI9CA. . . . Amateur licences in force at the end of October 1969 included 13,413 class A, 1,897 class B and 179 amateur television—class B licences are increasing much faster than class A. . . . The 28.185 MHz beacon station, GB3SX at Crowborough operates on a 24-hour basis with an output power of 20 watts to a three-element Yagi aerial usually, but not always, pointing East, or alternatively with an omni-directional aerial. . . . A German beacon station, DL0IGI operates on 28.20 MHz with a power of 200 watts to a vertical dipole. . . . The next U.K. Radio Amateurs Examination is being held on Monday, May 11th at 18.30 at many local venues. . . . A low-power 3.5-MHz contest is being held on April 5th. . . . W. E. Gardner, G3FYR, recently reported longish delay echoes during a contact with W2ELW on 28 MHz and received a letter from Professor O. G. Villard, Jr., W6QYT, acknowledging the usefulness of all such reports even though the present investigation (see December, 1969) is basically concerned with echoes of over one or two seconds and particularly those of five to ten seconds. These appear to be heard usually on only one station, and for time intervals of only a few minutes. . . . A printing error appeared in last month's note "50 years of callsigns"—line eight should refer to G4-*three*-letter callsigns.

PAT HAWKER, G3VA

Personalities

Several senior appointments in the Engineering Training Department have been announced by the B.B.C. **H. V. Sims,** M.I.E.E., F.I.E.R.E., previously head of training section (engineering) has been appointed to the new post of head of technical projects and services. He will be concerned with investigating new methods of presenting maintenance information and with the maintenance and installation of all the broadcasting training equipment at the Training Centre. **J. H. Brooks,** B.Sc.(Eng.), M.I.E.E., previously a senior lecturer, has become head of training section (engineering). He is responsible for the training of engineering and technical assistants in the Operating and Maintenance Departments of the Corporation. **D. G. Enoch,** M.I.E.R.E., previously a senior lecturer, has been appointed head of training section (technical operations) in succession to **G. W. MacKenzie** who was recently appointed head of engineering, Northern Ireland. Mr. Enoch is responsible for the technical training of the B.B.C's technical operators. **A. W. Harris,** B.Sc., A.C.G.I., M.I.E.E., is appointed assistant, overseas trainees, and is concerned with training courses and attachments for non-B.B.C. staff.

Among the 1970 recipients of awards by the Institute of Physics & Physical Society are: **Professor A. B. Pippard,** of Cambridge University, who receives the Guthrie Medal "for his contributions to low-temperature and solid-state physics"; **Dr. E. Eastwood,** director of research of the English Electric Company, who receives the Glazebrook Medal "for his work on radar and the application of physics in the electrical and electronics industry"; and **Dr. A. Hewish,** of Cambridge University, who receives the Charles Vernon Boys Prize "for his work in radio astronomy and particularly his discovery of the pulsar".

A. H. Ellson, M.B.E., B.Sc.(Eng.), M.I.E.E., has been appointed manager of the optical character reading group of the M.E.L. Equipment Company and **Th. P. Reede** will lead the company's technical marketing group, responsible for market research, business and product planning. Mr. Ellson was, until his new appointment, technical manager of the Microwave Division of M.E.L. and Mr. Reede joins M.E.L. from Philips Electrologica at Rijswijk in the Netherlands.

Norman Doyle, formerly marketing manager of Cossor Electronics' Communications Division, has been promoted divisional manager with overall responsibility for all aspects of the sales and marketing of Cossor's "Commando" range of radiotelephones and other u.h.f. and v.h.f. communications equipment. He is succeeded as marketing manager by **John Bonner** who recently joined the company. Mr. Bonner was previously sales promotion manager of Ultra Electronics for seven years.

Rank Precision Industries has announced the appointment of **James Warden** as chief engineer of the telecommunications product group of its Broadcast Division. Mr. Warden was formerly technical manager of the industrial products group of Cossor Electronics Ltd. He will be responsible for controlling the group's research and development programmes and will be based at Welwyn Garden City until June, when he will move to the new Rank Precision Industries factory at Ware.

Robert R. Heikes, B.Sc., Ph.D., director of engineering at Motorola's Semiconductor Products Division headquarters in Phoenix, Arizona, has been appointed as the company's managing director in Europe. Dr. Heikes will now be responsible for all Motorola activities in Europe. He will be based at the company's European Service Centre in Geneva and his responsibilities will cover the European sales offices and distributors and the manufacturing facilities in Toulouse, France, and East Kilbride, Scotland. Dr. Heikes received his degree in 1948 from the Massachusetts Institute of Technology and his doctorate in 1951 from the University of Chicago. Before joining Motorola he was associated with Westinghouse for 18 years.

Derek Ashby has joined Venner Electronics as their sales manager. Prior to joining Venner, Mr. Ashby, who is 34, was with Marconi Instruments for five years. He joined M.I. as a technical representative and was appointed manager of factored products in 1967. After National Service with the R.A.F. he joined Furzehill Laboratories as a development engineer.

Ferranti Ltd announces the appointment of **John Begbie** as general service manager with responsibility for all service policy in the Scottish Group and for co-ordinating activities with other departments in the Company. In addition, Mr. Begbie, who is 47, is appointed acting manager of the Ferranti factory at Dalkeith, Midlothian. Mr. Begbie studied at Edinburgh University, and after war-time radar experience joined Ferranti in Edinburgh in 1950 as a trials engineer. Following a spell in Australia as chief project engineer with a Vickers guided weapon team, he returned to Ferranti in 1957 to start the service department in Edinburgh. He is succeeded as service manager by **Eric Henney** who is 40. Mr. Henney was educated at the Royal College of Science and Technology, Glasgow, and after experience with I.B.M. and Barr & Stroud joined Ferranti in 1954.

Marconi-Elliott Computer Systems Ltd, Borehamwood, Herts, announces the appointment of **Iorwerth Evans,** B.Sc., as marketing director. He joins the company from Marconi Radar Systems Ltd in which he was general manager (Borehamwood) and a director. Born in 1932 Mr. Evans took a degree in mathematics at Imperial College, London. He joined the Guided Weapons Division of English Electric in 1953 where he stayed until 1959. After two years with Decca Radar Systems he joined Elliott Automation as chief systems analyst (defence systems), ultimately becoming general manager of Elliott Space and Weapons Automation Ltd. The 1968 merger between G.E.C. and English Electric resulted in the formation of Marconi-Elliott Computer Systems Ltd.

D. G. Smee, who joined Marconi in 1933, has been appointed an assistant managing director of both G.E.C.-Marconi Electronics and of the Marconi Company. He has held various senior management positions for the past 20 years (including manager of the Broadcasting Division) and has been Marconi's deputy managing director since 1968.

MCP Electronics Ltd (a subsidiary of Mining and Chemical Products Ltd) which acts both as a manufacturer and as a distributor for such companies as TRW Semiconductors Inc., will now operate with two principal divisions: intermetallics division, offering mainly semiconductor metals, under the management of **B. J. Wray,** a director of the company, and semiconductor division, with **David Cunningham** (newly appointed to the board) as general manager. Before joining MCP Electronics as sales manager, Mr. Cunningham was sales manager at SGS-Fairchild. Marketing in the semiconductor division has been divided into four groups, each with a product manager. **Terry Roeves** has been appointed product manager of the r.f. power devices group; **J. C. A. Chaimowicz,** of the optoelectronics group; and **W. E. B. Baldwin,** of the thick film integrated circuit group. A product manager for the industrial devices group has yet to be appointed.

OBITUARY

Lord Jackson of Burnley, F.R.S., D.Sc., F.I.E.E., professor of electrical engineering at Imperial College, London, from 1946-53 and 1961-67 died on February 17th aged 65. Willis Jackson graduated from the University of Manchester in 1925 and started on his academic career as a lecturer in electrical engineering at Bradford Technical College. In 1938 he became professor of electrotechnics at his old university, a post he held until his appointment to the chair at Imperial College. For the eight years between his incumbencies he was director of research and education with Associated Electrical Industries in Manchester. He was knighted in 1958 and created a life peer in 1967 for his services to education, science & technology. Lord Jackson served on many Government and scientific committees including the Television Advisory Committee of which he was appointed chairman in 1963.

Kenneth E. Harris, B.Sc., F.I.E.E., F.I.E.R.E., who died on January 27th aged 52, was in Sir Robert Watson-Watt's radar research team throughout the war and then for 14 years (1949-63) with Cossor latterly as technical director. His particular interest was secondary radar. In 1963 he joined Redifon as manager of the communications division and was appointed to the board in 1964. A year ago Mr. Harris left Redifon and has been associated with several other companies.

New Products

Two-hour Tape Cassette

The range of Scotch magnetic tape cassettes has been expanded to include a two-hour version. The new Philips-compatible cassette—the Scotch C-120—has an improved shim material which is reliable and eliminates tape binding and jamming. The shim material effectively reduces frictional drag and increases recorder battery life. The cassette uses Scotch Dynarange low-noise tape, giving good high-frequency response at slow ($1\frac{7}{8}$ i.p.s.) recording speed. The cassette is supplied in a durable hinged plastic case. Price 33s 6d. 3M Company, 3M House, Wigmore Street, London W.1.
WW 306 for further details

Coherent Filter

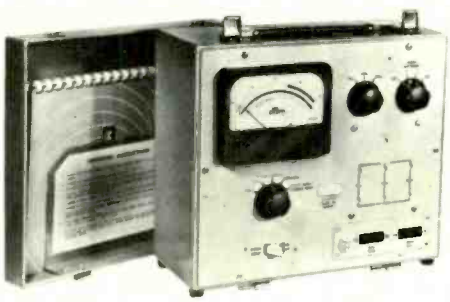
An active filter claimed to be capable of recovering signals which are more than 100dB below noise level has been introduced by Brookdeal Electronics (who tend to specialize in signal recovery instruments). Called the Type 467, it is a narrow-band coherent filter using a multi-path filter technique*, and is designed particularly for use in the signal channel of "lock-in amplifiers" (perhaps better

known to some readers as synchronous detectors). Its centre frequency is established by an external reference waveform, giving it the ability to follow a varying wanted signal, and normally it will use the same reference waveform as the synchronous detector. The bandwidth of the filter is 3Hz and the frequency range of operation is 10Hz to 100kHz. The output of the device is a square wave at the reference frequency with an amplitude 40dB greater than the in-phase component of that frequency at the input (max. output 3V pk-pk. from 600Ω). Input impedance of the filter to the signal is 100kΩ, 50pF, while the input impedance to the reference waveform is 10kΩ, 80pF. The design is such that the instrument requires no setting up or adjustment by the user. Brookdeal Electronics Ltd., 1 Market Street, Bracknell, Berks.
WW 301 for further details

*See, for example, *W.W.* March 1966, p.130.

Milliwatt Test Set

Hatfield Instruments, Type 747 universal milliwatt test set is a precision thermocouple meter for checking the standard 0dBm send level in 75Ω unbalanced, 140Ω balanced, and 600Ω balanced circuits. The 75Ω input covers frequencies up to 20MHz, whilst the 140 and 600Ω balanced inputs cover frequencies up to



1MHz. The instrument is protected against overloads of up to +25dBm on all inputs and the measurement range of −1 to +1dBm is displayed over the full 4-in scale of the meter. The accuracy of the standard version is ±0.05dB on all inputs. However, it is now available as option 1 with special calibration charts guaranteeing an accuracy of 0.02dB on all three inputs. Hatfield Instruments Ltd, Burrington Way, Plymouth PL5 3LZ, Devon.
WW 307 for further details

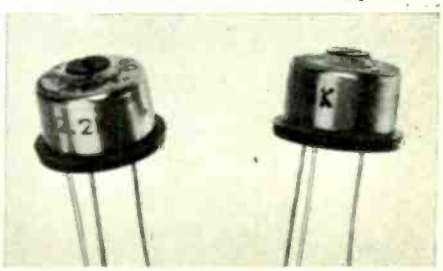
Memory Voltmeter with Chart Recorder

A dual-readout memory voltmeter with a built-in strip chart recorder, for use where a permanent record of transient or spike occurrences is desired, is available from Sintrom Electronics. This portable instrument, the 5201CR, has applications in monitoring power stations, power supplies, computer equipment and other similar installations. It employs amplitude memory to measure and hold 50 nanosecond or longer one-shot voltage peaks of single, transient, random or repetitive pulses permanently or until reset. A dual-shielded cabinet precludes common mode errors. The cabinet is isolated to 1000V. An optional gate circuit permits use as a sample-and-hold voltmeter. The recorder is a dry process, pressure-sensitive 63ft chart with a front access window. It will deliver 25 hours of continuous recording from a 30in/hr standard chart speed. A five position high response selector control is provided permitting the instrument bandwidth to be reduced in specific applications where the waveform to be measured is of

low frequency and where unwanted high-frequency noise is present. Voltage ranges are 0-3, 30, 100, 1000V to 30kV with optional probes. Input impedance is 10MΩ to 30kΩ depending on the range and accuracy ±3% of full scale. Sintrom Electronics Ltd, 2 Castle Hill Terrace, Maidenhead, Berks.
WW 316 for further details

Miniature Wire-wound Potentiometer

A miniature wire-wound trimmer potentiometer, the ADTO5, available from Guest International Ltd, is housed in a TO-5 type nickel-alloy case and may be mounted on a printed circuit board in exactly the same manner as a transistor. The terminal centres are spaced so as to enable flush fitting to a standard 2.54mm (0.1in) hole-pitch printed-circuit board. Rotation extends over 320° and mechanical overload protection is provided in the form of a slipping-clutch mechanism. Moulded-in terminations and a silicon rubber sealing ring help the device to withstand extremes of environmental conditions. The terminations are 0.28 to 0.36mm square copper/nickel alloy. The resistance range available covers from 15Ω to 15kΩ in preferred values. The power rating is 0.5W at 40°C and the temperature range is −55° to +150°C. The temperature



coefficient is not greater than 50 parts/10^6 per °C for the 15Ω to 47Ω values, 20 parts/10^6 per °C for the 100Ω to 200Ω values, and 120 parts/10^6 per °C for the 470Ω to 15kΩ values. Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey.
WW 302 for further details

Laboratory Power Supplies

Guest Electronics have modified their recently announced type 606 laboratory bench power supplies. These all-transistor units feature continuously variable ranges of 0-7.5, 15, 30 and 60V. Voltage output is controlled by a precision 10-turn helical potentiometer fitted with a vernier scale allowing the voltage to be set to a predetermined value with guaranteed repeat-

ability. A built-in meter enables the output voltage or current to be monitored. Ripple noise is less than 0.5mV pk-pk and overload protection limits the output current to 110% of maximum. Reset is automatic. The model 606 is available in current ranges from 0–500mA up to 0–2.5A. Dimensions are 156 × 152 × 102mm and prices from £34 15s to £42 15s. Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey.
WW318 for further details.

Linear Power Controllers

A range of solid-state linear power controllers has been introduced by Eurotherm to provide efficient control of a.c. loads from 10 to 300A. Units supplying d.c. and three-phase loads are also available. Power is controlled by an inverse pair of thyristors in series with the load. R.F. suppression and protection against supply-voltage transients can be incorporated. An additional feature is a 'soft start' characteristic—the firing angle is gradually increased over the first few

cycles after switching on, thus preventing the sudden application of full power which may be harmful to certain loads. In addition, facilities exist for an override control via external contacts. The control module is calibrated 0-100% power, with a linear scale owing to the "square law" feedback employed, and is fully compensated against supply voltage variations from +10% to −15% at 240V a.c. Units can also be supplied for operation from 415V a.c. Eurotherm Ltd, Broadwater Trading Estate, Worthing, Sussex.
WW 305 for further details

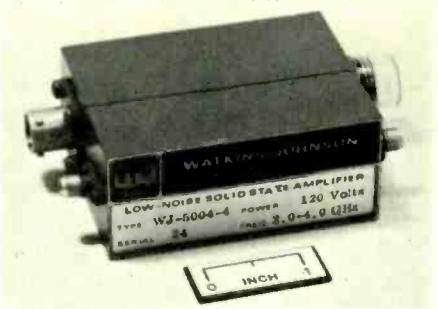
D.V.M. Multi-range Adaptor

Electrotech Instruments (of Coutant Electronics) have developed an adaptor unit that will convert any 1V full-scale digital voltmeter (input resistance ≥ 10MΩ) to a multi-range digital meter for the measurement of a.c. and d.c. voltages, currents, and resistance. Known as the MMA 100 the adaptor is available either as a free-standing unit or built in to Electrotech's modular system cabinet which includes their new CDM 100 digital panel meter. The MMA 100 is built with push-button range selection and, when used in conjuction with a 1V full-scale digital meter, provides five voltage ranges and five current ranges for a.c. and d.c., and five resistance ranges. These are 0.1, 1, 10, 100 and 660V a.c.; 0.16, 1.6, 16, 160 and 1000V d.c.; 100μA, 1mA, 10mA, 100mA and 1A a.c.; 160μA, 1.6mA, 16mA, 160mA and 1A d.c.; and 160Ω,

1.6kΩ, 16kΩ, 160kΩ, and 1MΩ. According to the measurement function and range selected, the full-scale accuracy is between 0.1% and 0.5% and the sampling rate is between 2 and 3 per sec. Overvoltage protection is provided on a.c. and d.c. ranges—1000V on the three highest d.c. ranges and 250V on the two lowest; and 700V for the three highest a.c. ranges and 180V for the two lowest. On a.c. it will operate at frequencies from 40Hz to 10kHz. In the free-standing form the multimeter adaptor unit measures 147 × 60 × 180mm. The price is £70. Electrotech Instruments, Coutant Electronics Ltd, Instrument Division, 5 Loverock Road, Reading, Berks.
WW323 for further details.

S-band Low-noise Transistor Amplifier

Watkins-Johnson Co. has placed on the market a low-noise microwave transistor amplifier for operation in the S-band (2 to 4GHz). Designated the WJ-5004-4, this amplifier, with integral power supply has



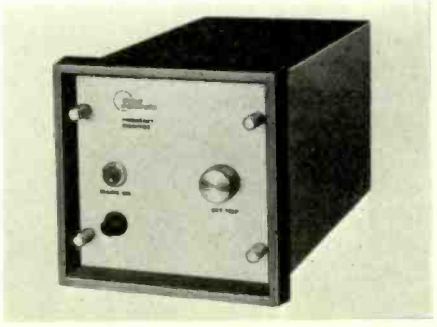
a guaranteed noise figure of 8.5dB maximum and power output of +7dBm (for 1dB gain compression). Overall design is consistent with the respective environmental requirements of MIL-E-16400F. Watkins-Johnson International, Shirley Avenue, Windsor, Berks.
WW 308 for further details

Oscilloscope for TV Servicing

Fully automatic television line and field triggering is featured in a new Philips oscilloscope, model PM3200X, specially designed for TV service and maintenance work. This ensures a completely stable display of all line- and field-signal waveforms. Other features are a 10MHz bandwidth, 2mV input sensitivity and the elimination of d.c. balance-correction by automatic drift compensation circuits in the vertical deflection pre-amplifier. The timebase circuit is triggered automatically but in the absence of a trigger it starts "free running". Sweep speeds cover the range 0.1μs/div to 0.5s/div. A separate triggering facility is provided for line/field triggering giving a stable display of both line and field information. The unit measures 175 × 210 × 330mm and weighs 5.3kg. Pye Unicam Ltd, York Street, Cambridge.
WW321 for further details.

Frequency monitor

Designed to provide an alarm or control signal when the input frequency deviates from a pre-determined figure, a new range of frequency monitors has been added to the Orbit 70 series of industrial control instruments. The principle of operation is based on the digital measurement of the period of the incoming signal giving a rapid single cycle response when the input frequency goes out of limits. Three versions, zero speed, underspeed and overspeed are available and combinations of under-



speed and overspeed modules can be housed in a single instrument to provide bandpass or high- and low-limit facilities. Thirteen overlapping ranges cover the frequency spectrum 1Hz to 30kHz. Alarm operation is within 0.1% of the set point and reset is automatically carried out without hunting. Output can be in the form of a relay changeover or of a logic level change. Construction is of i.cs mounted on plug-in p.c. modules. Orbit Controls Ltd, Alstone Lane Industrial Estate, Cheltenham, Glos.

WW 310 for further details

Field Intensity Receiver

A field intensity measuring receiver, designation number VSME1510, from Microwave International, covers the frequency band 30–300MHz in six ranges. The voltage measuring range covers 0-120dB (1 μV to 1V). The unit employs transistors throughout and has an accuracy on its frequency calibration of 0.5% without a warm-up period. The frequency response is $\pm$2.5dB on all ranges. The scale arrangement consists of a 340mm long cylindrical linear scale with continuously progressive frequency calibration. Total scale length is approximately 2 metres. The measuring accuracy when used on an accurate calibration source is better than $\pm$1dB. By narrowing the bandwidth it is possible to measure sinusoidal voltages down to 0.1 μV. The standard input impedance is 60 Ω, and a 50-Ω unit is available on request. The bandwidth is 120–130kHz with 6dB drop. Microwave International (U.K.) Ltd, 33-37 Cowleaze Road, Kingston Upon Thames, Surrey.

WW 303 for further details

H.F. Receiver

Astro Communications have announced a new h.f. communications receiver, model S.R.502. This is a compact all-transistor modular unit suitable for table top or standard 19-in rack mounting. Only 3½in high, the main frame contains fully protected power supplies, audio, demodulator and i.f. circuits. Two cavities are provided which will accept a variety of plug-in modules. The right-hand cavity will accept either an h.f. tuning unit (0.5–30MHz in one band) or a v.l.f. tuning unit (10–500kHz in one band). The left-hand cavity can accept a battery pack which contains its own automatic charging circuit, a panoramic display, a digital frequency read-out unit with digital a.f.c. facilities or a digital frequency synthesizer with 100-Hz resolution. The receiver has been designed for a.m., s.s.b, c.w. and f.m. operation. The use of separate upper and lower sideband filters enables independent sideband operation with a simple adaptor. A high m.t.b.f. of 10,000 hours is claimed. Astro Communications Laboratory (U.K.), Coventry.

WW317 for further details.

Colour TV Pattern Generator

The Philips PM 5508 pattern generator, available from Pye Unicam, takes full advantage of the "self checking" properties of the PAL system which enables a receiver to be adjusted using the picture tube as the only indicator. This virtually eliminates the need for an oscilloscope, but, if one is used it can be synchronized by line and field sync pulses from the generator. The generator delivers ten signals which are selected by the push-buttons arranged across the front panel: (1) Black and white checkerboard of 6 squares by 8 squares for checking tuning, scanning, amplitude and linearity, (2) Blank raster with constant white content for purity check, (3) Blank raster with constant red content for purity check, (4) Eight-step staircase for grey scale tracking, (5) 11 dots by 15 dots for adjustment of static and dynamic convergence, on 625 lines only, (6) Cross hatch, 11 lines by 15 lines, for adjustment of static and dynamic convergence, on 625 lines only, (7) Four colour bars for delay line phase and amplitude adjustment, using tube as indicator, (8) Four colour bars for demodulator phase adjustment, using tube as indicator, (9) Four colour bars for matrix check, using an oscilloscope, (10) Eight colour bars similar to B.B.C. signal for general check. The lower half of the picture is white to serve as reference to enable the adjustment of the amplitude ratio of the colour-difference signals to the picture tube. Alternatively a simple modification enables colour bars to be produced over the whole screen if this is preferred. The ranges covered are bands I, III, IV and V, which are selected by push-buttons and continuous tuning is provided. Outputs are 15-20mV at r.f. (continuously variable) and 1V at video, both into 75Ω. Burst amplitude is variable for checking colour killer and a.g.c. The sound carrier can be modulated internally, unmodulated or switched off. The generator measures approximately 270 × 290 × 190mm and weighs approx. 5.6kg. Pye Unicam Ltd, York Street, Cambridge.

WW331 for further details

Transistors for switching 150W Pulses

Three new silicon planar transistors announced by Mullard have high switching rates and very low saturation voltages of not greater than 0.9V. Consequently, although the transistors, types BDY60, BDY61 and BDY62, have a continuous power rating of only 15W they can switch 150W pulses that have a duration not exceeding 50μs and a duty factor of 0.1. Earlier devices that switched 150W pulses had to have a higher continuous rating because they could not switch so rapidly. Although particularly suitable for use in high-frequency, silent, inverters and converters where efficiency is required, these types can also be used with advantage as pulse modulators in communications and radar systems. Typical transition frequency, f_T, (I_C = 0.5A, V_{CE} = 5V is 100MHz, and minimum h_{FE} (I_C=0.5A, V_{CE}=10V) is 45. Mullard Ltd, Torrington Place, London W.C.1.

WW 313 for further details

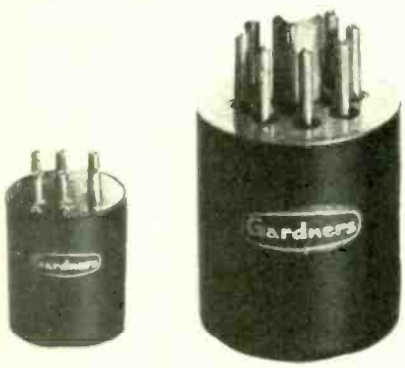
Sine/Cosine Module

Burr-Brown have announced a sine/cosine function generator, model 4118/25, that may be used to produce various trigonometric gain responses. The module provides non-linear gain-shaping such that the output is $-10 \sin \theta$, where $\pm$10V of input voltage represents a $\pm 90°$ of angle θ. In addition, the unit may be connected to form cosine functions. By adding one or more external operational amplifiers, operation may be extended to include four-quadrant sine and cosine functions. Arc cosine and arc sine response functions may also be obtained. Accuracy is $\pm$1% of full-scale for $\pm$ 10V input and

improves for small signals. Frequency response for accuracy of ±1% is d.c. to 1kHz—this accuracy includes both amplitude and phase shift errors. Temperature range is −25° to +85°C. The module is self contained and requires no external components. Operation is from ±15V supply. Fluke International Corporation, Garnett Close, Watford WD2 4TT.
WW330 for further details

New Audio Transformers

A new range of line-matching and microphone transformers for audio equipment is announced by Gardners Transformers. These complement the existing range introduced in 1961 and they come in two basic sizes using international octal, British 7-pin or flying screen lead connections. They are suitable for general purpose applications at high and low signal levels. Some of the new transformers, although similar in size and performance



to the existing types, now have a 20,000V capability to meet the Post Office requirement. They are protected mechanically by a new filling of closed-cell epoxide resin foam compound (the smaller types are vacuum-impregnated with a microcrystalline wax). Advanced technical data sheets AT15, AT16 and AT17 are available from the makers. Gardners Transformers Ltd, Christchurch, Hants., BH23 3PN.
WW 304 for further details

Precision R.F. Power Leveller

Weinschel Engineering introduces its model 1805 precision r.f. power leveller. This instrument is specifically designed to ensure precision and simplicity in systems used for transferring calibration factors of primary standards to bolometer mounts or secondary power standards (terminating or feedthrough type) and power meters. Model 1805 in conjunction with a d.c.-to-r.f. continuously variable attenuator, such as a p.i.n. modulator, establishes and maintains constant, precisely known reference values of r.f. power incident upon a terminating mount or emerging from a feedthrough mount into a Z_0 load. Minimum power level control range of 20dB is employed and only d.c.-substituted and bias power is used to maintain precise power levels, thus eliminating the a.c./d.c. error which is commonly found in some r.f. power bridge circuits. Selectable d.c.-

substituted power levels are 0.5, 1.0, 5.0 and 10mW; an external input capability is provided for establishing power levels between the fixed values. A selected level is maintained to within ±0.1% + 1μW and is held constant for long periods of time over an ambient temperature range of 20°C and r.f. source level variations of ±3dB. Once the desired power is selected with the range selector, the setting of a single toggle switch results in automatic control to maintain the selected value. If a deviation occurs, it is indicated on a meter having a 0.2μW resolution. Price $2,950. Weinschel Engineering Co, Inc., Gaithersburg, Maryland 20760, U.S.A.
WW324 for further details.

General Coverage Receiver Kit

The GR-78 general coverage receiver recently announced by Heath Company provides a.m., c.w. and s.s.b. coverage from 190 kHz to 30 MHz in six switch-selected bands. Solid-state circuit employs field-effect transistors in the r.f. section and four ceramic i.f. filters for improved sensitivity and selectivity and eliminating the need for alignment. Built-in bandspread tuning can be calibrated for either the shortwave broadcast or amateur bands, and a switchable 500-kHz crystal calibrator insures accurate dial calibration. This receiver comes complete with a rechargeable nickel-cadmium battery pack with a built-in charging circuit. Wiring options permit operation from either 120 or 240V a.c. and 12V d.c. Other features include switched a.g.c., an automatic noise limiter, receiver muting for use with a transmitter and a front panel relative signal strength meter. Price £68 18s. Daystrom Ltd, Heathkit Division, Gloucester.
WW 311 for further details

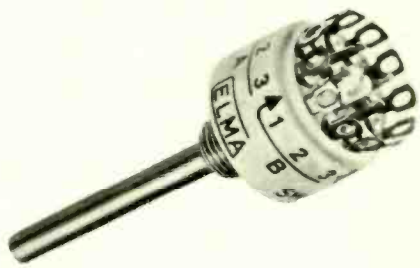
Time-interval Module

Time-interval measurements between pulses derived from two different lines can now be made with the addition of a time-interval unit, the PM6631, to the Philips PM6630 counter available from Pye Unicam. The unit can measure time

intervals between pulses with the same or opposite polarity, and also with amplitude differences as great as 20:1. With the addition of the PM6631, the counter can measure time intervals in the range 50ns to 10^6 seconds on pulses with widths down to 5ns. The triggering level for both pulses is individually adjustable in the range ±1.5V (no attenuation) to ±30V (20:1 attenuation), and trigger sensitivity is 150mV (pk-pk) for all pulses with widths greater than 5ns. Also provided is a separate d.c. output which indicates the trigger level used on the stop pulse and an oscilloscope output which can be used to display the exact position of the stop pulse in relation to the start one. Apart from this new measuring facility, the PM6630 combines a 160MHz frequency range with a 50mV r.m.s. input-signal sensitivity and an input impedance of either 1MΩ/15pF or 50Ω. A 100 MHz internal clock makes the instrument useful for signal-generator and communications equipment calibration, oscillator drift measurements and computer-clock frequency checks. Pulse width and delay measurement can also be obtained. Pye Unicam Ltd, York Street, Cambridge.
WW326 for further details

Rotary Stud Switch

The Elma sub-miniature rotary stud switch now features an improved case in glass-filled polycarbonate. This material is unaffected by most common solvents and is easily marked to aid wiring. Switches are available with tags for direct wiring to p.c. boards and may be supplied with screwdriver slots instead of shafts. Different torque settings are available. The



standard torque setting is 200 gm/cm; 400 and 600 gm/cm can be supplied to order. A ceramic wafer and gold-plated stud contacts are used. Contact resistance is better than 5mΩ and wafer insulation better than 10^{12}Ω. Switching capacity is up to 1A. Radiation Components Ltd, 76 Crown Road, Twickenham, Middlesex.
WW 309 for further details

Rotary Switch Kit

Switch kit series 44K30 by Highland Electronics enables designers to assemble their own prototype rotary switches. Over 400 switch combinations can be constructed with up to 12 poles and 12 switch positions. Assembled switches have an adjustable stop which can be changed without break-

continued on page 197

Europe's biggest sellers are still going strong

You're in excellent company with these general purpose instruments, they've just passed their 20,000th sale.
Understandable when you consider their price performance.

The 1420 D.V.M.

2.5μV-1000V
120 dB noise rejection
0.05% accuracy
33 conversions per sec
5000 MΩ input resistance

The 1400 Scope

Large, bright display
9 modules to choose from for your 'tailor-made' spec.
Choice of 3 amplifiers, including differential.
3 time bases, including sweep delay.
An X-Y plotter and custom blanks.

Post the magazine's reply-paid card and we'll send you our data sheet of full details.

SOLARTRON
Schlumberger

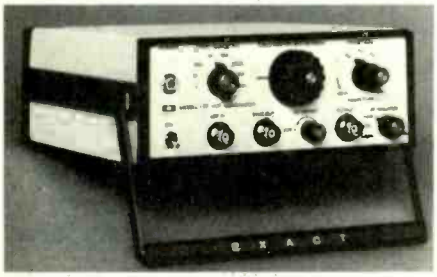
The Solartron Electronic Group Ltd Farnborough Hampshire England Telephone 44433

WW—106 FOR FURTHER DETAILS

ing-down the switch. Components are re-usable and can be returned to the kit when the prototype is dismantled. Typical contact resistance is 10mΩ and contact rating is 0.5A at 230V a.c. resistive; 1A at 28V D.C. resistive. Highland Electronics Ltd, 33-41 Dallington Street, London E.C.1.
WW322 for further details.

Voltage-coupled Waveform Generator

A waveform generator with voltage-controlled frequency over a 1000:1 ratio, and a bandwidth from 0.1Hz to 3MHz, is being marketed by Environmental Equipments. The instrument, model 123, produces sine, square and triangular waveforms, as well as a sync pulse. Frequency is controlled to $\pm$2% accuracy by a Kelvin-Varley divider in the form of a multiplier with both digital and vernier adjustments. External voltage control can



either be d.c. programming or a.c. frequency modulation. The output for all waveforms is at least 20V pk-pk into an open circuit, or 10V pk-pk into a 50Ω load. Attenuation of 60dB in steps of 20dB is provided, as well as variable $\pm$5V d.c. offset and floating output. A search mode is provided so the operator can use the vernier in the multiplier to sweep over a 1000:1 (three-decade) range within the frequency range selected. Both top and bottom panels of the instrument case are easily removable for calibration and maintenance. Environmental Equipments Ltd, Denton Rd., Wokingham, Berks.
WW328 for further details

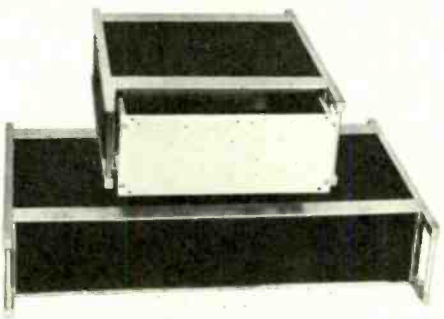
50-MHz Counter/Timer

Latest addition to the Marconi Instruments counter/timer range, TF2411, features a choice of plug-in frequency standards permitting the user to order an instrument with a performance and accuracy best suited to his applications. The TF2411 performs a wide range of functions including period and multi-period measurements, time interval, ratio and frequency measurements up to 50MHz. Using mainly integrated circuits and based on a system of plug-in printed circuit boards, the counter/timer has an f.e.t. input giving 10mV sensitivity and 1MΩ input impedance. Seven-digit readout is provided with a binary memory, and there is an optional b.c.d. printer-output. The cabinet measures 89 $\times$ 280 $\times$ 254 mm. The three plug-in

frequency standards at present available for TF2411 are: TM9933—a high-performance crystal and oven with an age rate of 1×10^{-7} per month and a warm-up time of 10 minutes to reach 1×10^{-7} operation; TM9888H—simple crystal oscillator which includes a 10-MHz external standard panel; and TM9890 which accepts external standard frequency signals between 1 and 10MHz. The choice of standard is made at the time of ordering. Marconi Instruments Ltd, Longacres, St. Albans, Herts.
WW 312 for further details

Equipment Cases

A range of modular instrument cases from Case Systems has been designed to give a flexible and compact method of housing electronic equipment. The cases are constructed from aluminium extrusions and plastic mouldings. Each case is mechanically stable when placed on any of its six sides, and the handles protect panel components, such as meters and switches, when the case is placed face



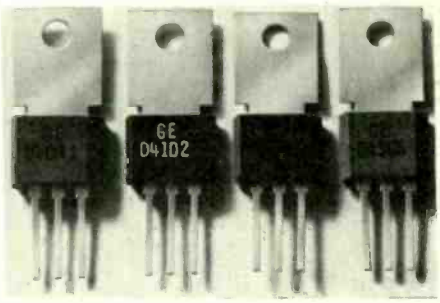
downwards or accidentally dropped. The protrusions at the rear which allow the case to stand face upwards, also protect rear connectors and components. The standard case, CS1 which is bench mounting can be converted to 19-in rack mounting simply by fitting brackets to each side. The CS1 will accept one module M1 or two modules M2. The CS2 or "half rack" case accepts one module M2 only. Case Systems, 20 Hunt Lane, Chadderton, Lancs.
WW329 for further details

High-Q Varactor Diodes for X-Band

Four gallium arsenide, Schottky barrier diodes announced by Mullard are intended for use as tuning elements in microwave circuits. Because the four devices, which form the 821CXY family, have resistances of not more than 3Ω, high Q-factors can be achieved. The diodes have zero-bias junction capacitances of 0.8 to 2.5pF, depending on the type. Breakdown voltage is not less than 12V, and the minimum ratio of junction capacitance at zero bias to capacitance at 12V reverse bias is 3. Mullard Ltd, Mullard House, Torrington Place, London W.C.1.
WW327 for further details

Colour-coded Audio Output Transistors

The full range of G.E. (U.S.A.) Power-Tab a.f. output transistors is now available from Jermyn Industries. Four main types, colour-coded for easy identification, make up two sets of complementary stereo



pairs: D40 brown, 1A 6W, n-p-n; D41 black, 1A 6W, p-n-p; D42 red, 3A 12W, n-p-n; D43 green, 3A 12W, p-n-p. Each type is available with 30, 45 or 60V continuous rating, with a wide range of gains up to 30. The flat pins are easily formed to TO5 or TO66 configurations. 100 up prices range from 7s 8d to 21s. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW325 for further details

Low-drift Op. Amps.

Advance Electronics announce three low-drift versions of their ZEL 1 series operational amplifiers. They are designated ZEL 1/02, /03 and /04 and have drift characteristics of 2.5, 5 and 10μV/°C respectively. Other main features of the ZEL 1 range are: d.c. gain 5×10^5 min; offset current 5nA max; slew rate 6V/μs min; c.m.r.r. 20,000 and input noise 2μV r.m.s. Prices £18 10s (/02), £11 (/03) and £8 10s (/04). Advance Industrial Electronics, Raynham Road, Bishops Stortford, Herts.
WW 314 for further details

Subminiature Relays

Two miniature relays measuring only 20.3mm long by 14.2mm wide by 6.35mm high have been introduced by Bourns. These are models 3120 s.p.d.t. and 3121 d.p.d.t. Both have a 1A rating at 26V d.c. and an operating temperature range of -65 to $+125$°C. Coil resistance and sensitivity ranges for the 3120 and 3121 respectively are 50—2,000Ω, 100mW nominal, and 65-2,000Ω, 160mW nominal. Contact material is gold-plated semi-precious metal and a life of 100,000 cycles is claimed. Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middx.
WW319 for further details.

Literature Received

For further information on any item include the WW number on the reader reply card

ACTIVE DEVICES

We have received the following literature from Marconi-Elliott Microelectronics Ltd, Witham, Essex.

t.t.l. 9000 series applications handbook .. price 30s
medium scale integrated circuits and memory elements product guide WW401
emitter coupled current steering logic data sheets:
MB501 dual four-input gate with bias driver WW402
MB502 dual four-input gate with bias driver and phantom NOR output WW403
MB503 eight-input logic gate with bias driver WW404

Microwave Associates, Ltd, Luton, Beds., have sent us a folder containing the following:

Micronotes WW405
high-power varactors (two) data sheet .. WW406
bulletin 4058 p.i.n. switching diodes (low-medium power) WW407
bulletin 4059 p.i.n. switching diodes (high-power) WW408
bulletin 4060 35V tuning varactors WW409
bulletin 4061A avalanche oscillator diodes WW410
bulletin 4063 varactors, high-power WW411
bulletin 4065A snap varactors WW412
bulletin 4067A varactors, high-power ... WW413
bulletin 4073 X-band Schottky diodes ... WW414
bulletin 4074/5/6/7/8/9, snap varactor diodes WW415
bulletin 4081 90V tuning varactors WW416

A number of additions for the Microspot cathode-ray tube manual and display equipment manual may be obtained from Ferranti Ltd, Gem Mill, Chadderton, Oldham, Lancs WW417

"What is Thick Film?", is the title of a leaflet which may be obtained from Reliance Controls Ltd, Drakes Way, Swindon, Wilts WW418

National Semiconductor Corporation, 2975 Ysidro Way, Santa Clara, California 95051, have published a data sheet on the LH101 operational amplifier, which is a variant of the LM101, and is now being manufactured in monolithic form WW419

Silicon General Inc., 7382 Bolsa Ave., Westminster, California 92683, U.S.A., have sent us data on the following products:

SG-1402, -2402, -3402 variable gain wideband amplifier/multiplier WW420
SG-710A, -710 differential voltage comparator WW421
SG-710B, -710C differential voltage comparator WW422
SG-711A, -711 voltage comparator WW423
SG-711B, -711C voltage comparator ... WW424
SG-105, -205, -305 voltage regulators .. WW425

Two more data sheets on d.t.l./t.t.l. compatible m.t.n.s. circuits from General Instrument Microelectronics, Stonefield Way, Ruislip, Middx, HA4 0JT, are available,

SS-6-2004 dual 4-bit parallel access, reversible static shift register WW426
SL-6-4025/32, quad 28/32-bit static shift register WW427

Leaflet No. 1, volume 1, of the Hivac Application Bulletin describes the use of glow diodes (cold-cathode glow-discharge tubes), in a number of circuits. Hivac Ltd, Stonefield Way, Ruislip, Middlesex WW428

A loose-leaf catalogue produced by Rastra Electronics Ltd, 275 King St, Hammersmith, London W.6, lists integrated circuits, transistors, diodes and many other items WW429

Quarndon Electronics (Semiconductors) Ltd, Slack Lane, Derby, DE3 3ED., who are distributors for Texas Instruments, S.G.S., Raytheon, Emihus and Sprague, have produced a comprehensive semiconductor catalogue, "Semicon 70", which is now available ..... WW 462

The E.E.V. equivalents for nearly 2000 valves are listed in the "Equivalents Index—1970" which is published by the English Electric Valve Co. Ltd., Chelmsford, Essex ..... WW 463

We have received a short-form catalogue from the Signetics Corporation, Trident House, Hayes, Middlesex, which lists linear and digital integrated circuits ..... WW 464

PASSIVE COMPONENTS

The 5th edition of "Components Applications Data", may be obtained from Radiospares, P.O. Box 427, 13-17 Epworth St, London E.C.2 ..... WW430

A leaflet, "Electrolube Contact Lubricant", is available from Electrolube Ltd, Oxford Avenue, Slough, Bucks WW431

Microwave waveguide filters manufactured by Ferranti Ltd, Components Division, Dunsinane Avenue, Dundee DD2 3PN, Scotland, are described in a leaflet WW432

"Military Specification Connector Manual", lists the products of Elco Pacific, 2200 Park Place, El Segundo, California 90245 ..... WW433

Two additions have been received for the Erie Catalogue dealing with r.f.i. filter devices. Erie Electronics Ltd, South Denes, Great Yarmouth, Norfolk WW434

"Product Selector Guide", from the Dialight Corporation, 60 Stewart Avenue, Brooklyn, N.Y.11237 lists indicator lamps, digital readouts and illuminated push-button switches WW435

The new range of "Control-Line" Modules, which operate high-current loads from low-level control systems without mechanical contacts, are described in a catalogue from FR Electronics, Flight Refuelling Ltd, Wimborne, Dorset WW436

"Component Socket Guide", from the Elco Corporation, Willow Grove, Pennsylvania 19090, U.S.A., lists valve, crystal, relay, transistor and d.i.l. sockets WW437

Reed relays are the subject of a new catalogue from: Kempston Electrical Co. Ltd, Shirley Rd., Rushden, Northants WW438

A catalogue listing the products distributed by the D-T-V Group, 126 Hamilton Rd, London S.E.27, is available WW439

A range of contactless switches is described in a catalogue from Cole Electronics Ltd, Lansdowne Rd, Croydon CR9 2HB WW440

Miniature switches, microphones, headsets, leads, plugs and sockets are the subject of a catalogue from Danavox (Great Britain) Ltd, "Broadlands", Bagshot Rd, Sunninghill, Berks. ..... WW 465

Two engineering bulletins received from Sprague (U.K.) Ltd., Sprague House, 159 High St., Yiewsley, West Drayton, Middlesex, describe capacitors.

2705A Metalized polycarbonate-film capacitors WW466
3456A Aluminium capacitors, non-aqueous electrolyte WW467

An eight-page potentiometer selection guide is available from Reliance Controls Ltd, Drakes Way, Swindon, Wilts. ..... WW 468

Details of a seven-day prototype illuminated pushbutton switch service are given in literature from Forder Graham Ltd., Pinnacle Hill, Keslo, Roxburghshire. The service is based on a 4-pole change-over switch which can be supplied in banks with a variety of mechanical actions and contact configurations ..... WW 469

HARDWARE, ETC.

A data sheet from Firth Cleveland Fastenings Ltd, Treforest, Pontypridd, Glamorgan, pictorially shows the uses of a range of Spire fasteners WW441

A copy of a paper "New Cleaning and Drying Techniques for Critical Electronic Assemblies", is available from: I.C.I. Ltd, Thames House North, Millbank, London S.W.1 ..... WW442

A modular connecting system called Hypertac is described in a leaflet S/294C from Smiths Industries, Industrial Instrument Division, Kelvin House, Wembley Park, Middx WW443

Applications data and technical information on Loctite products for thread locking, retaining and sealing is given in a brochure from: Douglas Kane Group Ltd, Swallowfields, Welwyn Garden City, Herts.. WW444

EQUIPMENT

Over 200 power supply modules and about 50 measuring instruments are the subject of a leaflet from Lambda Electronics, 21 Aston Rd, Waterlooville, Portsmouth, Hants WW445

Performance details of the type TSA 6636/3 counter timer are in a data sheet. Venner Electronics Ltd, Kingston By-Pass, New Malden, Surrey. ... WW446

Helium-neon lasers are described in a leaflet from Ferranti Ltd, Dunsinane Avenue, Dundee DD2 3PN, Scotland WW447

A leaflet describing the digital voltmeter type LM 1867 may be obtained from the Solartron Electronic Group Ltd, Farnborough, Hants WW448

Lyons Instruments Ltd, Hoddesdon, Herts, have produced a leaflet which describes six pulse generators WW449

A Gunn-oscillator, type PM7015X is described in a leaflet from Sivers Lab, U.K. Office, Old Haverhill Rd, Little Wratting, Suffolk WW450

The following literature is available from Dana Electronics Ltd, Bilton Way, Dallow Rd, Luton, Beds:

Series 5740 digital voltmeters WW451
Series 5700 digital voltmeters WW452

We have received the following literature from

Marconi Instruments Ltd, Longacres, St. Albans, Herts.
Automatic testing—the way ahead WW453
TF 2210, 100MHz oscilloscope WW454

Lyons Instruments (Hoddesdon, Herts), newsletter for January 1970 discusses a programmed pulse system for dynamic testing WW455

Thyristor controllers for use between 100 and 300A are the subject of a data sheet published by AEI Semiconductors Ltd, Carholme Rd, Lincoln. WW456

"Servoscribe" flat-bed chart recorders are described in a leaflet from the Industrial Instrument Division, Smiths Industries Ltd, Wembley, Middx WW457

The diverse products of Hewlett Packard Ltd, 224 Bath Rd, Slough, Bucks, for measurement, analysis and computation are described in a handsome 647-page hard-bound volume WW458

The following two brochures are obtainable from Racal Group Services Ltd., 26 Broad St., Wokingham, Berks.
Solid state h.f. communications receivers .. WW 470
Radio telecommunications equipment and systems ..... WW 471

V. N. Barrett & Co. Ltd., 1 Mayo Rd., Croydon, CRO 2QP. Surrey, have produced a new catalogue of used scientific and industrial equipment . WW 472

GENERAL INFORMATION

"Product Guide—1970", published by the Electronic Engineering Association, Berkeley Square House, Berkeley Square, London W.1, lists manufacturers of electronic capital equipment WW459

The Mullard Educational Service, Mullard House, Torrington Place, London W.C.1, have produced a leaflet listing all the publications available from them WW460

"Measuretest" instrument application notes (numbers 001 and 002), for colour television are available from Marconi Instruments Ltd, Longacres, St. Albans, Herts WW461

Tektronix U.K. Ltd, Beaverton House, P.O. Box 69, Harpenden, Herts, have three more books in their "Concept" series available; the price is 10s each including packing and postage. They are:
Horizontal Amplifier Circuits
Oscilloscope Probe Circuits
Probe Measurements

R.C.A. Great Britain Ltd, Lincoln Way, Windmill Rd, Sunbury-on-Thames, Middx, have available application note ICAN-4158 "Application of the CA 3059 zero-voltage switch in thyristor circuits"..... WW 462

The Scientific Instrument Manufacturers' Association of Great Britain, SIMA House, 20 Peel St, London W.8, have produced a booklet called "Metrication Guide" which is available from them price 50s.

Two new publications are available from the Mullard Educational Service, Mullard House, Torrington Place, London W.C.1
"A simple f.e.t. voltmeter" ..... WW 473
"Introducing thyristors" ..... WW 474

We have received two publications from the British Calibration Service, Millbank Tower, London S.W.1, which are listed below. The first of these explains what the British Calibration Service is and how a laboratory may apply for approval. The second publication lists all the laboratories that have obtained approval so far together with the type of measurements they can carry out and the degree of accuracy guaranteed.
About the British Calibration Service ... WW475
Directory of Approved Laboratories ... WW476

April Meetings

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

LONDON

1st. I.E.E.—Discussion on "Electrical measurement on acoustic surface wave devices" at 17.30 Savoy Pl, W.C.2.

1st. I.E.R.E.—Discussion on "Direct digital measurement of physical quantities" at 18.00 at 9 Bedford Sq., W.C.1.

3rd. I.E.E.—"Implementation of digital filters" by Prof. R. Boite at 17.30 at Savoy Pl., W.C.2.

3rd. I.E.E.—Discussion on "Aeronautical communication by satellite" at 17.30 at Savoy Pl., W.C.2.

6th. I.E.E.—Discussion on "Multi-element phased arrays" at 17.30 at Savoy Pl., W.C.2.

7th. I.E.E./R.Ae.S.—"Satellite communication" by J. K. S. Jowett at 18.00 at Savoy Pl., W.C.2.

8th. I.E.R.E.—Colloquium on "High resolution systems" at 14.30 at 9 Bedford Sq., W.C.1.

9th. R.T.S.—"Creating colour television titles" by M. H. Cox and R. Knight at 19.00 at I.T.A., 70 Brompton Road, S.W.3.

15th. I.E.E.—Discussion on "Photolithographic techniques in microelectronics" at 17.30 at Savoy Pl., W.C.2.

15th. B.K.S.T.S.—"The Minicam: the Pye/CBS miniature colour television camera" by Len Cosgrove at 19.30 at I.T.A., 70 Brompton Road, S.W.3.

20th. I.E.E./I.E.R.E.—Colloquium on "Skynet" at 10.00 at the I.E.E., Savoy Pl., W.C.2.

22nd. I.E.E.—"Telecommunications support for the Apollo programme" by Lorne M. Robinson (N.A.S.A.) at 17.30 at Savoy Pl., W.C.2.

22nd. I.E.R.E.—"Real-time computer model (business games)" by D. Simpson at 18.00 at 9 Bedford Sq., W.C.1.

23rd. I.E.E.—"Quasars and radiogalaxies" by Professor F. Hoyle at 17.30 at Savoy Pl., W.C.2.

23rd. Inst. Electronics—"Modern aspects of electronic instrument design" by G. F. Penner at 18.30 at West Ham College of Technology, Stratford, E.15.

23rd. R.T.S.—Fleming Memorial Lecture "The impact of automation on television transmission" by F. H. Steele, G. A. McKenzie and R. H. Vivian at 19.00 at the Royal Institution, Albermarle St., W.1.

28th. I.E.R.E.—Symposium on "Capacitors" at 10.00 at 9 Bedford Sq., W.C.1.

29th. I.E.E.—"Ionospheric research by means of oblique incidence sounders" by P. Bradley at 17.30 at Savoy Pl., W.C.2.

29th. I.E.R.E.—"Scanning circuits for 110° colour tubes" by K. E. Martin at 18.00 at 9 Bedford Sq., W.C.1.

30th. I.E.E./I.E.R.E.—"Microprogramming and processor design" by Prof. M. V. Wilkes at 17.30 at Savoy Pl., W.C.2.

30th. R.T.S.—"An image analyser for medicine using colour television techniques" by M. B. Coyne, F. Paice & Prof. E. D. Williams at 19.00 at the Wolfson Institute, Royal Postgraduate Medical School, Hammersmith Hospital, Ducane Road, W.12.

BARROW-IN-FURNESS

15th. I.E.E.—"Application of lasers" by Prof. E.D.R. Shearman at 19.30 at the Hotel Imperial, Cornwallis St.

BELFAST

10th. I.E.R.E.—"Aerials" by H. V. Sims at 18.30 at the Ashby Inst., the Queen's University, Stranmillis Road.

14th. I.E.E.T.E.—"Concorde—flight/auto controls and navigation" by H. Hill at 19.30 at the Ashby Institute, the University, Stranmillis Road.

17th. I.E.E.—Faraday Lecture—"People, communications & engineering" by J. H. H. Merriman at 20.00 at Sir Wm. Whitla Hall, Queen's University.

21st. I.E.E. Grads.—"Metal oxide silicon transistors" at 18.30 at the Main Lecture Theatre, Ashby Institute, Stranmillis Road.

BIRMINGHAM

8th. I.E.E. Grads.—"Thyristor drives" by M. F. Arnold at 19.00 at the Sumpner Bldg, the University of Aston, Gosta Green.

9th. I.E.R.E.—"Gramophone records—past and present" by G. M. Nathan at 19.30 at the University's Dept. of Electronic & Electrical Eng'g.

15th. R.T.S.—"University of Birmingham television service" by Dr. Peter Whitaker at 19.00 at the University.

BLETCHLEY

21st. I.E.E.—"Lasers and their applications" at 19.15 at Harwood House College.

BRIGHTON

14th. I.E.E.—"On the future of world communication" by Prof. E. C. Cherry at 18.30 at the College of Technology, Lewes Rd, Moulsecoumb.

CARDIFF

6th. I.E.E.—"Digital filters" by Dr. R.C.V. Macario at 18.00 at U.W.I.S.T.

23rd. R.T.S.—"The E.V.R. system" by Sir Francis McLean at 19.00 at the B.B.C. Llandaff.

CARLISLE

8th. I.E.E.T.E.—"Application of thyristors to industrial control systems" by S. Denyer at 19.30 at the Technical College, Victoria Place.

CHATHAM

23rd. I.E.R.E.—"Automatic trains on the Victoria Line" by R. I. M. Arthurton at 19.00 at the Medway College of Technology.

CHELMSFORD

15th. I.E.E.—"Radio-astronomy, thirty-five years progress" by F. W. Hyde at 18.30 at the King Edward Grammar School.

28th. I.E.R.E./I.E.E.—"24-channel p.c.m." by A. Stevens at 18.30 at the Civic Centre, Duke Street.

DUBLIN

15th. I.E.E.—Faraday Lecture—"People, communications & engineering" by J. H. H. Merriman at 20.00 at R.D.S. Hall.

DURHAM

22nd. I.E.E.T.E.—"Application of thyristors to industrial control systems" by S. Denyer at 19.30 at the University's Science Laboratories, South Road.

EVESHAM

20th. I.E.E./I.E.R.E.—"Large scale integration in microelectronics" by D. D. Jones at 19.30 at the B.B.C. Engineering Training Centre, Woodnorton.

LEEDS

16th. I.E.R.E.—"Thyristors into the home and industry" by R. Willis at 19.30 at the University's Dept. of Electronic and Electrical Eng'g.

28th. I.E.E.—"Electronic measurement as a guide to archeological research" by E. T. Hall at 18.30 at the University.

LIVERPOOL

1st. I.E.E. Grads.—"Laser holography" by Dr. J. M. Burch at 18.30 at the University.

6th. I.E.E.—"The pulsars" by Prof. F. Graham Smith at 18.30 at the University.

22nd. I.E.R.E.—"Schools project technology" at 19.30 at the University's Dept. of Electrical Eng'g.

MANCHESTER

8th. I.E.E. Grads.—"Communications bit by bit" by H. B. Law at 18.45 at U.M.I.S.T.

14th. I.E.E.—"History and development of time & frequency measurement" by C. R. Cordwell at 18.15 at U.M.I.S.T.

22nd. I.E.E.—"Radar data processing techniques with application to air traffic control" by Dr. P. J. C. Child at 18.15 at Renold Bldg, U.M.I.S.T.

NEWCASTLE-UPON-TYNE

8th. I.E.R.E.—"The symbolic integrated maintenance systems" by J. Hambleton at 18.00 at the Polytechnic (Rutherford College), Ellison Pl.

NORWICH

14th I.E.E.—"Electronic performance testing of motor vehicles" by E. Gamble at 19.30 at the Assembly Hall.

NOTTINGHAM

16th. R.T.S.—"Duplication of BBC-1 on u.h.f. & introduction of 3-channel colour" at 19.30 at the B.B.C. Studios, Wilson House, Derby Road.

PLYMOUTH

14th. I.E.E.T.E.—"Oceanographic instrumentation" by Lt. Cdr. T. J. Woodfin and Eng. Sub. Lt. M. Rushton at 19.30 at the Lecture Theatre, the College of Technology.

PORTSMOUTH

21st. I.E.E.—"Aids to all-weather landing of aircraft" by M. Catton at 18.30 at the Polytechnic, Anglesea Rd.

READING

16th. I.E.R.E.—"The design of solid-state audio amplifiers" by P. J. Baxandall at 19.30 at the J. J. Thomson Lab., the University, Whiteknights Pk.

RUGELEY

2nd. I.E.R.E.—"Engineer to manager—effecting the transition" by M. W. Lauerman at 19.00 at the Shrewsbury Arms Hotel, Market St.

SALFORD

13th. I.E.E.—"Electronics, man & aerospace" by R. E. Young at 19.30 at the University.

14th. I.E.E.—"Electronics, man & aerospace" by R. E. Young at 14.30 (students) and 19.30 at the University.

SALISBURY

13th. I.E.E.—"Colour television" by L. G. Dive at 19.00 at the Salisbury & Wilts College of Further Education, the Friary.

STOKE-ON-TRENT

9th. I.E.E. Grads.—"Voltage and its measurement from 'A' to about 'Q'" by F. W. Senior at 19.15 at the North Staffs College of Technology.

SWANSEA

9th. I.E.E.—"M.O.S. integrated logic" by J. A. Roberts at 18.15 at University College, Singleton Pk.

Go digital-with SE

See voltage, frequency, period, time, count, ratio — clearly, accurately.

With many variables, the instrument of the future is digital. As you would expect, S.E. Laboratories is in the forefront of this development, already offers you a huge range of accurate, versatile instruments at a rational price.

S.E. Digital Voltmeters are so cleverly designed that you can virtually have your D.V.M.s made to measure, from basic laboratory instruments to sophisticated data logging versions. The choice includes 3 models and 8 variations, with a maximum range up to 1kV, maximum resolution 10μV, accuracy 0.01%, and many different options including floating input, stored display, printer output, etc.

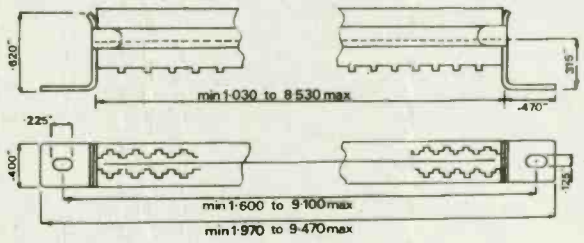
S.E. Timer Counters give you digital display at its most attractive and dependable: Five large, vividly illuminated figures. Simple and handy controls. Five modes — frequency, period, time, count and ratio — you *see* all these, accurate to one part in a million ± 1 count! With the Counters, too, S.E. offers you many features, including indefinitely held display, manual reset, remote start/stop, and others.

All S.E. digital instruments give you top value for your money. *See for yourself:* Write for details or for immediate demonstration.

SE Laboratories (Engineering) Limited. North Feltham Trading Estate, Feltham, Middlesex. Telephone: 01-890-1166 & 5246 (sales); 01-890-5876 (works). Telegrams: Selab, Feltham. Telex: 23995.
Northern Sales Office, Bessell Lane, Stapleford, Nottingham. Telephone: Sandiacre 3255.

WW—108 FOR FURTHER DETAILS

McMurdo's new 0.10" Pitch Connector - "RL" Series



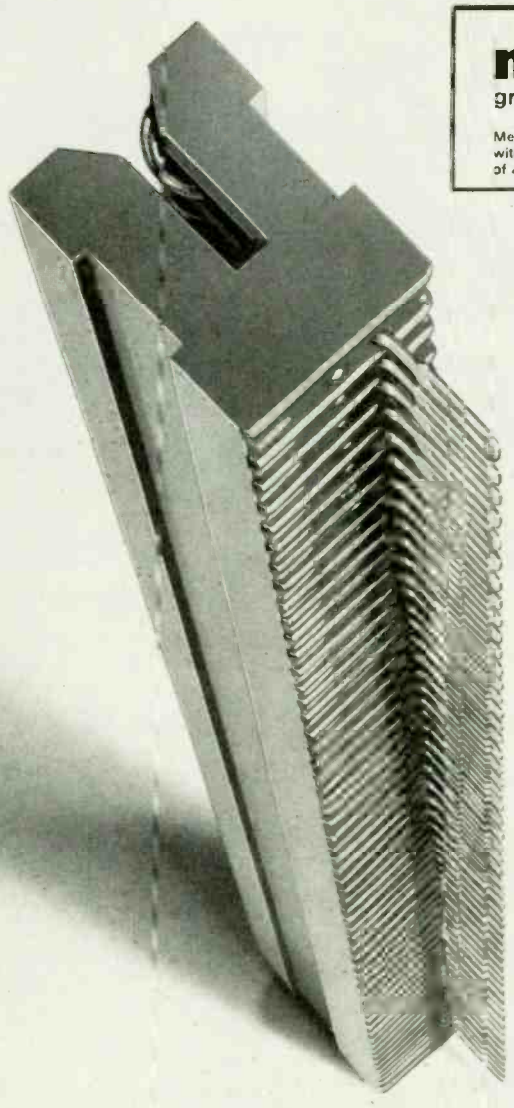
5 to 85 way single sided with solder and printed wiring tails.
10 to 170 way double sided with solder and printed wiring tails.
Wire Wrap and Crimp tails will shortly be available.

Working Voltage	(To be advised)
Proof Voltage	(To be advised)
Insulation resistance (dry)	10^3 Megohms min.
Contact resistance to test gauge	10 Milli-ohms max.
Insertion and withdrawal forces	6 oz. per contact max.
Contact finish	Flow tin or hard gold (specify when ordering)

Another new product from:
McMurdo Instrument Co. Ltd., Rodney Road, Portsmouth, Hampshire. Telephone: Portsmouth 35361. Telex: 86112.

mcmurdo
great facility for service

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

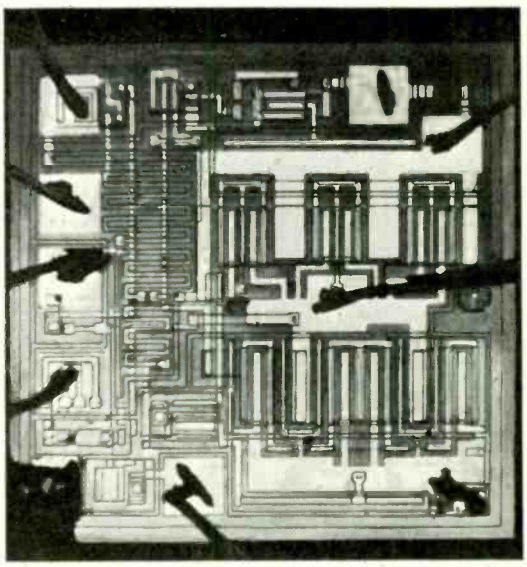


Authorised Stockists:—**Lugton & Co. Ltd.**, 209/210 Tottenham Court Road, London W.1. Tel: 3261
I.T.T.—electronic services, Standard Telephones & Cables Ltd., Edinburgh Way, Harlow, Essex. Tel: Harlow 26777.
and agents in principal overseas countries.

WW—109 FOR FURTHER DETAILS

SINCLAIR IC-10

MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



A 13 transistor circuit measuring only one twentieth of an inch square by one hundredth of an inch thick!

the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick, has 5 watts R.M.S. output (10w. peak). It contains 13 transistors (including two power types), 2 diodes, 1 zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout), etc. Once proven, the circuits can be produced with complete uniformity which enables us to give a full guarantee on every IC-10, knowing that every unit will work as perfectly as the original and do so for a lifetime.

MORE SINCLAIR DESIGNS ON PAGES FOLLOWING

■ SPECIFICATIONS

Output:	10 Watts peak. 5 Watts R.M.S. continuous
Frequency response:	5 Hz to 100 KHz ± 1dB
Total harmonic distortion:	Less than 1% at full output.
Load impedance:	3 to 15 ohms.
Power gain:	110dB (100,000,000,000 times) total.
Supply voltage:	8 to 18 volts.
Size:	1 x 0.4 x 0.2 inches.
Sensitivity:	5mV.
Input impedance:	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages, making battery operation eminently satisfactory.

■ APPLICATIONS

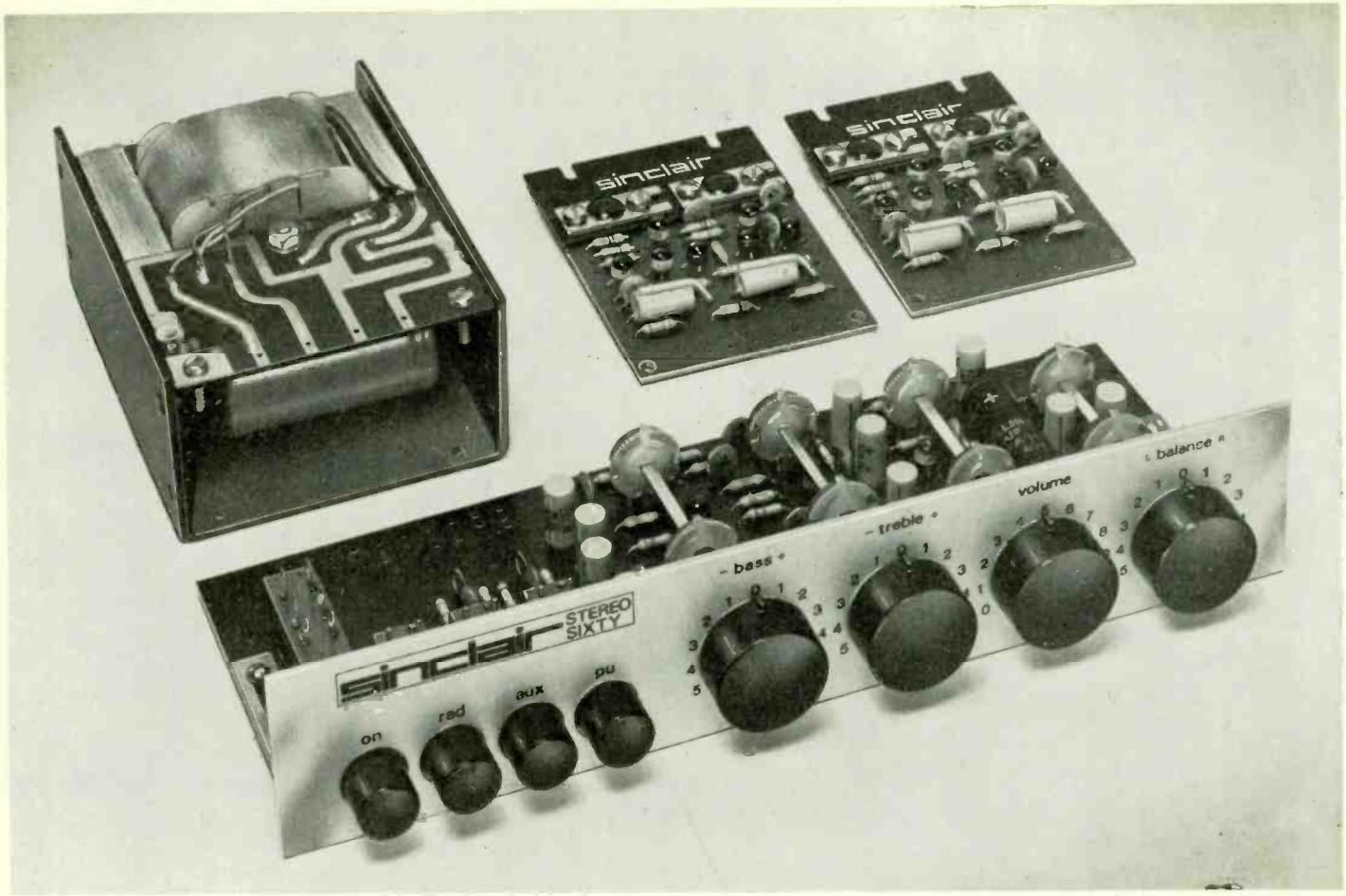
Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

SINCLAIR IC-10 *with IC-10 manual Post free.* **59/6**

sinclair

SINCLAIR RADIONICS LTD. 22 NEWMARKET ROAD, CAMBRIDGE
Telephone: 0223 52731

WW—110 FOR FURTHER DETAILS



Project 60 an exciting alternative

The buyer of an amplifier today has a remarkably wide variety to choose from. It is unlikely that a purchaser would have real difficulty in finding a unit that met all his requirements, although the price might not be as low as could be wished. The only snags are that one's needs can change and that the technically correct amplifier may be physically inconvenient. If you are confident that there is an amplifier available, of the right size and price, which will meet all your needs for the forseeable future, then that is your best buy. If not, however, we can offer you another possibility which we believe to be an exciting alternative approach. That alternative is **Project 60**.

Project 60 is a range of modules which connect together simply to form a complete stereo amplifier with really excellent performance. So good, in fact, that only 2 or 3 amplifiers in the world can compare with it in overall performance.

The modules are: **1.** The Z-30 high gain power amplifier, which is an immensely flexible unit in its own right. **2.** The Stereo 60 preamplifier and control unit. **3.** The PZ.5 and PZ.6 power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6. The power supplies differ in that the PZ-6 is stabilised whilst the PZ-5 is not. This means that the former should be used where the highest possible continuous sine wave rating is required. In a normal domestic application there will not be a significant difference between using either power unit unless loudspeakers of very low efficiency are being used.

All you need to assemble your system is a screwdriver and a soldering iron. No technical skill or knowledge whatsoever is required and, in the unlikely event of you hitting a problem, our customer service and advice department will put the matter right promptly and willingly.

Perhaps the greatest beauty of the system is that it is not only flexible now but will remain so in the future. We shall shortly be introducing additional modules which will include a comprehensive filter unit, a stereo F.M. tuner and an even more powerful amplifier for very large systems. These and all other modules we introduce will be compatible with those shown here and may be added to your system at any time.

Project 60 modules have been carefully designed to fit into virtually every known type of plinth or cabinet. Only holes have to be drilled into the wood of the plinth or cabinet to mount the Stereo 60 and any slight slips here will be covered completely by the aluminium front panel of the control unit. The Project 60 manual gives all the instructions you can possibly want clearly and concisely.

sinclair

SINCLAIR RADIONICS LTD · 22 NEWMARKET ROAD · CAMBRIDGE
Telephone: 0223 52731

WW—111 FOR FURTHER DETAILS

Z-30 TWENTY WATT R.M.S. (40 WATT PEAK) POWER AMPLIFIER

The Z-30 is a complete power amplifier of very advanced design employing 9 silicon epitaxial planar transistors. Total harmonic distortion is incredibly low being only 0.02% at full output and all lower outputs. As far as we know, no other high fidelity amplifier made can match this specification, no matter what the price. Thus you can be utterly certain that your Project 60 system will do full justice to your other equipment however good it may be. The Z-30 is unique in that it will operate perfectly, without adjustment, from any power supply from 8 to 35 volts. It also has sufficient gain to operate directly from a crystal pickup. So in addition to its use in a high fidelity system you can use a Z-30 to advantage in your car or a battery operated gramophone for your children, for example. These, and many other applications of the Z-30, are covered in the Project 60 manual.

SPECIFICATIONS

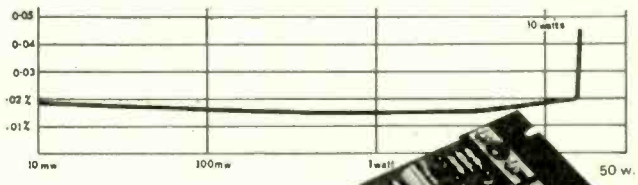
Power output—15 watts R.M.S. (30 watts peak) into 8 ohms using a 35 volt supply: 20 watts R.M.S. (40 watts peak) into 3 ohms using a 30 volt supply.

Output—Class AB.

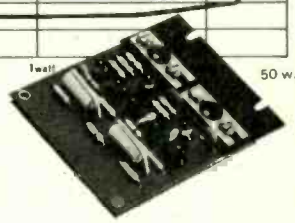
Frequency response:	30 to 300,000 Hz ± 1dB.
Signal to noise ratio:	better than 70dB unweighted.
Distortion:	0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.
Size:	3½ x 2½ x ½ inches.
Input sensitivity:	250mV into 100 Kohms.
Damping Factor:	>500.
Loudspeaker impedances	3 to 15 ohms.
Power requirements:	8 to 35 V.d.c.

APPLICATIONS

High fidelity amplifier: car radio amplifier: record player fed direct from pick-up: intercom: electronic music and instruments: P.A., laboratory work, etc. Full details of these and many other applications are given in the manual supplied with your Z.30.



Power versus distortion curve of Sinclair Z.30.



Z.30

Ready built, tested and guaranteed, with Z.30 manual.

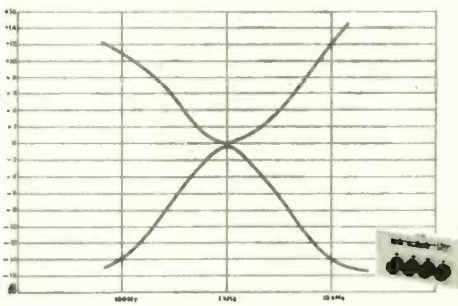
89/6

STEREO SIXTY PREAMPLIFIER AND CONTROL UNIT

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to achieving a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.

SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV: Magnetic Pickup—3mV Correct within ± 1dB on R.I.A.A. curve. Ceramic Pickup—up to 3mV: Auxiliary—up to 3mV.
- Output—250mV.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE + 15 to − 15dB. at 10 KHz: BASS +15 to −15dB at 100 Hz.
- Power consumption 5mA.
- Power requirement—PZ.5 or PZ.6.
- Finish—brushed aluminium front panel with black knobs.
- Mounting—on cabinet front by spindle bushes and adjustable brackets.

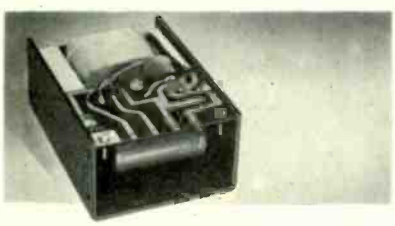


Treble and bass control curves

STEREO SIXTY

Ready built, tested and guaranteed **£9.19s.6d.**

SINCLAIR POWER SUPPLY UNITS



PZ-5 **30 volts unstabilised—sufficient to drive two Z-30's and a Stereo 60 for the majority of domestic applications.**

Price: £4. 19s. 6d.

PZ-6 **35 volts stabilised—ideal for driving two Z-30's and a Stereo 60 when very low efficiency speakers are employed.**

Price: £7. 19s. 6d.

GUARANTEE

If at any time within 3 months of purchasing Project 60 modules from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter.

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD, CAMBRIDGE
Telephone 0223 52731

sinclair

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE

Please send

.....

.....

.....

.....

for which I enclose cash/cheque money order

NAME .....

ADDRESS .....

.....

.....

WW370

WW—112 FOR FURTHER DETAILS

CONVERTOR/BATTERY CHARGER. Input 240v 50 c/s, output 12v 5 amp DC. Input 12v DC, output 240v AC. 170 watt max. Witb fuse and indicator lamps. Size 9½ × 10 × 4½in. Weight 19lb. 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/-.
G.M. TUBES. Brand new. G24/G38/G60 at **27/6** ea. G53/1, brass cased, **£6** ea.
PHOTOMULTIPLIERS. EMI 6097X at **£8/10/-** ea.
TRANSISTOR OSCILLATOR. Variable frequency 40 c/s to 5 kc/s. 5 volt square wave o/p, for 6 to 12v DC input. Size 1½ × 1½ × 1½in. Not encapsulated. Brand new. Boxed. **11/6** ea.
COUNTENAY TIMER sub-chassis with 2-12AU7, transistor, relay etc. Requiring 12V. A.C. or D.C. to operate 22/6.
As above but 1, 5, 10 or 15 minutes. State which. **25/-** ea.
RECEIVER UNIT TYPE 114. Freq. coverage 124-156 mc/s I.F. out 9.72 mc/s. Size 7 × 1½ × 5½in. In original service carton, complete with valves, connections, etc. **32/6** ea. P. & P. 5/- ea.

RELAYS

Omron/Schrack octal based plug-in relays. 2 pole c/o 5A, 6v only. Brand new. Boxed. **12/6** ea.
G.E.C. 4 pole c/o 6/12v operation 180 ohms. Platinum contacts. Brand new. Boxed **12/6** ea.
Min. VARLEY type VP4. 4 pole c/o 15 K/ohm. Brand new **4/6** ea.
Min. **S.T.C.** 4-pole c/o 7.5-18V. 185 ohms. Brand new boxed. **8/-** ea.; **6/-** ea. per 100.
S.T.C. sealed 2 pole c/o 48V. 2.500 ohm 48v. **3/6** ea. 12v **7/-** ea.
CARPENTERS polarised Single pole c/o 20 and 65 ohm coil as new, complete with base **7/6** ea. Single pole c/o 680, 1.110 and 1.570 ohm coil. As new **6/6** ea.
Brand New. Single Pole c/o (type 5A2), 2 × 1200 ohms. **8/6** ea.

POTENTIOMETERS

COLVERN Brand new. 5; 10; 50; 100; 250; 500 ohms; 1; 2.5; 5; 10; 25; 50k all at **2/6** ea. Special Brand new **MORGANITE** 250K 1 in. sealed. Normal price 9/-, our price **3/6** ea.
INSTRUMENT 3" Colvern. 5; 25; 100 ohms; 2.5. All at **7/-** ea.
TRIM POTS. Paignton-solder lugs 5, 10 & 25K at **5/-** each: Pins 10; 20; 50; 100; 200; 250; 500 ohms; 2.5; 25 and 50K at **10/-** each.
DARSTAN-preset-sealed ¼" dia. ½ high. 1; 2 and 5K **1/6** ea.
HIGH RESOLUTION 25K 80 turns. Complete with knob **6/6**
GENERAL CONTROLS. 100K Ten turn. Brand new. Boxed **25/-** ea.
ALMA precision resistors 100K; 400K; and 998K—0.1% **5/6** ea: 3.25K—0.1% **4/-** ea.
DALE heat sink resistors, non-inductive 50 watt. Brand new. 15 ohms—**6/6** ea.; 8.2K **4/6** ea. Excellent dummy load.

CAPACITORS

ERIE feed through ceramicons 1000 pf—**9d.** ea.
Sub-min. **TRIMMER** ½ square. 8, 5pf. Brand new **2/6** ea.
Concentric **TRIMMER** 3/30 pf. Brand new **1/6** ea.
DUBILIER Electrolytic. 32+32+16mfd. 350V. D.C. Brand new. **4/6** ea.; **3/9** ea. per doz.
EHT 1000pf 20KV working, ideal transmitter blocking capacitors **6/6** ea.
VISCONOL EHT. Brand new 0.0005 25 kV, **16/-** ea.
E.H.T. 0.02mfd 8KV- **6/-** ea.; 0.1mfd 2.5 KV-nitrogel—**4/6** ea.; 0.5mfd 5KV—**11/-** ea.; 0.05mfd 10KV—**7/6** ea.; 0.5mfd 2.5KV **7/-** ea.
GEARED MOTORS 240v 50 c/s synchronous. Geared down to 60 rpm. Brand new **30/-** ea. P. & P. 7/6.
DIODES 1N914. Brand new **1/3** ea.; **12/-** doz.; **£4**—100; **£25**—1.000.
PHOTOCELL equivalent OCP 71 **2/6** ea.
BURGESS Micro Switches VS 5930. Brand new **2/6** ea.
BULGIN panel mounting Lamp holders. Red. Brand new **2/3** ea.
MINIATURE SPEAKERS 15 ohm 2in. diameter. Brand new, **7/-** ea. P. & P. 2/6 ea.
CANNON XLR 11C Plug. Brand new **10/-** ea.
TRANSISTORS BC 114—NPN Low noise high gain audio. etc.; BC 116—PNP General purpose 200 mc/s. Ex brand new equipment. Guaranteed perfect. Good lead length. **2/-** ea.

NUCLEONIC INSTRUMENTS

SCALER type 1009 by Dynatron. Suitable Beta/gamma counts. Built in test signal. Calibrated adjustable discriminator. Read out 2 decade neons and 4 digit counter. Supplied in as new condition at **£5** ea. Carr. 30/-.
Few only **RATEMETER** type 1161B Complete with built in EHT supply. Separate metering EHT and Count. EHT available for external equipment 0 to 3 kv. As new **£35**. Carr. 30/-.
E.H.T. Power unit 0 to 5 Kv. Stabilized by General Radiological. As new **£20**. Carr. 30/-.
100 CHANNEL PULSE HEIGHT analyser type 1363B. As new **£75**. As above but type 1363C. **£120**.
ECKO PULSE HEIGHT ANALYSER type N101 **£25**. Carr. 30/-.
DEKATRON Display unit type NIS 223. **£20**. Carr. 30/-.
CINTEL Transistorised Nucleonic Scaler with adjustable discriminator. 6 meter display 0-9 giving count of 10 to the 5. New Condition. Now ONLY **£20**. Carr. 15/-.
PULSE Generator type 1147A. **£10**. Carr. 30/-.

TEST GEAR

OSCILLOSCOPES

E.M.I. WM 2 DC—13 mc/s **£35**
SOLARTRON 7118.2 D.B. DC—9 mc/s **£60**
SOLARTRON 643 DC—15 mc/s NOW only **£65**.
SOLARTRON 513/528 DC—10 mc/s **£35**
SOLARTRON 568 DC—6 mc/s **£18**
COSSOR 1035 DB. **£20**
COSSOR 1049; 1049 Mk. 3. DB. **£22/10** and **£30**
HARTLEY 13A DB. **£18/10/-**
All carefully checked and tested. Carriage 30/- extra.

MARCONI

TF 956 (CT44) Audio Freq. Wattmeter **£15**. Carr. 10/.
TF 886 Magnification Meter **£45** Carr. £1
TF 762C UHF Generator **£40** Carr. £1
TF 369 N. 5 Impedance Bridge **£55** Carr. 30/-
TF 144G Signal Generator, Serviceable, Clean **£15** In exceptional condition **£25**. Carr. 30/-
TF 885 Video Oscillator Sine/Square **£35** Carr. 30/-
TF 899 Millivolt meter **£8** Carr. 10/-
TF 195M Sine wave oscillator 0/40kc/s **£12** Carr. £1
TF 1343/2 'X' Band gen. **£35** Carr. 30/-
TF 428B/1 Valve voltmeter **£4** Carr. 10/-
TF 428B/2 Valve voltmeter **£8** Carr. 10/-
Type 801 Sig. Gen. **£45**. Carr. 30/-.
TF 934/2 FM Deviation Meter **£30**. Carr. 30/-.
TF 791B Carrier Deviation Meter **£40** Carr. 30/-

SOLARTRON

Pulse generator POS 100C 50 c/s—1 mc/s **£18** Carr. £1
Laboratory amplifier AWS51A. 15c/s—350kc/s **£35** Carr. £1
Stabilised P.U. SRS 151A **£20** Carr. 30/-
Stabilised P.U. SRS 152 **£15** Carr. 30/-
Stabilised P.U. AS 516 & AS 517 **£3**, and **£6** Carr. 10/-

AVO

AVO VALVE CHARACTERISTIC Meter. Excellent condition. **£30** Carr. 30/-.
Generator 50kc/s—80 mc/s **£16** Carr. 15/-
Testmeter No. 1 **£14** Carr. 15/-
Electronic Testmeter CT 38. Complete **£18** Carr. £1
SPECIAL by **G. & E. BRADLEY.** Multimeter type CT471B. Battery operated, fully transistorised, sensitivity 100 M ohm/V, measures a.c./d.c. voltage (12mV-1200V scales. +/— 3% /+ /— 2% f.s.d.) a.c./d.c. current (12 microA-1.2A scales. +/— 3% / +/— 2% f.s.d.) resistance (12 ohm-120M ohm scales. +/— 3% m.s.d.). h.f./vhf/uhf, voltage with multiplier (4V-400V scales up to 50 MHz; 40 mV-4V up to 1000 MHz). Brand new. Few only. **£60** Carr. 30/-

CINTEL

Wide Range Capacitor Bridge **£25** Carr. 15/-
Sine and Pulse Generator type 1873 **£25** Carr. 15/-

AIRMEC

Valve Millivoltmeter type 264. 3MV-1V **£20** Carr. £1
Counter type 865. 6 decades. Bright Vertical display gate facilities. Very good condition **£30** Carr. 30/-
Klystron Power Supply 698B **£25** Carr. £1
Signal Generator type 701. **£35**. Carr. 30/-.

OSCILLOSCOPE CAMERA Cossor type 1428. Brand new with standard 4in. fitting and spare cassets. **£45**. Also Shackman 25ft. Exp 270 frames. Times from 1/250 to 1 secs. auto. Dalmere Fl. 9 Focal 1½in. with standard 4in. to 5in. fitting. **£30**.

SOLARTRON CALIBRATION UNIT type AT203. **£25** Carr. 30/-

SOLARTRON. Process Response Analyser. Fine condition. **£350**.

E.H.T. Base B9A in Polystyrene holder with cover. Brand new. **2/6** ea.

ZENITH E.H.T. Tester, with Probes. Metered 0-3.5 kv. **£25** Carr. 30/-

DENCO Travelling Wave Amplifier **£40**. Carr. 30/-.

HEINZ GUNTHER AM/FM Generator 9—200 mc/s. **£30** Carr. **£1**

SIGNAL Generator CT 53. Complete with leads. Good condition. **£10** Carr. 15/-. With copy of charts.

FREQUENCY Meter LM 14. Modulated version of BC 221 with charts and covers. Brand new **£30**. Carr. 30/-.

SPECIAL. FURZEHILL V200 Valve millivolt meter. 10 mv to 1 kv. **£25** Carr. £1

MIC-O-VAC type 22 (CT54) Volts; Current; Ohms. D Cto 200 mc/s with probe, leads etc. As new **£8/10/0** P. & P. 10/-.

VIBRATING REED ELECTROMETER type N 572 by ECKO. Range 10 to the -14. Max sensitivity FSD for 1 of 0.03 Micro-microamps. **£20** ea. Carr. **£1**

SHORTS ANALOGUE COMPUTER. Complete. Fine condition. **£180** ea.

As above, complete, not serviced. **£75** ea.

Also large quantity spares available. Carriage at cost.

DISTRIBUTED AMPLIFIER type 2C/3 50 c/s 100 mc/s Gain 300. **£30** each.
Type 2C 50 c/s to 100 mc/s **£16** each.

DAWE Wide Range oscillator type 400A. 20 cs to 20 kc/s Sine wave. 500, 600 and 2000 ohm. Fine condition. **£25**. Carr. 30/-.

MUIRHEAD type D729 AM. Phase meter. As new condition. In transit cases. **£160**

PAIGNTON ATTENUATORS 0.1 db. to 100 db. in 3 decades, 600 ohm. 19" rack mounting. **£20** ea. Carr. 15/-

PISTON ATTENUATOR in carrying case. 30-140 mc/s calibrated 0/70 db. **£10** ea. Carr. £1

Precision **THERMOSTOR** by YSI. 100 k. at 25°C. Range: 40°C. to 150°C. Supplied with charts giving ohms for each degree over entire range. Brand new. **£2** ea.

ADVANCE Signal Generator type D1. 2 mc/s to 190 mc/s. Sine and square mod. With original charts. Excellent condition **£12/10/0** P. & P. £1

SERVOMEX. Stabilized D.C. Power unit. Type 38. Bench mounting. 0-15 volts. 0-2.5 amps. Separate voltage and current meters **£25**.

TRANSISTOR Stabilised Power Unit. 48v, 4 amp. Manufactured by E.M.I. Open chassis. Brand new. Highest quality. Size 10½ × 5½ × 6½in. high. **£6** ea.

HOLGATE 6 channel Event recorder. 1in. or 10in. inches per second. Size 4½ × 5 × 8in. Excellent condition. **£20**.

HEWLETT PACKARD Recorder and Decoder type 20610. As new. Write or phone for further details.
19in. Rack Mounting **CABINETS** 6ft. high 2ft. deep. Side and rear doors. Fully tapped, complete with base and wheels. **£12/10/0** Carriage at cost.
MULLARD Transistorised Analogue to Digital Convertor Model L 281. As new. **£20** Carr. 15/-
SUNVIC DC chopper Amplifier type DCA 1. Superb condition. **£22/10/0** ea. Carr. 20/-
PROCESS TIMERS 8 individual timer circuits. each with 0-100 sec callibrated dials. Ideal displays, processes, etc. Standard mains input **£20** Carr. 25/-.
ISOLATING TRANSFORMERS 240V in 240V 7 KVA out. As new. **£25** ea. Carr. £2/10/-
DESK Telephones. Current type. Standard dial. 3 wire red, green, white. Ideal extensions etc. As new **£3** each. Same but older type **17/6** each. P. & P. 5/-.
DIECAST ALLOY boxes. Size 4 × 2½ × 1½ in. Drilled ends for Belling Coax socket. 3 compartments link holes between. **6/6** each. P. & P. 2/-.
CONVERTOR 50 c/s single ph. to 400 c/s 3 ph. 250w. in 6ft. enclosed 19" rack cabinet. **£45** ea. Carr. at cost.

METERS

EHT ELECTROSTATIC Ernest Turner, etc.. 0-1.5kV. **£2** ea.; 0-3.5 KV **£2/15/0** ea.; 0-5 KV **£3/10/0** ea.; 0-7.5 KV **£4/5/0** ea.
TAYLOR 100-0-100 Micro amp scaled size 4 × 2" with internal lamp scaled 6-0-6 **1/10/0** ea.
GRIFFIN & GEORGE 3" round in sloped open ended case with terminals 2 types 0/20; 0/100. All 50 c/s. **£1** ea.

4 DIGIT RESETTABLE COUNTERS. 1000 ohm. coil. Size 1½ × ½ × 4½in. As new. by Sodeco of Geneva. **£2/10/0** each.
As above but 350 ohm. **£3/10/0** ea.

TRANSFORMERS. All standard inputs.

STEP DOWN ISOLATING trans. Standard 240v AC to 120v tapped 60-0-60 700w. Brand new. **£6** ea. As above but 500w. **£4** ea.
75 WATT Constant voltage transformer. 195 to 255 volts—240v out. **30/-** each. P. & P. 5/-.
MODULATION trans. PP—6 BW6. **30/-** each. P. & P. 5/-.
Transformer 0-215-250 120 MA; 6.3V 4A CT × 2; 2 × 6.3v 0.5A and separate 90v 100 MA **25/-** each P. & P. 4/-. Matching contact cooled bridge rectifier **7/6** each.
3kV 4·5mA, 4v 0·5 amp × 2. 4v 1·1 amp. **£3/10/-** ea. 350-0-350 75mA, 5v 2 amps × 2. **21/-** ea.
Gardners 6·3v 2A; 6·3v 1·5A; 6·3v 0·1A. Size 3 × 1½ × 4½in. As new. **9/6** ea. P. & P. 3/- ea.
Parmeko/Gardners. Potted. 475-60-0-60-475 at 160 mA; separate winding 215-0215 at 45mA; 6·3v 5A; 6·3v 0·75A; 5v 3A. As new. **£3** ea.
Gardners 400-350-0-350-400 at 250MA; 0/4/6·3v 4 amp × 2; 0/4/6·3 2 amp; 0/4/5 3·5A. In original boxes. **£4/10/-** inc. post. Gardiners 2kV 10MA. As new, **£3** incl. postage. Gardiners 2kV 10MA and 4 volts × 2. **£4/10/-** ea incl. postage.
Parmeko 65v 1 amp. Separate 0-18-24v at 0·5 amp. **30/-** ea. Gard/Parm/Part. 450-400-0-400-450. 180 MA. 2 × 6.3v. **£3** ea.
ADVANCE Constant Voltage Trans. 6 volts 50 watt. As new **£3** P. & P. 10/-
Gardners 5v 30amp. Brand new **£1/10** each incl. postage.
CHOKES. 5H; 10H; 15H; up to 120mA. **8/6** ea. Up to 250mA **12/6** ea.
Large quantity LT, HT, EHT transformers. Your requirements, please.
Panel switches DPDT ex eq. **2/6** ea.; DPST Brand new 3/6 ea.; DPDT twice, brand new **6/-**; heavy duty DPST brand new **6/-** ea.
SPECIAL. 813 valves. Brand new, boxed **£2/10/0.**
PRECISION continually rotarable stud switches. Single pole. 80 way; can be stacked if required. **£3** ea.
PRECISION rotary stud switches 2 pole 12W size 2" sq., ¼" shaft. **£2/10/0** ea.
Min. **SEALED** 4 pole 3 way and 3 pole 4 way rotary switches. ¼" shaft ¼" dia. × ½" **10/-** ea.
Solartron Storage. Oscilloscope type QD 910. MUST GO. Now only **£100** each.

CASH WITH ORDER **OFFICIAL ORDERS WELCOMED**

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 · Tel. No. 65916
moving to 7-9-11 ARTHUR ROAD, 300 yds. east (rear Tech. College) Tel. No. 582605

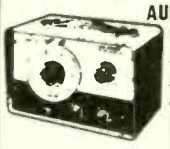
FREE NOW!

16-PAGE TEST EQUIPMENT CATALOGUE. ALL ASPECTS OF LOW COST INSTRUMENTS FOR AMATEUR, PROFESSIONAL AND EDUCATIONAL USE. OVER 50 UNITS DETAILED.

FREE! ORDER AS PUBLICATION 'T.'

★MULTIMETERS
★VALVE VOLTMETERS
★AF, RF MILLIVOLTMETERS
★PANEL, FS METERS
★VARIABLE TRANSFORMERS
★SCOPE, DECADES
★POWER SUPPLIES
★AUDIO, RF GENERATORS
★TESTERS, CHECKERS

✻ SINE/SQUARE WAVE AUDIO GENERATOR



Provides audio output on 4 bands, Sine wave 20c/s to 200 kc/s, output up to 7V; square wave 60c/s to 30kc/s, 7V p-p. Distortion under 2%. Output impedance 1kΩ. Variable output amplitude control. Supplied with leads and instructions. A.C. mains operated.
TE22 Price £16.10.0
Also TE22D (Size as TE20D) £16. 0.0

✻ GRID DIP METER

All transistor grid dip meter, absorption wavemeter and osc. detector. Frequency range 440kc/s to 280Mc/s in 6 coils. Uses 3 transistors plus diode with 500μA meter. Internal battery.
TE15 £11.10.0 p.p. 3/6

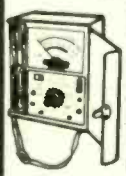
✻ VACUUM TUBE VOLTMETER

Features low price for such an instrument. Large 6in. full view scaled meter. 28 ranges. D.C. volts: 0/1½/5/15/50/150/500/1500. A.C. volts: 0/1½/5/15/50/150/500/1500 r.m.s.: 0/1.4/4/14/40/140/400/1400/4000 p-p. Resistance: R x 10-100-1k-10k-100k-1m-10m. Range 0.2 ohm to 1000MΩ. dB scales: —10 to +65dB. Complete with instructions and leads.
TE65 £17.10.0 p.p. 7/6

✻ TRANSISTOR CHECKER

Complete capacity for checking all transistors npn and pnp for alpha, beta and leakage. Also diodes. Complete with leads and instructions.
ZQM2 £5.19.6 p.p. 3/6

✻ 50,000 OHMS PER VOLT MULTIMETER



Recommended quality instrument with mirror scale and overload protection. 0/0.3/3/12/60/120/300/600/1200V d.c. (50KΩ/V); 0/6/30/120/300/600/1200V a.c. (10KΩ/V); 0/30μA/6/60/300mA, 0/12A; resistance 0/10kΩ/1/10/100MΩ. Meter movement 20μA. Polarity reversing switch. Complete with batteries, leads and instructions.
AF105 £8.10.0 p.o. 2/6
Leather case 28/6

✻ 20,000 OHMS PER VOLT MULTIMETER

Popular model but with extra scale range. 20,000 ohms per volt. 0/5/25/50/250/500/2500 V d.c., 0/10/50/100/500/1000V a.c., 0/50μA, 0/2½/250mA. Resistance 0-6kΩ and 6MΩ. Also dB scales or capacitance.
Model 200H Price 77/6
(Leather case, Price 15/- p.p. 2/-)

✻ RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120Kc/s-500Mc/s on 6 bands. Directly calibrated. Variable RF. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. Size 140 x 215 x 170mm.
TE20D Price £15 p.p. 7/6

✻ TRANSISTORISED RF MILLIVOLTMETER

Mains or battery operated. 0/3mV up to 300V AC. Input 1Meg. Response ±0.2dB 20c/s to 1Mc/s and ±1dB at higher and lower frequencies. Fully stabilised. Size: 150 x 240 x 114mm. Complete with handbook. 11 scales 0.003 FSD to 300V FSD. Also dBM and dBV scales.
VM51 Price £32 p.p. 8/6

NOMBREX TRANSISTORISED Test Equipment

MODEL		PRICE £ s. d.
29s	RF. Generator	21 0 0
29x	Xtal RF Gen.	29 10 0
30	Audio Generator	19 10 0
31	R.F. Generator	12 10 0
32	C.R. Bridge	10 10 0
33	Inductance Bridge	20 0 0

✻ PORTABLE OSCILLOSCOPE

Features 3in. clear view tube, easy to use controls and good stability. Y amp. Sensitivity. 1V p-p/CM. Bandwidth 1.5cps-1.5 MHz. Input imp. 2 meg Ω. 25 PF. X amp sensitivity. 9V p-p/CM. Bandwidth 1.5 cps-800 KHz. Input Imp. 2 meg Ω. 20 PF. Time base. 5 ranges 10 cps-300 KHz. Synchronization. Internal/external. Illuminated scale.
TO3 Price £37.10.0 p.p. 10/-

✻ DC STABILISED POWER SUPPLY

Switched DC Stabilised Outputs UP TO 1 AMP. 3-6-9 & 12 VOLTS. Indicator lamp for each voltage. Fully fused. Mains operated. Negligible ripple. Regulation 1%.
SE101A £8.15.0

QUALITY PANEL METERS

38 SERIES
Face Size 42 x 42mm. DC types.

50	μA	.. ..	37/6
100	,,	.. ..	35/-
200	,,	.. ..	32/6
500	,,	.. ..	27/6
50-0-50	,,	.. ..	35/-
100-0-100	,,	.. ..	32/6
500-0-500	,,	.. ..	25/-
1	mA	.. ..	25/-
5	,,	.. ..	25/-
10	,,	.. ..	25/-
50	,,	.. ..	25/-
100	,,	.. ..	25/-
500	,,	.. ..	25/-
1	Amp	.. ..	25/-
5	,,	.. ..	25/-
10	Volts	.. ..	25/-
20	,,	.. ..	25/-
50	,,	.. ..	25/-
300	,,	.. ..	25/-
500	,,	.. ..	25/-
'S' Meter	1mA	.. ..	29/6
VU Meter		.. ..	37/6

65 SERIES
Face Size 86 x 78mm. DC types.

50	μA	.. ..	62/6
100	,,	.. ..	52/6
200	,,	.. ..	47/6
500	,,	.. ..	45/-
50-0-50	,,	.. ..	52/6
100-0-100	,,	.. ..	49/6
500-0-500	,,	.. ..	37/6
1	mA	.. ..	37/6
5	,,	.. ..	37/6
10	,,	.. ..	37/6
100	,,	.. ..	37/6
500	,,	.. ..	37/6
10	Volts	.. ..	37/6
20	,,	.. ..	37/6
50	,,	.. ..	37/6
100	,,	.. ..	37/6
300	,,	.. ..	37/6
500	,,	.. ..	37/6
'S' Meter	1mA	.. ..	42/6

85 SERIES
Face Size 120 x 110mm. DC types.

50	μA	.. ..	69/6
100	,,	.. ..	59/6
500	,,	.. ..	52/6
100-0-100	,,	.. ..	59/6
1	mA	.. ..	49/6
100	,,	.. ..	49/6

Trade list on request.

ELECTRONIC COMPONENTS

- **Vast range of transistors, diodes, valves, tubes, IC's in stock. Free list No. 36, or see Catalogue A.**
- **Complete range of components in stock, including special and hard to get components.**

If you are at all interested in Electronics then you are missing out without a copy of 'Henry's' 320-page Catalogue 'A.' Price 7/6 p.p. 2/- with 10/- value discount vouchers.

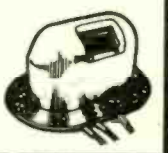
FREE
To all schools, colleges etc. and all companies interested.

UK's largest stockists of Electronics for every use. Over 6500 lines in stock.

PUBLIC ADDRESS SYSTEM

Complete system comprising Control Unit 4 Tannoy loud hailers, microphone and headphones, etc., 12V D.C. operation. Low battery drain. 8 watts power output. The ideal system for mobile use, outdoor meetings, sports days, factories, garden fetes, etc. Speakers can be spaced effectively over hundreds of yards. Also has talk back facility. Guaranteed Brand New in sealed cartons. Original cost over £60.

GRAVINER FIRE DETECTOR UNIT



Fire Detector Unit containing G31A photo multiplier and cold cathode tube. Shock and fire proof. Originally made for £74. Price complete with data sheet £6 Brand new.

STC CRYSTAL FILTER ±7.5 K/cs BAND WIDTH

25Kc/s Spacing. New purchase, brand new type 445 LQU 923E. 10.7 Mc/s. 6dB ± 7½Kc/s. Insertion Loss 3.5dB. Terminations 820 Ohms. Usually £12. Price £6 with Data Sheet.

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/-.** Plug in mains units 75/- 4 cell battery H.T. eliminator 55/-.
Dosimeters 0-50r 12/6. 0-150r 10/-.

HIGH CAPACITY ELECTROLYTICS

40,000 mfd 10 volt	10/0
35,000 mfd 15 volt	12/6
25,000 mfd 25 volt	15/-
46,000 mfd 25 volt	19/6

Discounts for quantities.
At a fraction of normal price.
MADE BY MALLORY, USA.

E.A.C. DIGIVISOR mk. II

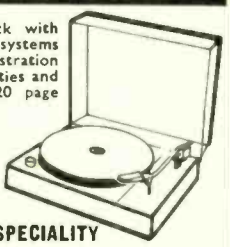
At a fraction of normal price. Moving Coil 0 to 9 Display. One inch character size. Light beam lens operated meter. Movement 500μA. Character lamp 6.3 volts. Also lamp for decimal point. Overall size: 4½ x 1½ x 2½. Brand new. **Price 79/6.**

STC TIME DELAY MOODULE

Ideal for experimenters, educational projects as well as for practical uses. Delay adjustable 3-15 secs. Operates 9-12 volts. Heavy Duty Relay Contacts. Complete with suggested applications sheet. Price 35/-, or 3 for 90/-.

HI-FI equipment to suit EVERY POCKET

Complete range always in stock with special low prices for complete systems and individual units. Two Demonstration Rooms, HP and Credit Sale facilities and plenty of free advice. New 120 page Catalogue covers every aspect, costs 5/-, p.p. 1/-, but contains 12/6 single extra discount voucher Order as catalogue 'B' —SEND TODAY.

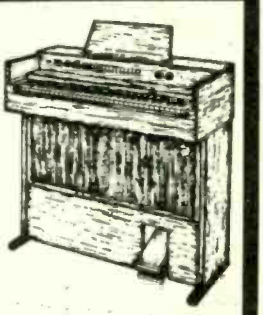


✻ DISCOTHEQUE AND PUBLIC ADDRESS—A SPECIALITY

ELECTRONIC ORGANS

★MODERN ALL BRITISH TRANSISTORISED DESIGNS AVAILABLE AS KITS OR READY BUILT
★VENEERED CABINETS FOR ALL MODELS
★49 NOTE, 61 NOTE SINGLE MANUAL DESIGNS ALSO TWO MANUAL 49 NOTE
★KITS AVAILABLE IN SECTIONS AS REQUIRED
★HP and CREDIT SALE FACILITIES

When in London call in and try for yourself.



FREE! 16 PAGE ORGAN BROCHURE COVERING ORGANS IN KIT FORM AND READY BUILT—WRITE OR PHONE TO ORGAN DEPT. ASK FOR PETER ELVINS.

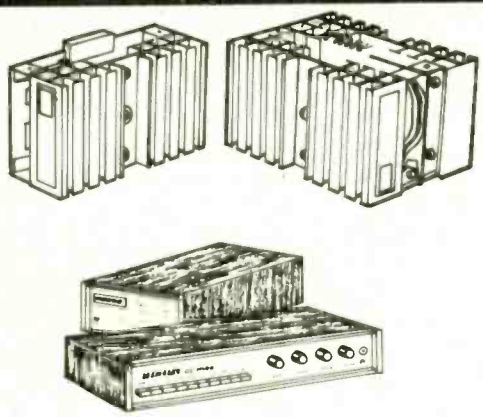
HENRY'S RADIO LTD.

Mail Order Dept, Electronic Components and Equipment, and Electronic Organ Dept.
303 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 1008/9
Open Mon-Sat. 9am–6pm. Thurs. 9am-1pm

High Fidelity and Audio Centre
309 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 6963
Open all day Saturday.

HENRY'S RADIO LTD. ENGLAND'S LEADING COMPONENT AND EQUIPMENT CENTRES

NEW FOR 1970



ON DEMONSTRATION

✲ **HENELEC 'IC STEREO'**

Three dual-channel integrated circuits are used in this new design by Henry's Radio, which has the unusual facility of doubling as a high quality headphone amplifier. Inputs are provided for magnetic, crystal and ceramic pickups and microphones, radio tuners, equalised tape signals, etc. Wide range tone controls and switched high and low pass filters are incorporated, and the unit has its own power supply. The silver and gold front panel, and slimline teak cabinet, give an impressive appearance to this fine amplifier. **PRICE £25.0.0**

✲ **HENELEC STEREO 25-25**

Comprises two PA25 amplifiers and MU442 in matching teak cabinet for direct use with above IC Stereo. **PRICE £23.0.0**

✲ **HENELEC 'PA25' POWER AMPLIFIER**

This silicon design uses complementary transistors in the symmetrical output stage, direct coupled to a loudspeaker of 8 ohms impedance or higher. Power output is 25 watts RMS with an 8 ohm load or 12 watts into 15 ohms, over a frequency range of 15Hz-25Hz 3db. Cool running is assured by the use of generously dimensioned black anodised heatsinks. Input 700mV 15Kcm. **PRICE £7.10.0**

✲ **HENELEC 'PA50' POWER AMPLIFIER**

Basically similar to the 'PA25', the 'PA50' will deliver 50 watts RMS to a 3-4 ohm load. Extra power is handled by complementary triplet circuits using the latest PNP and NPN silicon power transistors. As a result of extra heatsinking, the 'PA50' runs as cool as the 'PA25'. **PRICE £9.10.0**

✲ **HENELEC MU442 POWER SUPPLY**

Designed to run one or two 'PA25's' or one 'PA50' the MU442 connects to the amplifiers by means of plug-on harnesses. No soldering is required to connect up the system. Audio input plug and speaker plug go to the panel of the MU442. **PRICE £6.0.0**

✲ Mk.I 100 watts RMS with stabilised power supply overcurrent trip 100mV input sensitivity. Ideal for public address and discotheque equipment. **PRICE £49.10.0**

THE FINEST SOLID STATE UNITS ALL SILICON BRITISH EQUIPMENT

✲ *SEND FOR FREE BROCHURES* ✲

TRANSISTORS

FROM STOCK THE LARGEST RANGE AVAILABLE. COVERING ALL TYPES OF TRANSISTOR, INTEGRATED CIRCUITS, DIODES, RECTIFIERS, ZENERS, LIGHT DEVICES. FREE LIST No. 36 OF OVER 1,000 TYPES ON REQUEST.

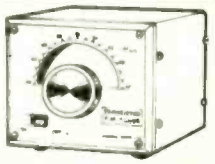
TRADE AND INDUSTRIAL ENQUIRIES INVITED

ALSO IN STOCK. TRANSDUCERS £5.18.0 PAIR WITH CIRCUITS. LARGE RANGE OF NUMICATOR TUBES AND INDICATORS, RELAYS AND COUNTERS, SOLENOIDS AND ACTUATORS—SEE CATALOGUE "A".

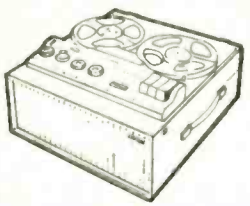
BUILD THIS VHF FM TUNER

5 MULLARD TRANSISTORS. 300 kc/s BANDWIDTH. PRINTED CIRCUIT. HIGH FIDELITY REPRODUCTION MONO AND STEREO. A popular VHF FM Tuner for quality and reception of mono and stereo. There is no doubt about it—VHF FM gives the REAL sound. ALL PARTS SOLD SEPARATELY.

TOTAL COST £6.19.6 DECODER £5.19.6
ASK FOR BROCHURE No. 3 (FOR STEREO)



BUILD A QUALITY 4 TRACK 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 for making a superb Tape Recorder. You need no experience or technical skill to bring this about. THE INSTRUCTIONS MANUAL MAKES BUILDING EASY, AND SUCCESS IS ASSURED. Kit comprises Deck, Amplifier Cabinet and speaker, with microphone, 7" 1,200 ft. tape, and spare spool.

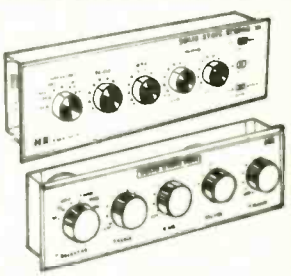
ASK FOR BROCHURE 6 TODAY'S VALUE £60
PRICE 39 gns. p. & p. 22/6 NOTHING ELSE TO BUY

HENELEC 5-5 STEREO AMPLIFIER

Excellent low-priced British designed Stereo Amplifier for use with Record Decks, Tuners. 16 transistor mains operated. Output 5+5 watts for 8-15 ohm speakers. Black, silver and wood finish, size 13in. × 3in. × 6in. **PRICE £13.10.0.** p.p. 7/6. (Leaflet on request.)

Complete Stereo System 5-5.
Garrard 2025TC stereo, 5-5 Amplifier, Plinth/Cover. Two 10 watt speakers with tweeters in polished cabinets, size 18in. × 11in. × 7in. Usual price £49.10.0. **OUR PRICE £39.10.0.** p.p. 20/-. ASK FOR BROCHURE 13.
OTHER SYSTEMS—ASK FOR BROCHURE 16/17. Over 40 specially designed systems, covering all price ranges.

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 AND MIXERS from **£11.12.6** to **£38.17.6** (all units available separately).

CHOOSE FROM 25 SYSTEMS
THE FINEST VALUE IN LOW-COST HIGH FIDELITY—CHOOSE A SYSTEM TO SUIT YOUR NEEDS AND SAVE YOURSELF POUNDS. Amplifiers 7, 12 and 25 watts, two types of Stereo Preamplifier, Mono Preamps and Mixer Modules.
*SEND FOR BROCHURES No. 12/14 and 21

INTEGRATED MICRO CIRCUITS

BP1010	3 watt Amp.	25/-
MC1304	Stereo Decoder	55/-
TAD100	AM Radio	47/6
PA237	2 watt Amp.	37/6
PA234	1 watt Amp.	20/-
PA230	Preamp.	22/6
MC1303	Stereo Preamp.	52/6
LA705C	Amp.	22/6
SL403	3 watt Amp.	49/6
TAA263	Amp.	15/-
SL702C	Amplifier	29/6
μL90C	Buffer	10/-
TAD110	AM/FM Radio	59/6
CA3028	Osc/Mixer	24/6
CA3036	Dual Dar	18/6
CA3020	Amplifier	27/6
CA30 8	Array	22/6
CA30 4	FM	29/6

TRANSDUCERS. Type 1404 for LF communication with circuit £5.18.0 pair. Complete list and details of all integrated circuits No. 35A free on request.

9 AND 12 VOLT STABILISED SUPPLIES

Size approx. 3in. × 2in. × 1½in. Output 100mA. Transistorised and Zener stabilised. Also unstab. output. UK made on PC with metal chassis.
PS 900 9 volt. 45/- p.p. 2/-
PS1200 12 volt. 47/6 p.p. 2/-

HENRY'S RADIO COMPONENT/EQUIPMENT ILLUSTRATED CATALOGUE

Continually revised and enlarged. Now 350 pages of all types of components and equipment for every use. Complete with 5 2/- Discount Vouchers for purchases.
***Order as Catalogue 'A'** Price 7/6, p.p. 2/-.
Why not send today! 9th edition, 6th impres.

GARRARD TURNTABLES

★GOLDRING★BSR★THORENS

2025GRS25		£5.19.6
2025TC, 3000LM	9TAHC DIAM	£7.19.6
3500	CERAMIC	£8.19.6 £12.19.6

Cartridge Model	Less Cartridge	9TAHC Diam.	AT21 or M3DM	G850 AT21X*	AT33 Deram*	G800	J2203 800SE*	CS91E Ceramic
	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d
SP25 Mk II	11 9 6	13 12 6	19 0 0	16 15 0	16 10 0*	21 0 0	15 10 0	19 0 0
AP75	17 15 0	19 15 0	25 10 0	23 0 0	27 0 0	27 0 0	21 17 6	25 10 0
GL75P	46 0 0	—	53 10 0	60 0 0*	55 10 0	53 0 0	70 0 0*	53 10 0
GL69P	35 0 0	37 0 0	42 10 0	40 0 0	44 10 0	42 0 0	59 0 0*	42 0 0
MA70	12 10 0	14 10 0	20 0 0	17 12 6	—	—	16 10 0	20 0 0
AT60 Mk II	13 10 0	15 15 0	21 7 6	19 0 0	18 0 0*	—	17 12 6	21 10 0
GL75	33 0 0	35 0 0	40 10 0	47 0 0*	42 10 0	40 0 0	57 0 0*	40 10 0
SL72B	25 0 0	27 0 0	32 10 0	30 10 0	34 10 0	34 0 0	29 0 0	32 10 0
SL75B	31 0 0	33 0 0	33 10 0	36 10 0	40 10 0	40 0 0	35 0 0	38 10 0
SL95B	39 0 0	41 0 0	46 10 0	53 10 0*	48 10 0	48 0 0	43 0 0	46 10 0
SL65B	15 19 6	18 0 0	23 10 0	21 10 0	20 10 0*	25 0 0	19 15 0	23 10 0
GL69	23 0 0	25 0 0	30 10 0	28 0 0	32 10 0*	30 0 0	47 0 0*	30 10 0

PLINTHS/COVERS DE LUXE TYPE FOR GARRARD DECKS £8.10.0 (STATE MODEL) P.P. 6/-
★ **STOCK LIST REF 16/17 FREE. 10 PAGES ALL HI-FI SPECIAL PRICES**

HENRY'S RADIO LTD.

Mail Order Dept, Electronic Components and Equipment, and Electronic Organ Dept.
303 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 1008/9
Open Mon-Sat. 9am—6pm. Thurs. 9am-1pm

High Fidelity and Audio Centre
309 EDGWARE ROAD, LONDON W2.
Telephone: 01-723 6963
Open all day Saturday.

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1

THE VALVE SPECIALISTS *Telephone 01-722-9090*

GLOUCESTER ROAD, LITTLEHAMPTON, SUSSEX. *Littlehampton 6743*

Please forward all mail orders to Littlehampton

Save postal costs! Cash and carry by callers welcome.

OA2	5/9	6BW6	12/9	6Y6G	8/-	20P4	15/6	6060	5/6	DY86	5/9	ECL85	11/-	GZ30	7/-	PCF801	7/-	RG1/240A		U191	12/6	AC113	5/-	BCY39	4/6	GET587	8/6	OC26	5/-
OB2	6/-	6BW7	11/-	6Y7G	12/6	20P5	18/-	7193	10/6	DY87	5/9	ECL86	8/-	GZ32	9/-	PCF802	9/-		39/6	U193	6/9	AC114	8/-	BC107	4/-	GET872	19/-	OC28	5/-
OZ4	4/6	6C4	5/-	7B6	10/9	25L6GT	5/6	7475	4/-	E80F	24/-	ECLL800		GZ33	12/6	PCF805	11/6	RK34	7/6	U251	14/6	AC127	2/6	BC108	3/6	GET873	3/-	OC29	23/6
1A3	4/6	6C6	3/9	7B7	7/-	25Y5	8/-	A1834	20/-	E83F	24/-		30/-	GZ34	10/-	PCF806	11/6	SP13C	12/6	U282	8/-	AC154	5/-	BC113	5/-	GET874		OC35	5/-
1A5	5/-	6C9	14/6	7C6	6/-	25Y5G	8/6	A2134	10/-	E88CC	12/-	EF22	12/6	GZ37	14/6	PCF808	12/6	SP42	12/6	U282	8/-	AC156	4/-	BC115	3/-		23/6	OC36	7/6
1A7GT	7/3	6CD6G	19/6	7H7	5/6	25Z4G	6/-	A3042	15/-	E180F	17/6	EF36	3/6	HABC80	8/-	PCH200	12/3	SP61	3/3	U301	11/-	AC157	5/-	BC116	5/-	GET8821	0/-	OC38	9/6
1C5	4/9	6CH6	6/-	7R7	12/-	25Z5	7/-	AC2PEN		E1148	10/6	EF37A	7/-	HL13C	4/-	PCL82	7/-	TH4B	10/-	U329	14/6	AC165	5/-	BC118	4/6	GET887	4/6	OC41	10/-
1D5	6/9	6CL6	8/6	7V7	5/-	25Z6G	8/6		19/6	EA50	1/6	EF39	5/-	HL23DD	5/-	PCL83	9/-	TH233	7/-	U403	6/6	AC166	5/-	BCZ11	3/6	GET889	4/6	OC42	12/6
1D6	9/6	6CW4	12/-	7Y4	6/6	30C1	6/6	AC2PEN/		EA76	13/-	EF40	8/9	HL41DD		PCL84	7/6	TP2620	8/9	U404	7/6	AC167	12/-	BD119	9/-	GET890	4/6	OC43	23/6
1FD1	6/6	6D3	7/6	9BW6	7/-	30C15	13/-	DD	19/6	EABC80	6/-	EF41	10/-		19/6	PCL85	9/-	UABC80	6/-	U801	19/6	AC168	7/6	BF154	5/-	GET896	4/6	OC44	2/-
1FD9	4/3	6D6	3/-	9D7	9/-	30C17	16/-	AC6PEN	4/9	EAC91	3/-	EF42	3/6	HL42DD	8/-	PCL86	8/6	UAF42	9/6	U4020	6/9	AC169	6/6	BF159	5/-	GET897	4/6	OC44PM	8/3
1G6	6/-	6F1	8/9	10C1	12/6	30C18	11/6	AC/PEN (5)		EAF42	8/9	EF54	10/-	HN309	27/4	PCL88	15/-	UB41	6/6	VP2	3/6	AC176	11/-	BF163	4/-	GEX13	3/6	OC45	1/9
1H5GT	7/-	6F6	12/6	10C2	10/-	30F5	16/-		19/6	EB34	3/-	EF73	6/6	HVR2	8/9	PEN45	7/-	UBC41	8/6	VP2B	9/6	AC177	5/6	BF173	7/6	GEX35	4/6	OC46	3/-
1L4	2/6	6F6G	4/-	10D1	8/-	30FL1	15/-	AC/PEN (7)		EB41	4/6	EF80	4/6	HVR2A	8/9	PEN46DD		UBC81	7/-	VP4B	10/6	ACY17	3/-	BF180	6/-	GEX36	10/-	OC65	22/6
1LD5	5/-	6F12	3/3	10D2	14/7	30FL12	16/-		19/6	EB91	2/3	EF83	9/6	1W3	5/6		12/-	UBF80	5/9	VP13C	7/-	ACY18	3/8	BF181	8/-	GEX45	6/6	OC70	2/3
1LN5	8/-	6F13	3/6	10F1	15/-	30FL14	12/6	AC/TH110/-		EBC41	9/6	EF85	5/3	IW4/350	5/6	PEN46	4/-	UBF89	6/9	VP23	2/6	ACY19	3/9	BF185	8/-	GEX55	15/-	OC71	2/-
1N5GT	7/9	6F14	15/-	10F9	9/-	30L1	6/3	AC/TP	19/6	EBC81	5/9	EF86	6/3	IW4/500	6/-	PEN453DD		UBL21	9/-	VP41	7/6	ACY20	3/8	BFY50	4/-	GT3	5/-	OC72	2/-
1R5	5/6	6F15	10/-	10F18	7/-	30L15	13/9	AC/VP2	10/6	EBC90	4/-	EF89	5/-	KT2	5/-		19/6	UC92	5/6	VR75	24/-	ACY21	3/9	BFY51	4/-	M1	2/10	OC73	16/-
1S4	4/9	6F18	7/6	10LD11	10/-	30L17	15/6	AL60	15/6	EBC91	5/6	EF91	3/3	KT8	34/6	PENA4	19/6	UCC84	8/-	VR105	5/-	ACY22	3/8	BFY52	4/6	M3	2/10	OC74	2/6
1S5	4/3	6F23	13/3	10P13	13/-	30P4	12/-	ARP3	7/-	EBF80	6/9	EF92	2/6	KT41	19/6	PEN/DD		UCC85	6/9	VR150	5/-	ACY28	4/-	BTX34/400		MAT100	7/9	OC75	2/-
1U4	5/9	6F24	11/9	10P14	12/6	30P4MR		ATP4	2/3	EBF83	8/-	EF97	10/-	KT44	20/-		4020	17/6	UCF80	8/3	VT61A	7/-	AD140	7/6		40/-	MAT101	8/6	OC76	2/6
2D21	5/6	6F25	13/-	12A6	3/6		17/6	AZ1	8/-	EBF89	6/3	EF98	10/6	KT61	12/-	PFL200	12/6	UCH21	9/-	VT501	3/-	AD149	8/-	BY100	3/6	MAT120	7/9	OC78	3/-
3A5	10/-	6F26	5/3	12AC6	7/-	30P12	13/9	AZ31	9/6	EBL21	11/-	EF183	6/-	KT63	4/-	PL33	19/6	UCH42	13/-	VU111	7/3	AD161	9/-	BY101	3/-	MAT121	8/6	OC78D	3/-
3B7	5/-	6F28	14/-	12AD6	6/-	30P19	12/-	AZ41	7/6	EC53	12/6	EF184	6/-	KT66	17/3	PL36	9/6	UCH81	6/6	VU120	12/-	AD162	9/-	BY105	3/6	OA5	5/6	OC79	3/-
3D6	3/9	6H6GT	1/9	12AE6	7/6	30PL1	15/-	BL63	10/-	EC54	6/-	EH90	7/6	KT74	12/6	PL81	7/3	UCL82	7/-	VU120A	12/-	ADT140	12/6	BY114	3/6	OA9	2/6	OC81	2/-
3Q4	6/6	6J5G	3/9	12AT6	4/6	30PL13	15/6	CL33	18/6	EC70	4/9	EK90	4/9	KT76	12/6	PL81A	10/6	UCL83	10/-	VU133	7/-	AF102	18/-	BY126	3/-	OA10	8/6	OC81D	2/-
3Q5GT	6/-	6J6	3/-	12AT7	3/9	30PL14	15/-	QV6	10/6	EC86	12/6	EL32	3/6	KT88	29/-	PL82	6/6	UF41	10/-	W76	5/9	AF106	10/-	BY127	3/6	OA47	2/-	OC81M	5/-
3S4	5/9	6J7G	4/9	12AU6	4/9	30PL15	15/-	CY1C	10/6	EC88	12/-	EL33	12/-	KTW61	8/6	PL83	6/6	UF42	9/-	W81M	6/-	AF114	4/-	BYY23	20/-	OA70	3/-	OC82	2/3
3V4	5/9	6J7GT	6/6	12AU7	4/6	35A3	9/-	CY31	7/6	EC92	6/6	EL34	10/6	KTW62	10/-	PL84	6/6	UF80	6/9	W107	7/-	AF115	4/3	BYZ10	5/-	OA73	3/-	OC82D	2/3
5R4GY	8/9	6K7G	2/-	12AV6	5/6	35A5	15/-	D63	5/-	EC931	15/6	EL37	17/3	KTW63	5/9	PL302	12/-	UF85	6/9	W729	10/-	AF117	4/6	BYZ11	5/-	OA79	1/9	OC83	2/-
5U4G	5/6	6K7GT	4/6	12AX7	4/6	35D5	12/6	D77	2/3	ECC32	4/6	EL41	10/3	L63	3/9	PL500	13/-	UF86	9/-	XE3	£5	AF119	3/-	BYZ12	5/-	OA81	1/9	OC84	3/-
5V4G	7/6	6L1	19/6	12AY7	9/9	35L6GT	8/6	DAC32	7/-	ECC33	31/6	EL42	9/9	LN152	6/6	PL504	13/6	UF89	6/9	XFY12	9/6	AF121	6/-	BYZ13	5/-	OA85	1/6	OC123	4/6
5Y3GT	5/6	6L6GT	7/9	12BA6	6/-	35W4	4/6	DAF91	4/3	ECC34	29/6	EL81	8/-	LN309	9/-	PL505	28/9	UL41	10/6	XH1.5	9/6	AF124	7/6	BYZ15	35/-	OA86	4/-	OC139	12/-
5Y4G	7/6	6L1	19/6	12AY7	9/9	35L6GT	8/6	DAC32	7/-	ECC33	31/6	EL42	9/9	LN319	15/-	PL508	27/10	UL46	12/6	X41	10/-	AF126	5/-	CG12E	4/-	OA90	2/6	OC140	19/-
5Y3GT	5/6	6L6GT	7/9	12BA6	6/-	35W4	4/6	DAF91	4/3	ECC34	29/6	EL81	8/-	LN339	15/-	PL509	28/9	UL84	6/6	X61	5/9	AF139	13/-	CG64H	4/-	OA91	1/9	OC169	3/6
5Z3	8/-	6L7GT	12/6	12BE6	5/9	35Z3	10/-	DAF96	6/6	ECC40	9/6	EL83	6/9	MK1400	14/9	PL802	15/-	UM80	6/6	X65	5/-	AF167	13/6	F8Y11A	4/6	OA95	1/9	OC172	4/-
5Z4G	7/-	6L18	6/-	12BH7	6/-	35Z4GT	4/9	DCC90	10/-	ECC81	3/9	EL84	4/9	MHL4	12/6	PM84	7/9	UR1C	10/6	X66	7/6	AF179	13/6	F8Y28A	4/6	OA200	1/-	OC200	4/4
6/30L2	12/6	6L19	19/-	12E1	17/-	35Z5GT	6/-	DD4	10/6	ECC82	4/6	EL85	7/6	MHLD6	7/6	PX4	14/-	UU5	7/-	X101	30/6	AF180	9/6	GD4	6/6	OA202	2/-	OC201	5/6
6A8G	5/6	6LD20	9/6	12J7GT	6/6	50B5	6/3	DF33	7/9	ECC83	4/6	EL86	8/-	MU12/14	4/-	PY32	10/-	UU6	14/-	X109	26/-	AF181	14/-	GD5	5/6	OA210	9/6	OC202	4/6
6AC7	3/-	6N7GT	8/6	12K5	10/-	50C5	6/3	DF91	2/9	ECC84	5/6	EL91	2/6	MX40	12/6	PY33	10/-	UU9	7/3	Z329	15/-	AF186	11/-	GD6	5/6	OA211	13/6	OC203	4/6
6AG5	3/6	6P1	12/-	12K7GT	5/9	50CD6G	48/3	DF96	6/6	ECC85	5/6	EL95	5/3	N78	40/3	PY80	6/-	UU12	4/9	Z749	13/3	AF239	7/6	GD8	4/-	OAZ200	12/-	OC204	5/6
6AK5	5/-	6P25	12/-	12Q7GT	4/6	50L6GT	9/-	DF97	10/-	ECC86	8/-	EM80	7/-	N108	27/10	PY81	5/3	UY1N	9/-	Z759	45/-	AF27	8/6	GD9	4/-	OAZ201	10/6	OC205	7/6
6AK6	6/-	6P26	12/-	12SA7GT		72	6/6	DH63	6/-	ECC88	7/-	EM81	7/6	N118	6/6	PY82	5/-	UY21	9/6	*Transistors*		A8Y28	6/8	GD10	4/-	OAZ202	9/-	OC206	10/-
6AL5	2/3	6P28	25/-		6/8	85A2	8/6	DH76	4/6	ECC189	9/6	EM84	6/6	N139	25/-	PY83	5/9	UY41	7/-	*and diodes*		A8Y29	10/-	GD11	4/-	OAZ203	9/6	OC812	8/-
6AM4	16/6	6Q7G	6/-	12SC7	4/-	85A3	8/-	DH77	4/-	ECC804	12/6	EM85	11/-	P61	2/6	PY88	6/9	UY85	5/9	1N1124	10/6	AY100	26/-	GD12	4/-	OAZ204	9/-	OCP71	27/6
6AM6	3/8	6Q7GT	8/6	12SG7	3/-	90AG	67/6	DH81	10/9	ECC807	27/-	EM87	7/6	Q875/20		PY300	12/6	U10	9/-	2G225	10/6	B1181	10/-	GD14	10/-	OAZ205	9/-	ORP12	8/6
6AQ5	5/6	6R7G	7/-	12SH7	3/-	90AV	67/6	DH101	25/-	ECF80	6/6	EY51	7/6		10/6	PY301	12/6	U11	9/-	2G360	10/6	BA102	9/-	GD15	8/-	OAZ206	9/-	S6M1	5/-
6AR6	20/-	6R7	11/-	12SJ7	4/6	90CG	34/-	DK32	7/3	ECF82	6/6	EY81	7/-	P8AC80	7/3	PY800	7/6	U12/14	7/6	2N404	6/-	BA115	2/8	GD16	4/-	OAZ207	10/6	S8X1/6	3/6
6AT6	4/-	6S4A7GT	7/-	12SK7	4/9	90CV	33/6	DK40	10/-	ECF86	9/-	EY83	8/3	Q8150/15		PY801	6/9	U16	15/-	2N966	10/6	BA116	5/-	GET111		OAZ210	7/-	SM1036	10/-
6AU6	5/-	6S7GT	6/6	12SQ7GT	7/6	90C1	16/-	DK91	5/6	ECF804		EY84	7/6		9/6	PZ30	9/6	U17	5/-	2N1756	10/-	BA129	2/6		15/6	OAZ213	7/-	ST1276	10/-
6AV6	5/6	6S8G7	6/-	14H7	9/6	150B2	14/6	DK92	9/-		42/-	EY86	6/6	QQV03/10		U22	7/9	2N2297	4/6	BA130	2/-	GET113	4/-	OAZ22416/6		UI4706	5/-
6B8G	2/6	6S8H7	3/-	1487	15/-	150C2	5/9	DK96	7/-	ECH21	12/6	EY87	6/6	27/6		U25	13/-	2N2369A	4/3	BCY10	5/-	GET11517/-		OC19	25/-	XZ30	5/-
6BA6	4/6	6S8J7	6/6	18	12/6	301	20/-	DL33	6/-	ECH35	5/9	EY88	7/6	Q875/20		U26	11/9	2N2613	7/9	BCY12	5/-	GET116	6/6	OC22	5/-				
6BE6	4/9	6S8K7	4/6	19AQ5	4/9	302	16/6	DL35	4/9	ECH42	12/6	EY91	3/-		10/6	U31	6/-	2N3053	6/6	BCY33	5/-	GET118	4/-	OC23	5/-	Y543	3/6
6BH6	7/6	6S8N7GT	4/6	19H1	40/-	303	15/-	DL92	5/9	ECH81	5/9	EZ35	5/-	PACC80	7/3	U33	29/6	2N3121	50/-	BCY34	4/6	GET119	4/-	OC24	5/-	Y728	3/6
6BJ6	8/6	6S8Q7	7/6	20D1	13/-	305	16/6	DL94	5/9	ECH83	8/-	E240	7/6	Q8150/15		U35	18/6	2N3703	3/9	BCY38	5/-	GET573	7/6	OC25	5/-	ZE12V7	1/9
6BQ5	4/9	6U4GT	12/-	20D4	20/5	306	13/-	DL96	7/-	ECH84	7/6	EZ41	8/6		9/6	U37	34/11	2N3709	4/-										
6BQ7A	7/-	6U7G	7/-	20F2	14/-	807	11/9	DM70	6/-	ECL80	6/6	EZ80	4/6	Q8150/15		U45	15/6	2N3866	20/-										
6BR7	8/6	6V6G	3/6	20L1	18/-	956	2/-	DM71	7/6	ECL82	6/-	EZ81	4/9		9/6	U47	13/-	2N3988	10/-										
6BR8	8/-	6X4	4/3	20P1	17/6	1821	10/6	DW4/350		ECL83	9/-	EZ90	4/3	R10	15/-	U49	11/9	28323	10/-										
6B87	16/6	6X5GT	5/-	20P3	18/-	5763	10/-		8/6	ECL84	12/-	FW4/500	6/6	R11	19/6	U50	5/6	AA119	3/-										
														R19	6/6	U76	4/9	AA129	3/-										
														R20	11/9	U78	4/3	AAZ13	3/6										
														R52	7/6	U107	18/3	AC107	3/-										

All goods are new and subject to the manufacturers' guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life. Business hours Mon.-Fri. 9-5.30 p.m. Sats. 9-1 p.m. Littlehampton closed Sats. Terms of business. Cash with order only. Post/packing 6d. per item. Orders over £5 post/packing free. All orders cleared same day by first-class mail. Any parcel insured against damage in transit for only 6d. extra. Complete catalogue of valves, transistors and components with conditions of sale, price 10d. post free. No enquiries answered unless S.A.E. enclosed for reply.

MATCHED TRANSISTOR SETS:—
LP15 (AC113, AC154, AC157, AA120). 10/6.
1—OC44 and 2—OC45. 8/6.
1—OC81D and 2—OC81. 7/6.
1—OC82D and 2—OC82. 8/6.
1—OC83D and 2—OC83. 8/6.
S.T.C. 1 watt Zener Diodes. 2.4v., 2.7v., 3.0v., 3.6v., 4.3v., 13v., 15v., 16v., 18v., 3/6 each.

---

1. ULTRASONIC CLEANERS

(Burndept B.E.352) 60 watt model. Supplied Brand New complete with stainless steel tank 9¾ × 6½ × 4½ in. **£60.** Carr. 20/-.

2. **FAST NEUTRON MONITORS** (Burndept 1407C) for measuring neutrons in the energy range 0.15-15 meV. **£100.**

3. **Radiation Monitors** (Burndept BN 110 MK. V) 0-5/50/500/5k. c.p.s. Brand new. **£100.** Alpha and Beta Gamma probes available at extra cost.

4. **PORTABLE RADIATION MONITORS** (Burndept BN 132) 0-5/50/500/5k c.p.s. With built-in Gamma probe. Brand new. **£50** complete with carrying harness.

S.A.E. for literature. 10% discount for Educational Authorities

SPEAKERS

"E.M.I." 19 × 14 in. 50 watts. 8 ohm (14A/600A.) Four tweeters mounted across main axis. Separate "X-over" unit balances both bass and h.f. sections. 20 Hz. to 20,000 Hz. Bass unit flux 16,500 gss. A truly magnificent system. **£25.** P.P. 50/-.

"E.M.I." 13 × 8 in. 10 watts. 3/8/15 ohm. models. With two tweeters, plus "X-over". **65/-** ea. P.P. 5/-.

"E.M.I." 13 × 8 in. 10 watt 3/8/15 ohm. models less tweeters. **45/-** P.P 5/-.

"E.M.I." 6½ in. Rd. 10 watt woofers. 8 ohm. **30/-** ea. P.P. 2/6.

"FANE" 12 in. 20 watt. 15 ohm. (122/10A.) With integral tweeter. **£6** ea. P.P. 7/6.

CAR RADIO SPEAKERS. 3 ohm. 7 × 4 in. **14/-.** 8 × 5 in. **16/-.** P.P. 2/6.

SPEAKER SYSTEM (20 × 10 × 10 in.) Made to Spec. from ¾ in. board. Finished in black leathercloth. 13 × 8 in. speaker with twin tweeters complete with "X-over". 50 Hz. to 20,000 Hz. **£7 10s.** P.P. 10/-.

SPEAKER CABINET KIT. Above mentioned cabinet only. In kit form which you may assemble and cover to your own choice. **40/-.** P.P. 5/-.

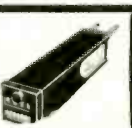
EXTRACTOR FANS/BLOWERS

"AIRMAX" 7½ in. FAN. In aluminium diecast housing (9 in.). 240v. Brand new. **£4 10s.** P.P. 10/-.

"PLANNAIR" 5½ in. FAN. (Type 5 PL 121-122.) Diecast housing. 240v. Brand new. **£6.** P.P. 10/-.

"SOLARTRON" TANGENTIAL BLOWERS. Overall size 16 × 5¾ × 3½ in. Air outlet 12 × 1½ in. 240v. Brand new. **50/-** ea. P.P. 7/6.

HIGH SPEED MAGNETIC COUNTERS (4 × 1 × 1 in.) 4 digit. 6/12v. 24/48v. (state which), 6/6 ea. P.P. 1/-.



LEVEL METERS (1¼ × ¼ in.). 200 micro-amp. Made in Germany. **15/-** each.

PHOTOMULTIPLIERS 6262 and 6262b. **£15** ea.

RELAYS H.D. 2 pole 3 way 10 amp. contacts. 12v.w. **7/6** ea.

LIGHTWEIGHT RELAYS (with dust-proof covers) 4 c/o contacts. 24v. 500 ohm **7/6** ea.

SIGNAL GENERATOR (Type 801A). 10-300 Mc/s. in 4 bands Ext. 50 c/s.-10 kc/s. Output 200 m/v. **£50** ea. P.P. 25/-.

PRECISION CAPACITANCE JIGS. Beautifully made with Moore & Wright Micrometer Gauge. Type 1. 18.5 pf-1,220 pf. **£10** ea. Type 2 9.5 pf-11.5 pf. **£6** ea.

POT CORES TYPE LA 3. 10/- ea.

71 WAY PLUG & SOCKET (Painton Series 159). Gold plated contacts with hood & retaining clips. **30/-** pair.

50 WAY PLUG & SOCKET (U.C.L. miniature). Gold plated contacts **20/-** pair. 34 way version **15/-** pair.

LOGIC BOARDS with 31 ACY40s—38 diodes etc **20/-** ea. P.P. 2/6.

CO-AX RELAYS (magnetic devices) 1 change-over 12 v.w **20/-** ea.

ELECTRONIC ORGAN BUILDERS. We now have in stock P.C. boards built to computer standards. Each board is a complete 4 octave divider (4½ × 3 in.). All connection data supplied. **30/-** each. Set of 13 (gives 5 octaves to keyboard) **£16.**

DIODE LOGIC BOARDS contains 10 diode gating circuits which convert any one of 10 inputs into an equivalent binary code. **10/-** each.

TRANSFORMERS

L.T. TRANSFORMERS (shrouded). Prim. 200/250v Sec. 20/40/60v. 2 amp. **52/6.** P.P. 7/6.

L.T. TRANSFORMERS. Prim. 200/250v. Sec. 20/40v. 1.5 amp. **30/-.** P.P. 5/-.

"ADVANCE" CONSTANT VOLTAGE. Prim. 190/250v. ±15%. Sec. 115v. 2,250 watts. **£15** ea. P.P. 50/-.

L.T. TRANSFORMER 60v. 8 amp. **£5.** P.P. 15/-.

L.T. TRANSFORMER 20v. 1.5 amp. **15/-.** P.P. 2/6.

L.T. TRANSFORMER Prim. 200/250v. Sec. 0/25/35v. 30 amp. **£7.10.** P.P. 20/-.

STEP-DOWN TRANSFORMERS Prim. 200/250v. Sec. 115v. 1.25 amps, **25/-** ea. P.P. 5/-.

L.T. TRANSFORMERS Prim. 240v. Sec. 8/12/20/25v. 3.5 amp models **20/-**; 5 amp model **25/-.** P.P. 5/6.

L.T. TRANSFORMERS Prim. 240v. Sec 14v. 1 amp **10/-** ea. P.P. 2/6.

COPPER LAMINATE PRINTED CIRCUIT BOARD (8½ × 5½ × 1/16 in.), **2/6** sheet. 5 for **10/-.** Also 11 × 9 in., **4/-** ea., 3 for **10/-.**

ELECTRIC SLOTMETERS (1/-) 25 amp. L.R. 240v. A.C. **85/-** ea. P.P. 5/-.

QUARTERLY ELECTRIC CHECK METERS, 40 amp 240v. A.C., **20/-** ea P.P. 5/-.

"LONG LIFE" ELECTROLYTICS (screw terminal). 25,000 u.f. 40v. (4½ × 2½ in.). **20/-** ea. P.P. 2/6. 10,000 u.f. 75v. (4½ × 2½ in.) **17/6** ea. P.P. 2/6. 3,150 u.f. 40v. (4½ × 1½ in.). **15/-** ea. P.P. 2/6.

EXECUTIVE "SIXTY" AMPLIFIER. (60 w. r.m.s. into 8 ohm.) British designed and built. True hi-fi performance. Built-in filters to protect speakers. Three independently mixed inputs. High-Low impedance. Mic. Crystal-Ceramic-Magnetic Cartridge, or aux. equipment. **£58.** P.P. 50/-. S.a.e. literature.

TELEPHONE DIALS (New) 20/- ea.

RELAYS (G.P.O. '3000'). All types. Brand new from **7/6** each. 10 up quotations only.

EXTENSION TELEPHONE (Type 706) Black or 2 tone Grey. **65/-.** P.P. 5/-.

UNISELECTORS (Brand new) 25-way 75 ohm. 8 bank ½ wipe **65/-.** 10 bank ½ wipe **75/-.**

REED RELAYS 4 make 9/12v. (1,000 ohm.) **12/6** ea. 2 make **7/6** ea. 1 make 5/- ea. Reed Switches (1½ in.) **2/-** ea. £1 per doz.

SUB-MINIATURE REED RELAYS (1in. × ½in.). Weight ½ oz. Type 1. 960 ohm. 3/9v. 1 make. **12/6** ea. Type 2. 1800 ohm, 3/12v. 1 make. **15/-** ea.

SILICON BRIDGES. 100 P.I.V. 1 amp. (⅜ × ⅜ × ¾ in.). **8/6** ea.

COMPUTER BOARDS containing 4 thyristors (C.106B1) 200 P.I.V. 6 amp. 1-2N3705, and numerous other ultra-modern diodes, resistors, capacitors. **10/-** ea.

PATTRICK & KINNIE

81 PARK LANE · ROMFORD · ESSEX

ROMFORD 44473

R.S.C. SENSATIONAL HIGH FIDELITY STEREO 'PACKAGE' OFFERS

Matching as recommended for optimum performance. Compare prices with equipment and cabinets purchased individually.

★ Super 30 Amplifier (30 Watt) in veneered housing.
★ Goldring Transcription Turntable on Plinth.
★ Shure or Goldring Magnetic Pick-up Cartridge.
★ Pair of Stanway II Loudspeaker Units.

Special total price. Four fully wired units ready to "plug-in". Really superb performance. Send S.A.E. for leaflet. **86 Gns.** Carr. 30/-

'Package' prices apply providing all individual units are purchased from any branch within 3 months (see leaflet).

★ Super 30 Amplifier (30 Watt) in veneered housing.
★ Garrard SP25 Mk. II Turntable on Plinth.
★ Goldring CS90 Ceramic diamond tipped Cartridge.
★ Pair of Stanway II Loudspeaker Units.

Extremely Attractive Plinths finished in Teak or Afrormosia veneer. Tinted Transparent Plastic cover.

Special total price. Four fully wired units ready to "plug-in." **76 Gns.** Carr. 30/-

★ TA12 13 W Amplifier in veneered housing.
★ Pair of Dorchester Loudspeaker Units.
★ Garrard SP25 Mk II 4-speed Player on Plinth.
★ Goldring CS90 Ceramic P.U. Cartridge with diamond Stylus. Special total price. **53 Gns.** Carr. 25/-

Transparent Plastic cover **3 gns** extra inc. carr. Terms Dep. £10.0.3 and 9 monthly payments £5.15.5 (Total 59 Gns.) Carr. 25/-

As above but with Garrard 3000 and Sonotone 9TA cartridge in lieu of SP25 and C890. Special total price **47½ Gns.**

Transparent cover 3 gns. extra inc. carr. Carr. 25/-

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround or "L" indicates Roll Rubber surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Exceptional performance at low cost. Impedance 3 or 15 ohms.

Prices include carriage. PLEASE STATE IMPEDANCE

HF 510L 5"	10W	49/9	HF 105DL 10"	10W	£6/6/0
HF 801D 8"	8W	59/9	HF 120	12" 15W	79/9
HF 811D 8"	10W	£4/4	HF 120D	12" 15W	89/9
HF 102D 10"	10W	65/-	HF 126	12" 15W	£5/5/-
HF 100D 10"	15W	£4/19/9	HF 126D	12" 15W	£5/15/-

HIGH FIDELITY LOUDSPEAKER UNITS

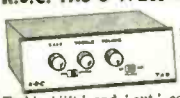
Cabinets of latest styling Satin Teak or Afrormosia veneer. Acoustically lined or filled with acoustic damping material. Ported where appropriate. Credit terms available.

DORCHESTER Size 16 × 11 × 9in. Appr. Range 45-15,000 c.p.s. Rating 8-10 watts. Fitted High flux 13 × 8in. Dual cone speaker. Impedance 3 or 15 ohms. **£8.19.9** Carr. 7/6

STANWAY II Size 20 × 10½ × 9½in. approx. Rating 10 watts. Inc. Pane 13 × 8in. speaker with highly flexible cone surround, long throw voice coil and 11,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 35-20,000 c.p.s. Impedance 15 Ω. Gives smooth realistic sound output. Inc. carr. **16Gns.**

F.A.L. "PHASE 100" AMPLIFIER Fully Transistorised (Silicon) 100 watt Music Rating. 4 individually controlled Jack Inputs. For 3-30 ohm Speakers. S.a.e. for leaflet. Only **59 Gns.**

R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER



200-250v. A.C. mains operated Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram. Radio or Tape. Input selector switch. Output for 3-15 ohm speakers. Max. sensitivity 5mV. Output rating I.H.F.M. In fully enclosed enamelled case, approx. 9½ × 2½ × 5½in. Attractive brushed silver finish facia plate 10½ × 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. Or factory built with 12 months' guarantee. £8.19.9. Carr. 7/6.

AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 11,000 line 15 watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction.

Or **SENIOR** 15 watt inc. HF 126 15,000 line Speaker **£8/15**. Carr. 6/6. Carr. 5/9 **£5.15.0**

HI-FI LOUDSPEAKER ENCLOSURES

Teak or Afrormosia veneer finish. Modern design. Acoustically lined. All sizes approx. Prices inc. carr.

JE8 Size 16 × 11 × 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£4.14.6**

SE8 For optimum performance with any 8in. Hi-Fi speaker. 22 × 15 × 9in. Ported **£5.15.0**

SE10 For outstanding results with Hi-Fi 10in. speaker. 24 × 15 × 10in. Ported **£5.19.9**

SE12 For high performance with 12in. Hi-Fi speaker and Tweeter. Size 25 × 16 × 10½in. Pressurised. **£6.19.9**

THE 'YORK' HIGH FIDELITY 3 'SPEAKER SYSTEM

• Moderate size approx. 25 × 14 × 10 in. • Range 30-20,000 Complete kit, c.p.s. Impedance 15 ohms. • Performance comparable with units costing considerably more. Consists of (1) 12 in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. **20 Gns.**

REMARKABLE VALUE — HEAR IT AT ANY BRANCH

RSC TA12 Mk II 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL

Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3-15 ohms ★ For 200-250 v. A.C. mains ★ Frequency Response 30-20,000 c.p.s. —2dB ★ Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise —70dB ★ Sensitivities (1) 300 mV (2) 50 mV (3) 100 mV (4) 2 mV ★ Handsome brushed silver finish Facia and Knobs. Output rating I.H.F.M. Complete kit of parts with full wiring diagrams and instructions. 13½ GNS. Carr. 7/9. Factory built with 12 mth. gntee. **17 GNS.** Or Dep. £5/2/8 and 9 mthly pymts. 34/- (Total £20/8/6). Or in Teak or Afrormosia veneer housing 20½ GNS. or Dep. £5/10/6 and 9 mthly. pymts. £2/1/7 (Total £24/4/9).

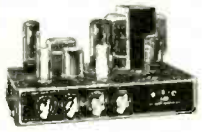
R.S.C. BATTERY/MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.5 v. and 90 v. where A.C. mains 200/250 v. 50 c/s. is available. Complete kit with diagram 52/6 or, Ready for use, **3 GNS.**

SELENIUM RECTIFIERS

F.W. Bridged 6/12v. D.C. Output Input Max. 18v. A.C. 1a., 4/3; 2a., 6/11; 3a., 9/9; 4a., 12/9; 6a., 15/9.

R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



Highly sensitive. Push-Pull high output. with Pre-amp./Tone Control Stages. Performance figures: Hum level —70dB. Frequency response ±3dB 30-20,000 c/s. Sectionally wound output transformer. All high grade components. Valves EF86, EF86, ECC83, 807. 807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 millivolts. Suitable for High Impedance mic. or pick-ups. Designed for Clubs, Schools, Theatres, Dance Halls or Outdoor Functions, etc. For use with Electronic Organ, Guitar, String Bass, etc. Gram. Radio or Tape. Reserve L.T. and H.T. for Radio Tuner. Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250 v., 50 c/s. A.C. mains. For 3 and 15 ohm speakers. Complete Kit parts wiring diags., instructions. Twin-handled perforated cover 27/6. Or factory built with EL34 output valves and 12 months' guarantee for 18 gns. Tech. figs. apply to factory built units. Carr. 12/6. **15 Gns.**

TERMS: Deposit £6.3.0 and 9 monthly payments of 34/- (Total £21/9/0.) Send S.A.E. for leaflet.

R.S.C. MAINS TRANSFORMERS

FULLY GUARANTEED. Interleaved and impregnated. Primaries 200-250v. 50c/s. Screened

MIDGET CLAMPED TYPE 2½ × 2½ × 2½in.

250 v., 60 mA, 6.3 v. 2 a.	17/11
250-0-250v., 60mA, 6.3v. 2a.	18/11

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250v. 60mA., 6.3v. 2a., 0-5-6.3v. 2a.	24/9
250-0-250v. 100mA. 6.3v. 4a., 0-5-6.3v. 3a.	39/9
300-0-300v. 100mA. 6.3v. 4a., 0-5-6.3v. 3a.	39/9
300-0-300v. 130mA. 6.3v. 4a., c.t., 6.3v. 1a. For Mullard 510 Amplifier	47/11
350-0-350v. 100mA., 6.3v. 4a., 0-5-6.3v. 3a.	39/9
350-0-350v. 150mA. 6.3v. 4a., 0-5-6.3v. 3a.	47/9
425-0-425v. 200mA. 6.3v. 4a. c.t., 5v. 3a	89/9
425-0-425v. 200mA, 6.3v. 4a., 6.3v. 3a, 5v. 3a	93/9
450-0-450v. 250mA. 6.3v. 4a., ct., 5v. 3a.	99/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250v. 70mA, 6.3v. 2a., 0-5-6.3v. 2a.	23/9
250-0-250v. 100mA. 6.3v. 3.5a.	27/9
250-0-250v. 100mA, 6.3v. 2a., 6.3v. 1a.	28/9
350-0-350v. 80mA, 6.3v. 2a., 0-5-6.3v. 2a.	29/11
250-0-250v. 100mA. 6.3v. 4a., 0-5-6.3v. 3a.	39/9
300-0-300v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a.	39/9
300-0-300v. 130mA, 6.3v. 4a., 0-5-6.3v. 1a. Suitable for Mullard 510 Amplifier	46/9
350-0-350v. 100mA., 6.3v. 4a., 0-5-6.3v. 3a.	39/9
350-0-350v. 150mA., 6.3v. 4a., 0-5-6.3v. 3a.	46/11

FILAMENT or TRANSISTOR POWER PACK Types 6.3 v. 1.5a. 8/9; 6.3v. 2a. 9/9; 6.3v. 3a. 13/9; 6.3v 6a. 22/9; 12v. 1a. 9/11; 12v. 3a. or 24v. 1.5a. 23/9; 0-9-18v. 1½a. 19/11; 0-12-25-42v. 2a. 31/9.

CHARGER TRANSFORMERS 0-9-15v. 1½a. 18/9; 2½a 19/11; 3a. 21/11; 5a. 25/11; 6a. 29/9; 8a. 36/9.

AUTO (Step UP/Step DOWN) TRANSFORMERS 0-110/120v.-200-230-250v. 50-80 watts 19/9; 150 watts, 33/6; 250 watts 49/9; 500 watts 105/-

OUTPUT TRANSFORMERS

Standard Pentode 5,000Ω or 7,000Ω to 3Ω	8/9
Push-Pull 8 watts EL84 to 3Ω or 15Ω	14/9
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15Ω	24/9
Push-Pull EL84 to 3 or 15Ω 10-12 watts	23/9
Push-Pull Ultra Linear for Mullard 510, etc.	39/9
Push-Pull 15-18 watts, sectionally wound 6L6 KT66, etc., for 3 or 15Ω	35/9
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66, etc. to 3 or 15Ω	59/9

SMOOTHING CHOKES

150mA. 7-10H. 250Ω 12/9; 100mA, 10H. 200Ω 10/9; 80mA, 10H, 350Ω. 8/9; 60mA, 10H. 400Ω 4/11.

INTEREST CHARGES REFUNDED

On Credit Sales settled in 3 months.

R.S.C. A11 HIGH FIDELITY 12-14 WATT AMPLIFIER

Push-pull ultra linear output "built-in" tone control pre-amp. Two input sockets with associated controls allowing mixing of "mike" and gram, etc. etc. High sensitivity. 5 valves—ECC83 (2), EL84 (2), EZ81. High quality sectionally wound output transformer. IND. BASS AND TREBLE CONTROLS. Frequency response ±3dB 30-20,000 c/s. Hum level—60dB. SENSITIVITY 40 millivolts. For Crystal or Ceramic PUs. High Impedance "mikes". For Musical Instruments such as String Bass, Electronic Guitars, etc. Size approx. 12 × 9 × 7in. For AC mains 200-250v. 50 cps. Output for 3 and 15 ohm spkrs. S.A.E. for leaflet. Complete kit **9½ Gns.**

Full instructions and point-to-point wiring diagrams. Carr. 11/6 (or factory built Full instructions and point-to-point wiring diagrams. Carr. 11/6 (or factory built Twin handled metal cover 27/6. Terms on assembled units. Deposit 99/6 and 9 monthly payments of 26/-. (Total £16/13/6. RSC A11T transistorised version of above complete kit 9 Gns. (Assembled 13 gns.)

R.S.C. COLUMN SPEAKERS

Covered in two-tone Rexine/Vynair, ideal for vocalists and Public Address. 15 ohm matching.

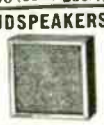
TYPE C57 15 watts inc. five 7 × 4in. spkrs. £7/19/11.

TYPE C48S, 30 watts. Fitted four 8in. high flux 8 watt speakers. Overall size approx. 42 × 10 × 5in. 16 Gns. Or deposit 67/- and 9 mthly pmts. 34/9 (Total £18/19/9). Carr. 10/-.

TYPE C412S, 50 watts. Fitted four 12in. 11.000 lines 15 watt speakers. Overall size 56 × 14 × 9in. approx. 26 Gns. Or deposit £5/17/6 and 9 monthly payments Carr. 15/- of 54/6 (Total £30/7/-).

7 Gns.

High Quality LOUDSPEAKERS



In teak or afrormosia veneered cabinets. L13 13" × 8" 10 Watt Model Gauss 10,000 lines, 3 or 15 ohms. Carr. 7/6. **£4/19/9**

L12 12" 20 Watt Model. 15 ohm. Size 18 × 18 × 10in. approx. Gauss 10,000 lines. Rexine covered 10/- extra. Carr. 8/9 **£8/19/9**

FANE ULTRA HIGH POWER L'SPEAKERS

High flux ceramic magnets. Imp. 8-15 Ω. 2 yrs. guarantee.

12" 50w 10Gns.
15" 60w 12Gns.
18" 100w 21Gns.

All carr. free

W.B. 'STENTORIAN' HI-FI 10" SPEAKERS HF1012 £4.19.9

10w 3 or 15 ohms. Cambric Cone. Cast chassis. Mail Order only

R.S.C. TFM1 SOLID STATE VHF/FM RADIO TUNER

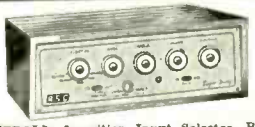
★ High-sensitivity. ★ 200-250v. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Output ample for any amplifier (approx. 500 m.v.). ★ Output for feeding Stereo Multiplexer. ★ Tuner head using silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input. Visually matching our Super 15 and 30 amplifiers. Printed circuitry. A quality product at considerably less than the cost of comparable units. Factory built 18 gns. Or in Teak finished cabinet as illustrated 21 gns. Terms: Deposit £6/1/- and 9 monthly payments £2/2/-. Total £24/19/-. STEREO VERSION 23½ gns. or in Cabinet 26½ gns. All prices include carriage.

R.S.C. SUPER 30 MK II HIGH FIDELITY STEREO AMPLIFIER

HIGH GRADE COMPONENTS.
SPECIFICATIONS COMPARABLE WITH UNITS COSTING CONSIDERABLY MORE

Employing Twin Printed Circuits 200/250v. A.C. mains operation.

TRANSISTORS: 9 high-quality types per channel.
OUTPUT: 10 Watts R.M.S. continuous into 15 Ω (Per channel) 15 Watts R.M.S. continuous into 3 Ω
INPUT SENSITIVITIES: Mag. P.U. 4 m.v. Ceramic P.U. 35 m.v. Tape Amp. 400 m.v. Aux. 100 m.v. Mic. 5 m.v. Tape Head 2.5 m.v.
FREQUENCY RESPONSE: ±2dB. 10-20,000 c.p.s.
TREBLE CONTROL: +17 dB to —14 dB at 10 Kc/s.
BASS CONTROL: +17 dB to —15 dB at 50 c/s.
HUM LEVEL: —80 dB.
HARMONIC DISTORTION: 0.1% at 10 Watts 1,000 c.p.s.
CROSS TALK: 52 dB at 1,000 c.p.s.



CONTROLS: 5-position Input Selector, Bass, Treble, Vol., Bal., Stereo/Mono Sw., Tape Monitor Sw., Mains Sw.
INPUT SOCKETS: (1) P.U. (2) Tape Amp. (3) Radio (4) Mic. or Tape Head. (Operation of Input Selector assures appropriate equalisation.)
CHASSIS: Strong Steel construction. Approx. 12 × 3 × 8 in.
FACIA PLATE: Attractive design in rigid Perspex. 8pun silver matching control knobs as available.

EMINENTLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MIC. (Ceramic or Magnetic Moving Coil, Ribbon or Crystal.)
CURRENTLY AVAILABLE. SUPERB SOUND OUTPUT QUALITY CAN BE OBTAINED BY USE WITH FIRST-RATE ANCILLARY EQUIPMENT.

COMPLETE KIT OF PARTS, point to point wiring diagrams & detailed instructions. **22 Gns.** Carr. 15/-.

UNIT FACTORY BUILT 29 Gns. or Deposit £7/5/- and 9 mthly. payments 58/9 (Total £33/13/9) or in Teak or Afrormosia veneer housing 32 gns. Carr. 15/-. Terms: Deposit £7/3/6 and 9 mthly. payments 66/6 (Total £37/2/-.) Send S.A.E. for leaflet.

R.S.C. SUPER 15 HIGH FIDELITY AMPLIFIER

Solid state. Approx. as Super 30 but single channel. Complete kit with full constructional details and point to point wiring diagrams. Carr. 12/6. **12½ Gns.**

Or factory built: 15½ Gns., Carr. 12/6. Terms: Deposit 4 Gns. and 9 monthly payments 31/1 (Total £18/3/9); or in Teak or Afrormosia veneered housing 19 Gns.

R.S.C. PLINTHS

for Record Playing units. Cut for Garrard 1025, 2025, 3000, 59/9 AT60, SP25 etc. etc. Available with Transparent plastic cover. Prices inc. carr. **6 Gns.**

Record Playing Units

MONEY SAVING UNITS Ready to plug into Amplifier.

RP2C Consisting of Garrard SP25 Mk. II (with heavy turntable fitted Goldring C890 high compliance ceramic Stereo/Mono cartridge with diamond stylus. Mounted on plinth. Transparent plastic cover included. **23 Gns.** Inc. carr.

RP5C Garrard 2025 Auto Unit fitted GC823 Stereo Cartridge with diamond tip. Plinth and Cover as RP2C. Inc. Carr. **15 Gns.**

Various other types with Magnetic P.U. Cartridges and 'Lift off' or 'Roll over' transparent covers at lowest prices.

FANE 'POP' 30C LOUDSPEAKER

12" 25 w 15Ω Dual cone

Post Free **£5.19.9**

BRADFORD 10 North Parade (Half-day Wed.). Tel. 25349

BLACKPOOL (Agent) O & C Electronics 227 Church St.

BIRMINGHAM 30/31 Gt. Western Arcade. Tel.: 021-236 1279. Half-day Wed.

DERBY 26 Osmaston Rd. The Spot (Half-day Wed.). Tel. 41361

DARLINGTON 18 Priestgate (Half-day Wed.). Tel. 68043

EDINBURGH 133 Leith St. (Half-day Wed.). Tel. Waverley 5766

GLASGOW 326 Argyle St. (Half-day Tues.). Tel. CITy 4158

HULL 91 Paragon Street (Half-day Thurs.). Tel. 20505

R·S·C HI-FI CENTRES LTD.

MAIL ORDERS to: 102-106 Henconner Lane, Leeds 13. No C.O.D. under £1. Terms C.W.O. or C.O.D. Postage 4/6 extra under £2. 5/9 extra under £5. Trade supplied. S.A.E. with enquiries Branches open all day Sats. MAIL ORDERS MUST NOT BE SENT TO SHOPS.

32 High Street (Half-day Thurs.). Tel. S6420 LEICESTER

5-7 County (Mecca) Arcade, Briggate (Half-day Wed.) Tel. 28252 LEEDS

73 Dale St. (Half-day Wed.). Tel. CENtral 3573 LIVERPOOL

238 Edgware Road, W.2 (Half-day Thurs.). Tel. PAD 1629 LONDON

60A Oldham Street (Half-day Wed.) Tel. CENtral 2778 MANCHESTER

106 Newport Rd. (Half-day Wed.). Tel. 47096 MIDDLESBROUGH

41 Blackett Street (opp. Fenwicks Store) (Half-day Wed.). Tel. 21469 NEWCASTLE UPON TYNE

13 Exchange Street (Castle Market Bldg.) (Half-day Thurs.). Tel. 20716 SHEFFIELD

New 1970 prices LST Electronic Components Ltd.

AC107	14/6	BD119	15/–	NKT123	6/–	OC72	4/6	2G306	8/6	2N3133	6/–	2S003	12/6		
AC126	5/–	BD121	18/–	NKT125	5/6	OC75	4/6	2G339A	5/–	2N3135	6/–	2S004	15/–		
AC127	5/6	BD123	21/6	NKT127	5/6	OC76	2/6	2G371	3/–	2N3136	6/–	2S005	15/–		
AC127Z	9/6	BD124	12/–	NKT128	5/6	OC77	5/6	2G371B	3/–	2N3235	28/6	2S006	15/–		
AC128	4/–	BF115	5/–	NKT129	6/–	OC81	4/6	2G374	5/–	2N3234	27/6	2S012	25/–		
AC176	5/–	BF152	13/6	NKT141	7/–	OC81D	3/–	2G378	7/–	2N3391A	6/–	2S012A	22/6		
AC187	12/–	BF154	9/–	NKT142	6/–	OC82	5/–	2G381	5/–	2N3392	5/–	2S017	15/–		
AC188	12/–	BF159	15/–	NKT143	5/6	OC82D	3/–	2N109	11/–	2N3393	5/–	2S018	17/6		
ACY17	5/–	BF163	9/–	NKT144	8/–	OC83	4/6	2N174	16/–	2N3394	4/9	2S019	19/6		
ACY18	3/6	BF167	5/–	NKT152	3/6	OC84	5/–	2N217	7/6	2N3402	5/6	2S104	12/6		
ACY19	4/5	BF173	6/–	NKT161	6/–	OC123	7/–	2N370	15/–	2N3403	5/6	2S301	8/6		
ACY20	3/7	BF178	10/6	NKT162	6/–	OC139	5/–	2N384	17/–	2N3404	7/6	2S302	7/6		
ACY21	4/–	BF179	12/6	NKT163	5/6	OC140	7/–	2N386	12/–	2N3414	5/6	2S303	10/–		
ACY22	2/9	BF180	6/–	NKT164	5/6	OC170	5/–	2N385A/		2N3415	6/–	2S304	12/6		
ACY40	3/–	BF181	6/6	NKT165	6/–	OC171	6/–	2N388A	15/–	2N3416	7/6	2S306	15/–		
ACY41	4/4	BF184	7/–	NKT211	6/–	OC200	6/3	2N404	4/6	2N3436	15/–	2S320	9/–		
ACY44	8/–	BF185	8/–	NKT212	6/–	OC201	9/6	2N410	8/–	2N3525	21/9	2S321	6/–		
AD140	11/–	BF194	3/6	NKT213	4/–	OC202	18/–	2N458A	25/–	2N3528	19/–	2S323	10/–		
AD149	11/6	BF200	10/6	NKT214	4/–	OC203	7/6	2N511A	49/6	2N3606	5/6	2S701	8/6		
AD161	6/–	BFX13	5/–	NKT215	4/–	OC204	8/–	2N513A	122/6	2N3607	4/6	2S703	12/6		
AD162	6/–	BFX29	8/–	NKT216	10/–	OC205	9/–	2N599	10/–	2N3702	3/3	2S720	25/–		
ADT140	12/6	BFX44	8/–	NKT217	13/–	OC206	10/6	2N601	25/–	2N3703	3/–	2S732	8/6		
AF102	12/6	BFX84	7/6	NKT218	5/3	OC207	7/6	2N657	20/–	2N3704	3/3	2S1002	10/–		
AF106	7/6	BFX85	9/–	NKT219	6/–	OC309	12/–	2N696	4/–	2N3705	3/–				
AF114	5/–	BFX86	6/6	NKT221	5/6	OCP71	19/6	2N697	4/–	2N3706	2/9	**DIODES AND RECTIFIERS**			
AF115	5/–	BFX88	5/–	NKT222	4/–	ORP12	9/6	2N698	6/–	2N3707	3/–				
AF116	5/–	BFY50	4/6	NKT223	3/6	ORP60	8/–	2N706	2/6	2N3708	2/–				
AF117	5/–	BFY51	3/9	NKT224	4/6	ORP61	8/–	2N706A	2/6	2N3709	3/–	AA119	2/–		
AF118	12/6	BRY52	4/6	NKT225	3/6	ORP63	9/–	2N708	4/–	2N3710	3/–	AAY11	2/–		
AF121	6/–	BFY53	3/3	NKT226	10/–	P346A	5/–	2N711	7/6	2N3711	3/–	AAZ12	6/–		
AF124	4/6	BFW57	6/–	NKT227	5/6	RAS310AF	6/–	2N711A	7/6	2N3819	8/–	AAZ13	2/6		
AF126	3/6	BFW58	5/6	NKT228	6/–	RAS508AF	15/–	2N715	7/6	2N3820	18/9	BA110	6/–		
AF127	3/6	BFW59	5/–	NKT261	4/3			2N716	7/6	2N3826	6/–	BA111	6/–		
AF139	7/6	BFW60	4/6	NKT262	4/3			2N743	4/6	2N3854	5/6	BA112	18/–		
AF178	9/6	BSX19	3 6	NKT264	4 3	S1M	19/–	2N744	6/–	2N3854A	5/6	BA115	1/6		
AF179	11/6	BSX20	3/4	NKT271	4/–	S4M	33/6	2N753	5/6	2N3855	5/6	BA130	3/–		
AF180	12/6	BSX21	7/6	NKT272	4/–	ST140	3/–	2N914	4/6	2N3855A	6/–	BAY31	2/6		
AF181	8/6	BSX76	4/–	NKT273	4/–	ST141	5/–	2N918	7/6	2N3856	6/–	BAY38	3/–		
AF186W	9/–	BSX77	6/–	NKT274	4/–	ST2	9/9	2N929	5/6	2N3856A	6/–	BY100	5/–		
AF186G	9/–	BSX78	6/6	NKT275	5/–	T1407	9/8	2N930	7/6	2N3858	5/–	BY125	3/6		
AF239	7/6	BSY27	4/–	NKT276	3/6	TIS34	17/6	2N1090	6/6	2N3858A	6/–	BY127	4/–		
AFY19	22/6	BSY29	5/–	NKT279A	2/6	TIS43	6/9	2N1091	6/6	2N3859	5/6	BY234	2/3		
AFZ11	8/–	BSY32	5/–	NKT281	5/–	TIS44	1/9	2N1131	6/6	2N3859A	6/3	BYX10	3/–		
ASY26	5/–	BSY36	5/–	NKT301	16/–	TIS45	3/3	2N1132	8/–	2N3860	6/–	BYX36			
ASY27	6/–	BSY37	5/–	NKT302	11/–	TIS46	3/3	2N1302	4/–	2N3866	25/–	150	2/6		
ASY28	5/–	BSY38	4/–	NKT303	10/–	TIS47	3/3	2N1303	4/–	2N3877	9/–	BYX36			
ASY29	6/–	BSY95A	3/6	NKT304	9/6	TIS48	3/3	2N1304	5/–	2N3877A	9/6	300	2/10		
ASZ21	7/6	BSW41	8/6	NKT351	8/–	TIS49	3/6	2N1305	5/–	2N3900	10/6	BYX36			
ATZ10	40/–	BSW70	5/6	NKT352	7 6	TIS50	5/6	2N1306	5/–	2N3900A	11/6	600	3/9		
AUY10	30/–	BTX39		NKT401	17/6	TIS51	4/–	2N1307	5/–	2N3903	7/–	BYY21	25/–		
B2M	12/6	600	120/–	NKT402	24/–	TIS52	4/–	2N1308	7/–	2N3904	7/–	BYY23	26/3		
B3M	15/–	BTX40		NKT403	15/–	TIS53	6/6	2N1309	7/–	2N3905	7/6	BYY25	31/9		
BC107	2/9	600	120/–	NKT404	12/6	TIS60	6/6	2N1496	34/–	2N3906	7/6	BYY142	3/9		
BC108	2/9	BTY87		NKT405	15/–	TIS61	7/–	2N1507	4/8	2N4037	15/–	BYZ10	9/–		
BC109	2/9	150R	31/–	NKT406	15/–	TIP31A	19/6	2N1613	5/6	2N4058	4/6	BYZ12	6/–		
BC113	5/–	C106F1	9/–	NKT451	12/6	TIP32A	22/6	2N1671A	29/6	2N4059	5/–	BYZ13	5/–		
BC115	6/6	C111	18/–	NKT452	12/6	TSW30C	18/–	2N1711	6/6	2N4060	5/–	CG6E	4/–		
BC116	8/–	C111E	12/–	NKT453	10/–	U23AAA	5/–	2N1893	10/–	2N4061	4/–	CG63	2/–		
BC118	5/–	C400	9/–	NKT613F	5/–	V20S	20/–	2N2147	17/–	2N4062	4/6	EA403	3/6		
BC125	11/–	C426	8/3	NKT674F		V405A	9/3	2N2152	27/6	2N4284	3/–	EC401	5/–		
BC126	11/–	C444	9/8	NKT675	5/–	XA102	6/–	2N2148	12/6	2N4285	3/–	EC402	4/8		
BC134	5/–	DI3TI	10/–	NKT676	5/–	XA702	15/–	2N2160	14/9	2N4286	3/–	EB383	3/6		
BC135	6/–	GET102	6/–	NKT677F	5/–	ZE12V7	3/6	2N2243	26/–	2N4287	3/–	GEX45/1	4/–		
BC136	8/–	GET113	4/–	NKT703	8/–	ZT22	19/–	2N2368	5/–	2N4288	3/–	GJ3M	4/–		
BC137	8/6	GET114	4/–	NKT713	7/6	ZT86	27/6	2N2369	5/–	2N4289	3/–	OA5	3/8		
BC138	12/–	GET120	6/6	NKT773	5/–	ZT2270	19/6	2N2369A	5/6	2N4290	3/–	OA10	6/–		
BC140	3/3	GET880	9/–	NKT10339		40250	12/6			2N4291	3/–	OA47	1/6		
BC147	2/9	GET887	4/–		6/6	40309	9/6	SN2432	67/–	2N4292	3/–	OA70	1/6		
BC148	3/3	GET889	6/–	NKT10419		40310	13/–	2N2484	8/–	2N4871	6/9	OA73	1/6		
BC149	3/–	GET890	6/6		6/–	40311	10/6	2N2613	7/6	2N5027	10/6	OA79	1/6		
BC154	12/–	GET896	4/6	NKT10429		40312	13/6	2N2614	4/–	2N5028	11/6	OA81	1/6		
BC167	3/6	GET897	4/6		11/–	40314	10/6	2N2646	10/–	2N5029	9/6	OA85	1/6		
BC168	3/9	GET898	6/–	NKT10519		40315	10/6	2N2711	6/–	2N5030	8/6	OA90	1/6		
BC169	3/9	GEX45/1	3/–		6/6	40316	13/–	2N2712	6/–	2N5172	3/–	OA91	1/6		
BC182L	3/–	MAT100	5/–	NKT16229		40317	11/–	2N2713	5/6	2N5174	10/6	OA95	1/6		
BC183L	2/6	MAT101	5/6		11/–	40319	15/–	2N2904	8/6	2N5175	10/6	OA200	2/–		
BC184L	3/–	MAT120	5/–	NKT20329		40320	10/6	2N2904A	8/–	2N5176	9/–	OA202	2/–		
BC212L	3/9	MAT121	5/6		11/–	40323	10/6	2N2905	10/–	2N5232	5/6	SD19	–/7		
BCY10	10/–	MJ400	21/6	OC20	19/6	40324	12/6	2N2905A	8/–	2N5249	13/6	TD716	12/–		
BCY12	12/–	MJ420	22/6	OC22	8/–	40326	10/6	2N2923	4/–	2N5249A	13/6	1N34A	4/–		
BCY30	5/–	MJ421	22/6	OC23	8/–	40329	7/6	2N2924	4/–	2N5305	7/6	1N60	4/–		
BCY31	3/6	MJ430	20/6	OC24	8/–	40344	8/–	2N2925	3/6	2N5306	8/–	1N64	4/–		
BCY32	10/–	MJ440	19/6	OC25	7/6	40347	9/6	2N2926		2N5309	12/6	1N82A	9/6		
BCY33	4/–	MJ480	20/6	OC26	6/6	40348	14/6	Green	2/–	2N5354	5/6	1N87A	4/6		
BCY34	5/–	MJ481	27/–	OC28	12/–	40360	11/6	2N2926		2N5355	5/6	1N191	5/–		
BCY38	6/–	MJ490	22/6	OC29	15/–	40361	12/–	Yellow	2/–	2N5356	10/6	1N914	1/9		
BCY40	10/–	MJ491	29/6	OC35	9/–	40362	14/–	2N2926		3N84	29/6	1N4001	2/–		
BCY42	4/–	MPF102	8/6	OC36	12/6	40370	8/6	Orange	2/–	3N128	18/6	1N4005	4/–		
BCY43	4/–	MPF103	7/6	OC41	4/6	40406	16/–	2N2926		3N140	19/6	1N4007	5/–		
BCY54	7/6	MPF104	7/6	OC42	4/6	40408	14/–	Brown	2/–	3N141	21/6	1N4148	1/9		
BCY70	4/6	MPF105	8/–	OC43	4/6	40467	16/6	2N3011	12/6	3N142	16/6	1S44	1/9		
BCY71	8/–	MPS3638	6/6	OC44	3/–	40468A	16/6	2N3036	39/–	3N143	19/6	1S130	2/–		
BCY72	4/–	NKT0013	9/6	OC45	3/–	40602	9/–	2N3053	5/–	3N152	24/–	1S131	2/6		
BCY87	86/9	NKT121	11/–	OC70	2/6	2G301	3/9	2N3054	12/6	2S001	10/–	1S132	3/–		
BCZ11	7/6	NKT122	8/–	OC71	3/–	2G302	3/9	2N3055	15/–	2S002	12/6	1S113	4/6		

LOWEST I.C. PRICES YET!

IC10	59/6	Sinclair IC amp.
PA230	20/–	IC Preamplifier
PA234	20/–	1 watt audio amp.
PA237	32/6	2 watt audio amp.
PA246	52/6	5 watt audio amp.
PA424	43/–	Zero voltage switch
SL403A	49/6	3 watt Plessey amp.
TAA263	15/–	Mullard linear amp.
TAD100	45/–	IC receiver
TAA293	20/–	Mullard gen. purp. amp.
TAA310	30/–	Record/Playback preamp.
TAA320	13/–	MOS LF amplifier
UL702C	29/6	Plessey linear amplifier

Data sheets available on request 1/– per copy.

PLEASE NOTE: Only new—full specification integrated circuits, no below-specification types.

FAIRCHILD MICRO-LOGIC

	1–6	7–11	12+
ul 900	9/9	9/–	8/–
ul 914	9/9	9/–	8/–
ul 923	12/6	11/9	11/–

Prices for 100+ and 1,000+ on application.
5 page data and circuits article—2/6.
Plastic spreaders—1/6 each.

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 trans-ducers can transmit and receive.
FREE: With each pair our complete transmitter and receiver circuit.
PRICE £5.18.0 Pair
(Sold only in pairs)

SC41D GE triac
400 piv 6 amp
37/-

2N3819 8/-
Texas FET
25+6/9 100+5/9

BRY45/400 21/3
Transistor size T05
Triac 400 piv 3 amp

2N4871 6/9
Motorola unijunction
25+5/9 100+4/8

BT102/500R 12/6
Mullard thyristor 500 piv 6·5 amp.
25+11/- 100+10/3

2N3055 15/-
115 watt silicon power transistor
25+13/- 100+11/-

IRC 20 8/6
Int. Rectifier thyristor 200 piv 1·2amp (similar C10881)
25+7/9 100+7/-

BC107/8/9 2/9
NPN Planar transistors
BC107 & 8 25+2/5 100+2/2
BC108 25+2/3 100+2/-

BY 127 4/-
Mullard Plastic HV rectifier 800 piv 1 amp (similar BY100 etc.)
25+3/3 100+3/-

2N2926 2/-
NPN Planar transistors
25+1/8 100+1/6

INFRA-RED DEVICES

56 CAY 29/6
Gallium arsenide emitter

MGA 100 35/-
Gallium arsenide emitter

31F2 28/6
Infra-red detector diode

AD161/2 10/-
Siemens/Telefunken NPN/PNP output pair
25+9/- 100+8/-

OCP 71 19/6
Mullard Phototransistor
25+17/3 100+14/9

Prices quoted are current at time of going to press and may be subject to variation without notice.
Semiconductors offered in this advertisement bear the relevant Manufacturers' original markings and are subject to our full replacement guarantee if not to published specifications.
WE DO NOT offer "Re-marked" makers' rejects or similar out of specification devices.
Please enclose a stamped self-addressed envelope with any query.
Quantity prices on application: many more types in stock and expected daily. If you buy in bulk we can save you money!
Export enquiries particularly welcome. Cable Address: Lestroco Brentwood.
TERMS OF BUSINESS: Retail orders; cash with order please.
TRADE: Please furnish references if credit account required.
POSTAGE: 1/- per order inland; 4/- Europe; 12/- Commonwealth.

ADDRESS YOUR ORDERS TO:

L.S.T. LTD. 7 COPTFOLD ROAD, BRENTWOOD, ESSEX

DIRECT LINES TO SALES DEPT: BRENTWOOD (ESSEX) 226470/1

ELECTRONIC BROKERS

MEASURING INSTRUMENTS AND RECORDERS

NEW

6 Pen Event Recorder, 6 in. Chart width. Available in wide range of chart speeds. Rack mounted £79/10/0. Case to suit extra.

VOLTMETER—Solartron VM 1484

Very suitable for the measurement of distorted or complex signals, noise or pulse voltages, employs thermocouples in a self-compensating bridge circuit. Reads true RMS values. Highcrest factors. Output up to 1 volt is available as a drive source for a DVM. Frequency range 10 Hz - 10 MHz. Accuracy 1% of FSD. Sensitivity 1 millivolt - 300 volts. Dimensions H. 8½ in., W. 5½ in., L. 13 in. £150. Carr. extra.

PORTABLE AC/DC PEN RECORDER

A most versatile pen recorder. Produces a trace on a curvilinear 3½ in. strip chart. Two speeds 1 in. and 6 in./hr. Limiting contacts to give alarm, and limits the current when it exceeds the high and/or low preset values. Range: 0 - 1MA D.C. Meter Resistance 400 ohms; 0 - 1MA A.C. Meter Resistance 1800 at 50 Hz; —10 to + 5 dB into 600 Ω Impedance Source. Power supply: 230V50 Hz. driving Synchronous Motor. Price: £52.10.0. Postage and packing £1 5s. 0d.

STRIP-CHART INDICATING RECORDER

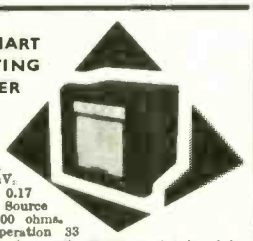
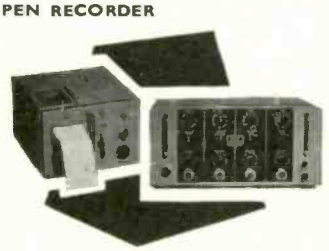


Chart width 9½ in. 10 mV. Sensitivity ± 0.17 of full scale. Source impedance 100 ohms. Speed of operation 33 sec. for full-scale travel. Chart speed ½ in., 3 in., 6 in. per hour. Single point. £49.10.0. P. & P. 30/-.

NEW PORTABLE RECORDING AMMETER

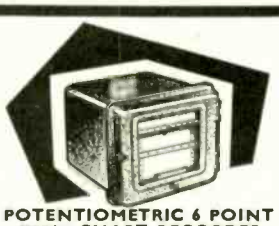
Specification. Type: Moving Coil. D.C. Range: 0-5 amp. D.C. Chart Width: 100 mm. Scale Length: 127 mm. Chart Speeds: 20, 60, 180, 600, 1800 and 5400 mm/hr. Dimensions: 180h × 163 w × 245mm. Weight: 5.5kg. List price £65. Our price £35.

PEN RECORDER



Portable 1, 2 and 4 channel pen recorders by Kelvin Hughes. General purpose recorders providing clear instantaneous and permanent records of phenomena with comparatively high rates of change. The torsion-strip suspension of the moving-coil renders the instrument immune to the effects of vibration and acceleration.

Six possible chart speeds, chart width 55 mm. length 150 ft., linearity 8 v. at 3 m.A. response D.C. to 100 c/s. Single pen with amplifier £99; 2 pen recorder £85, 4 pen with amplifier £149. Also 5 pen recorder complete with amplifiers, specification as above but housed in cabinet £225. P. & P. extra.



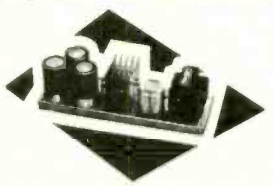
POTENTIOMETRIC 6 POINT STRIP CHART RECORDER BRAND NEW

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. Also available 0-100mW F.S.D. £89.10.0.

POWER SUPPLIES

UNUSED MINIATURE ¼ MILLION MAGNETIC STORAGE DRUM

Type N.S. 1389 16 write and 16 read heads 256 tracks magnetic storage drum. Each track at 600 r.p.m. Holds 1024 bits (32 words of 32 bits). Total storage 250,000 bits. Suitable for many data storage problems. 8" high, 10" dia., 21" base. £290, carr. extra.



ADVANCE TRANSISTORISED DC POWER UNITS

	Input Volts	Output Volts	Amps	Price
DC 4	200-245 ± 15%	12	4	£14.10.0
DC 6	230-245 ± 15%	24	5	£17.10.0
DC 8	230-245 ± 15%	48	4	£19.10.0

METERS

DIGITAL VOLTMETERS

DM.2022 digital voltmeter and ratiometer, accurate to 0.0025% offering exceptional linearity. Reading rate of 50 per second. Outputs: Parallel B.C.D. Scale 39999. Inputs: 26000MQ CMR 160dB on d.c. Range 10μV to 2KV. This is a rare opportunity to obtain such an instrument at such a low price of £350. Carriage free.

DM2006. An all solid state D.V.M. having a wide application. Scale 9999. D.C. accuracy 0.017f.s.d. with a D.C. range of 10μV to 1KV. Input impedance 10000MQ. C.M.R. 154dB. Outputs parallel B.C.D. £245. Carriage free.

DM2023. This D.V.M. is suitable for data-logging due to the high C.M.R. 175dB. It has six operating modes. Accurate to 0.001% and complete with plug in units to give either manual or automatic ranging from 10μV to 1KV with a 10MQ input impedance. £460. Carriage free.

All the above units have been calibrated.

Digital Voltmeters 2003 A.C./D.C. D.C. range 1mV.-1KV. 4 Digits. £135.

Type 2025. Scale 19,999. Accuracy .005%. Range 10 micro volts - 2 Kilo Volts. Input Z greater than 25,000 megohms. CMR 160 d.B. Price new £660. Our price £295. Carr. extra.

2 in. dia. mounting A.C. voltmeter 0-300 V. A.C. £1.15.0. Carriage 6/-.

3½ in. dia. Electrostatic Kilo Voltmeter in wooden case. £2.15.0. Carriage 10/-.

Precision A.C. & D.C. Wattmeter. Model 8.67 certificated. Accuracy to ½% up to 133 c/s. Range 250/450 V. and 0.5 to 1 A. £29.10.0. Carriage 30/-.

INDICATING MEASURING AMPLIFIER PR 7410

Suitable for vibration and frequency analysis. Frequency response 10-1,000 Hz. £45. Carr. 40/-.

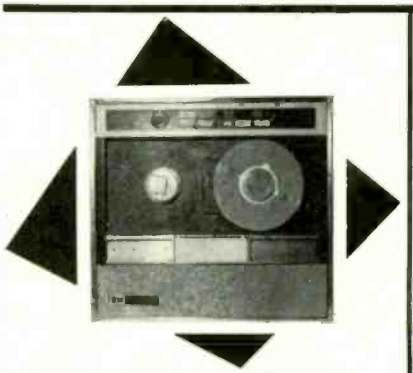
BRAND NEW S.E. LABORATORIES TRANSDUCER complete with encapsulated

Amplifier/demodulator 8.E. 441/2
Frequency D.C.—60 c.p.s.
Available in the following ranges:
8E150, 8E50 or 8E165A.

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.
0 - 350 p.s.i.	0 - 2000 p.s.i.	

Also available differential types ± 10 p.s.i.
Also available differential types, + 10 p.s.i.
List price £70+. Our price £15

COMPUTER AND PERIPHERAL EQUIPMENT



7 TRACK DIGITAL MAGNETIC TAPE STORAGE DECK

These machines originally ex-computer, are multi-track recording units, ideal for data storage. Record and Replay heads encased in one common unit. Low resistance heads. Frequency response approximately 0 Kc/s. to 50 Kc/s. Bit density 557 b.p.i. ½ in., 10½ in. spools 230 V. to 380 V. A.C. Capstan Motor speed 1,500 r.p.m. 48 V. D.C. Rewind motors complete with vacuum Assembly. Finished in brush aluminium and matt-black. Size 27 in. × 26 in. × 8 in. Weight 90 lb. Price £72.10.0. Carriage extra.

½" 7 TRACK

Ex-computer record/replay head complete with guides. Little used. Price £12.10.0 Carriage 15/-.

BRAND NEW

Gresham Lion 1 in. 1 + 7 track record/replay heads. Of the highest professional quality. Cost £100 plus price £12.10.0. Carr. 15/-.

9 TRACK 1 in. Record/replay heads with sprocket drive, driven by synchronous motor. Mounted with integrated head assembly eliminating alignment problems. This can be fitted to any suitable type of transport system. Price £8.10.0. Carriage 15/-.

MODEL 72 MAGNETIC TAPE DATA STORAGE UNIT

This unit consists of ½ in. 8 channel read-write heads. Can be used to record any 6 bit code. Data can be read in either a forward or backward direction plus giving search facilities. The unit consists circuits for receiving and storing instruction signals. Recording density 250 characters per inch. Tape speed 100 in. per second, price £190. Excellent condition.

CANCELLED EXPORT ORDER

90 Column card sorter and punch type 425/0. Price on application.

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, aborting or plugging in pins. Ideal for prototype work, etc. Boards available in 24 × 60 2 plane £12.10.0. Pins available 1/3 each.

MEMORY PLANES

Ferrite core memory planes with wired Ferrite cores. Used for building your own computer or as an interesting exhibit in the demonstration of a computer. Mounted on plastic material, frame 5 × 8 in. Consisting of matrices 40 × 25 × 4 cores each one individually addressable and divided into 2 halves with independent sense and inhibit wires. £8.10.0. P. & P. 3/-.

MULLARD MATRIX CORE STORE STACKS

A.W. 510 5 planes 8 × 16 cores/per plane	£12/10
A.W. 511 5 planes 18 × 32 cores/per plane	£25
A.W. 534 20 planes 64 × 64 cores/per plane	£89/10
A.W. 537 8 planes 32 × 32 cores/per plane	£55
Single plane 40 × 25 × 4	£8/10
Flexi-writer 7 hole punch and keyboard	£199/10

MEMORY STORE

M. M. 1044 complete with logic circuits mounted in Imhof cabinet

COMPUTERS Burroughs E 201

225 words store. £450

LINEAR THYRISTOR CONTROLLED LIGHT DIMMER

600w. module. Ideally suitable for photofood or speed controller, etc. Will mount into standard socket boxes. Our price 49/6 + p. & p. 3/-.

DATA DISC HANDLER MK. IV

Self contained magnetic disc memory unit. Designed for integration with small computers and other digital systems. Suitable for Random Access. High density contact, recording, etc.

BRAND NEW COMPUTER TAPES AND EMPTY SPOOLS

Made by well known manufacturers

½ in. certified 2,400 ft. 800 b.p.i.	£8.10.0
½ in. 2,400 ft.	£6.10.0
½ in. Highest grade 2,400 ft.	£3. 0.0
½ in. 10½ in. dia. spool and cassette	£1.10.0
½ in. 8½ in. dia. spool and cassette	£1.10.0
1 in. metal 10½ in. dia. spool and cassette	£2.10.0
½ in. N.A.B. centres 10½ in. spool only	£1. 0.0

TAPE PUNCH MODEL 25 7 HOLE

A multiwire tape punch designed for general application involving the conversion of parallel wire electrical impulses into punched papertape at 33 characters per second. Unit completely self-contained requiring only motor power and signal supplies.

7 HOLE NON PARITY TAPE PUNCH

New condition.

LOW SPEED 7 HOLE TAPE PUNCH

60 characters per second by well-known manufacturer.

TELETYPE 8 HOLE PAPER PUNCH BRPEII

Also available 5 hole punch BRPE2 as above. This model has interchangeable heads. Complete with spooler. Price £35.

HIGH SPEED 5/7 HOLE OPTICAL READER

20 characters per second.

CARD READERS

80 column 1500/80 model, punch } £325 Excellent condition.
80 column 1400/80 model verifier. }

HOLLERITH 80 COLUMN CARD PUNCH TYPE HO29 & VERIFIER AVAILABLE

MULTI-RANGE TRANSISTORISED VOLTMETER 1063

Employing silicon planar F.E.T., this instrument gives long-term stability and negligible drift over a wide temperature range. Wide frequency band 0-300 MHz. using HPV 1063. Voltage range 0-30KV. Centre zero on DC ranges for differential circuit application. Input resistance 1 M.ohm/Volt on all DC ranges. Accuracy ± 3% F.S.D. Meter scale 5in. with 1M different colour for different scales.
Special price £42/10/0 each. Carriage £1/10/0.

TRANSFER CASE

For sending data by personal carrier, GPO post, passenger train, etc. Ideal. Suitable for despatching tape 20/-. P. & P. 5/-.

EICHNER 8 Hole Punch OR READERS

No motor drive required. Solenoid operated equipment using 48v.
Reader £29.10
Punch £42.10
Carriage 25/-.

FLEXIWRITERS FPC8

Both Punch and Read Type Available. Any code can be made to suit customers requirements. Price on application.

LOW COST ELECTRONIC AND SCIENTIFIC EQUIPMENT AND COMPONENTS

SOLARTRON MILLIVOLTMETER Type F252
1% accuracy on all ranges. 1.5 millivolts - 150 volts. F8D. Input resistance 30 Megohms. £35. Carr. extra.

5 DIGIT COUNTER
A very sturdy counter. Coil resistance 100 ohms. Minimum operational voltage 5v. Counting speed 13 counts per sec. Suitable for continuous counting with sine wave drive. Coincidence, recording and frequency meter 35/- p. & p. 5/-.

VEEDER ROOT 6 DIGIT COUNTER

Suitable for counting all kinds of production runs, business machine operation. Mechanically driven Type KA1337. Reset manual knob. Ex-equipment but new condition. Special price 25/- plus 5/- p. & p.

MINIATURE SQUARE COUNTER 6 DIGIT
by Veeder Root. Rotary ratchet type, adds 1 count for each 36° movement of shaft 9/8 + 2/6 p. & p.

6 DIGIT ELECTRICAL IMPULSE COUNTER

With electrical and mechanical reset. Counter driven by a 110v D.C. 4,400 ohms coil. Reset 110v D.C. 800 ohm coil. Housed in plastic-alloy case. The units can be interlocked with each other to give vertical or horizontal displays. Price 79/6 p. & p. 5/-.

HAND TACHOMETERS
By SMITHS within 2 p.c. accuracy. 4 ranges, 500, 1,000, 5,000 and 50,000 Price

£19.10.0
carr. extra

BERKELEY DECIMAL COUNTING UNIT 0-9
4 valves double triode type 5965 special quality Unit plugs into standard octal base. Modular construction with 10 miniature neon lamps on display panel. Power supplies 6.3v A.V. 150v D.C. Cut-on or Cut-off—15v. Size 5½ × 5½ in. xl. ¾ in. Price 65/- p. & p. 5/-.

UNISELECTOR
8 and 4 Banks, 25 contact per bank, 2 sets of wipers 2 in. radius. Complete with surge capacitor. 25/- and 45/- respectively.

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. 3⅛ in. deep. 1⅛ 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.

LOW OHM SAFETY METER
12 milli-amps 5 ohms. suitable for testing circuits where currents must be limited £12/10/- p. p. 17/6.

MOTORS

HYSTERESIS REVERSIBLE MOTOR
Incorporating two coils. Each coil when energised will produce opposite rotation of output shaft. 240V 50 Hz. ¼ r.p.m., ½ r.p.m., 120V 60 Hz, 1/10 r.p.m., 30/- each. P. & P. 3/-.

HIGH TORQUE INDUCTION MOTOR.
3-30 oz/inch. Available in the following speeds only 240V 50 Hz ¼ r.p.m., 1 r.p.m., 2 r.p.m. 120 V 50 Hz 20 r.p.m. 30/- each. P. & P. 3/-.

LOW TORQUE HYSTERESIS MOTOR MA23

Ideal for instrument chart drives. Extremely quiet, useful in areas where ambient noise levels are low. High starting torque enable relative high inertia loads to be driven up to 6-oz/in. Available in the following speeds and ranges: 240V 50 Hz 4 r.p.m., 2 r.p.m., 1¼ r.p.m., 1 r.p.m., ¾ r.p.m., 1/3 r.p.m., 1/5 r.p.m., 1/10 r.p.m., 1/12 r.p.m., 1/20 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/75 r.p.m., 1/120 r.p.m., 1/360 r.p.m., 1/720 r.p.m., ½, 1/20, 1/45 r.p.m; 190V 50 Hz 1/6 r.p.m., 1/15 r.p.m., 1/16 r.p.m., 1/20 r.p.m., 1/24 r.p.m., 1/30 r.p.m., 1/60 r.p.m., 1/120 r.p.m., 1/240 r.p.m., 1/300 r.p.m., 1/720 r.p.m., 1440 r.p.m. 25/- each. P. & P. 3/-.

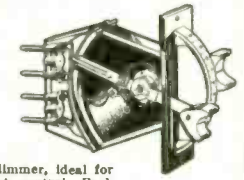
HYSTERESIS CLUTCH MOTOR
with integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz. torque at 1 r.p.m. 240 v., 50 c/s. L=left, R=right. 15 r.p.m. L. 4 r.p.m., ½, ¾ r.p.m. L, 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/-. P. & P. 3/-.

HIGH PRECISION MAINS MOTOR
230V 50 Hz 1/8 h.p. continuously rated. 3000 r.p.m. Made by Croydon Engineering Model KA 60 JFB. Suitable for capstan motor. Size 8 in. long, 4¾ in. diameter with 6 in. diameter flange and 4 fixing holes. £4.10.0 each. £1.5.0 postage and packing.

SYNCHRONOUS MOTORS
Model 8 71 r.p.h. and 1/60 r.p.h. Self starting complete with gearing shaft ⅜" dia. ½" long. 200/250 V 50 Hz. New Condition Ex. Equipment. 30/- p. & p. 3/.

OSCILLOSCOPES

Solartron AD 513	£49/10
Solartron CD 513/2	£49/10
Solartron AD 557	£55
Solartron CD 711	£65
Solartron CD 7118-2	£80
Solartron QD 910	£275
Solartron 5238-2	£52.10
Furzehill 0.100	£25
Airmec 249	£25
Airmec 723	£19/10s.
Philips 3230	£85
Mullard L101 Double Beam	£96/10
Cossor 1035	£25
Cossor 1049 MkIII	£40
Cossor 1049	£35

DOUBLE FADERS 3W

1000 & 500 dimmer, ideal for light and heat control. Each resistive dimmer is adjustable and independent of each other. Ex. equipment but in an almost new condition. Price £3.19.6. Postage & packing 7/6.

PRECISION POTENTIOMETERS


TEN TURN 3600° ROTATION BRAND NEW

Res. Ohms	Linearity Per cent	Manufacturer	Model	Price
5	0.2	Colvern	2506	60/-
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	8A1101	80/-
2K		Beckman	7216	80/-
2K		Reliance	GPM15	40/-
10K	0.5	Beckman	A	60/-
10K	0.1	Beckman X	A	70/-
15K		Foxes	GPM15	50/-
18K		Beckman	A	60/-
20K	0.5	Beckman	A	60/-
30K		Colvern	2402	30/-
30K		Beckman	8A95C	60/-
30K	0.1	Beckman	A.88	70/-
30K	0.5	Beckman	8A 1692	60/-
30K	0.25	Beckman	8A 1692	65/-
50K		Reliance	07.10	45/-
50K			07.5	45/-
50K		Colvern	2503	45/-
50K	X	Foxes	PX4	45/-
50K	0.5	Beckman	A	60/-
50K	0.1	Beckman	A	70/-
100K/100K		Ford	A	100/-
100K	0.1	Beckman	A	70/-
100K	0.5	Beckman	A	60/-
100K		Colvern	2501	45/-
100K		Colvern	2610	50/-
298K	0.1	Beckman	8A3902	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	C.88 45/-
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/-
U1.5K	Colvern	CLR 2605 40/-

SINE COSINE

Kelvin & Hughes 8CP5..14·4K		£17.10.0
Colvern 8601	30K	£17.10.0
CLR 9602—Cam Corrected 25K		£17.10.0
8CP4	32K	£17.10.0
8CP1	35K	£17.10.0

PRECISION BECKMAN 40 TURN 14,400° ROTATION
Wirewound Precision Potentiometer. 8E 107A 20 watts at 40°C. 3 1/16" Diameter. Servo Mounting. 200 K. Brand New £12.10s. List Price £30.

GENERATORS

SIGNAL GENERATOR
T.F. 801A Sine Wave, Square Wave Generator. Frequency Range: 10-310 M.c/s. Output Voltage (maximum) 200 milli-volts ± 2db. Output impedance 75 ohms. Mark/Space Ratio 50/50 on square wave. Price £80. Packing and carriage £2.

SIGNAL GENERATOR
T.F. 517F/1 Sine Wave, Square Wave Generator. Frequency Range: 120-300 M. C/s. Auxiliary 18-58 Meg. c/s. Output Voltage 0.2 Volts. Output impedance 75 ohms. £85.

MARCONI T.F. 144G
Frequency Range 85 k.c/s. 25Mc/s. Output voltage 1 micro-volt to 1 volt. Output impedance 1 micro-volt, 100 milli-volt, 10 ohms. 100 milli-volts to 1 volt. 52.5 ohms. £55 + £2 carriage.

PULSE GENERATORS
Model 101 Repetition rate 10 Hz-10MHz. Delay 30 n·10 m. secs. Output 10V. into 50 ohms. £95.

SQUARE WAVE GENERATOR
Frequencies: 1M. 100kc/s 10kc/s 50c/s Load impedance 75 ohms. Output Voltage 10V. 75 ohms. 0-18 volts into 2000 ohms. Rise time from 30-50 Milli micro seconds at 1 meg. Cycle. £65.

MARCONI VALVE VOLTMETER TF 428B/1
Frequency response on probe 10Kc/s/3-100Mc/s. Five separate Voltage Ranges. Overload Protection 100-250 A.C.I.P. Input 1MΩ Acc. ±2 % or 00.2V. Size: 10 × 16½ × 9in.—15lb. £5/19/6.

VOLSTAT
Advance
CV500/27. Input 95-130v. 50 Hz. Output 85v. R.M.S. Load 4 amps £8/10/0
CV25E. Input 190-260v. 50 Hz. Output 6v. 25 watts £9/10/0
CV50J. Input 190-260v. 50 Hz. Output 230v. 50 watts £12/10/0
Carriage extra 15/-.

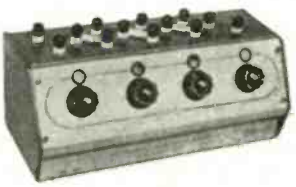
RIGHT ANGLED GEAR BOXES

Gear boxes give a drive ratio of 2.5 : 1 at right angles to the input. Driveable through the 1/p shaft only. Dimensions 4in. wide × 3½in. deep × 4½in. high. Robust construction in cast iron. Price 74/-. With pulley and ball race shaft mountings. Price 99/6. Carriage 15/-

OSCILLATORS

DAWE 443 B AUDIO SWEEP OSCILLATOR AND CONTROLLER
Brand new. 2C C/S—20 Kilocycles per sec. Accuracy. F 1%. FM and adjustable frequency sweeps from 0 - 250 c/s. Sweep repetition rates 1 - 25 sweeps/sec. Price £89.10.0. Carr. extra.

BRAND NEW LABORATORY TEST EQUIPMENT AT LESS THAN HALF PRICE

HIGH VALUE RESISTANCE BOX TYPE R.7003

Specification. Range: 0.01-111 Meg. 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/-.

PORTABLE WHEATSTONE BRIDGE

Specification. Type: Moving Coil Galvanometer. 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. Dimensions: 200 × 110 × 65mm. Weight: 0.9 kg.
List price £25. Our price £9/19/6.

MUTUAL INDUCTANCE BOX TYPE R.7005
Specification Range: 0 - 11.100 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 range: 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: 0.001 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/-.

ALL ORDERS ACCEPTED SUBJECT TO OUR TRADING CONDITIONS A COPY OF WHICH MAY BE INSPECTED AT OUR PREMISES DURING TRADING HOURS OR WILL BE SENT ON APPLICATION THROUGH THE POST.

CARRIAGE EXTRA

ELECTRONIC BROKERS LTD., 49-53 PANCRAS ROAD, LONDON, N.W.1. Tel: 01-837 7781/2 Cables: SELELECTRO

BRAND NEW SEMICONDUCTORS & COMPONENTS GUARANTEED

TRANSISTORS Brand new and fully guaranteed. **PLEASE NOTE:—A large number of our transistors have now been reduced in price. Many more semi-conductors in stock. Please enquire for types not listed.**

2G301	4/-	2N3392	5/-	3N128	18/6	BC159	4/-
2G302	4/-	2N3393	5/-	3N140	19/6	BC160	12/6
2G303	4/-	2N3394	5/-	3N141	21/6	BC167	3/6
2G306	8/6	2N3402	5/6	3N142	16/6	BC168B	3/6
2G308	6/-	2N3403	5/6	3N143	19/6	BC168C	3/9
2G309	6/-	2N3404	7/6	3N152	24/-	BC169B	3/6
2G371	3/-	2N3405	9/-	R.C.A.:		BC169C	3/9
2G374	4/-	2N3414	5/6	40050	18/6	BC170	3/6
2G381	4/6	2N3415	6/6	40250	12/6	BC171	3/6
2N388A	10/6	2N3416	7/6	40309	9/6	BC172	3/6
2N404	4/6	2N3417	9/6	40310	13/-	BC175	6/-
2N696	4/-	2N3439	39/6	40311	10/6	BC182	4/6
2N697	5/-	2N3440	25/-	40312	13/6	BC183	4/6
2N698	5/-	2N3570	17/6	40314	10/6	BC184	4/6
2N699	7/6	2N3572	17/6	40315	10/6	BC182L	4/6
2N706	2/6	2N3605	5/6	40316	13/-	BC183L	4/6
2N706A	2/6	2N3606	5/6	40317	11/-	BC184L	4/6
2N708	3/-	2N3607	4/6	40319	15/-	BC212L	5/-
2N709	12/6	2N3662	7/6	40320	10/6	BCY10	5/6
2N718	6/-	2N3663	8/-	40323	10/6	BCY12	5/6
2N718A	6/-	2N3702	3/6	40324	12/6	BCY30	5/6
2N726	5/-	2N3703	4/6	40326	10/6	BCY31	5/6
2N727	5/-	2N3704	4/6	40329	7/6	BCY32	7/6
2N914	3/6	2N3705	4/-	40344	8/-	BCY33	4/-
2N916	3/6	2N3706	4/6	40347	9/6	BCY34	4/6
2N918	6/-	2N3707	4/-	40348	14/6	BCY38	4/6
2N929	4/6	2N3708	3/6	40360	11/6	BCY39	7/6
2N930	7/-	2N3709	3/6	40361	12/6	BCY40	6/6
2N987	10/6	2N3710	4/-	40362	14/6	BCY42	3/-
2N1090	6/6	2N3711	4/-	40370	8/6	BCY43	3/-
2N1091	6/6	2N3713	27/6	40406	16/-	BCY54	7/6
2N1131	5/6	2N3714	27/6	40408	16/-	BCY58	4/6
2N1132	6/6	2N3819	9/-	40467	16/6	BCY59	4/6
2N1302	3/6	2N3823	27/6	40468A	16/6	BCY60	19/6
2N1303	3/6	2N3854	5/6	AC107	6/-	BCY70	4/6
2N1304	4/6	2N3854A	5/6	AC126	4/-	BCY71	8/6
2N1305	4/6	2N3855	5/6	AC127	5/-	BCY72	4/-
2N1306	5/-	2N3855A	6/-	AC128	4/-	BCZ10	5/6
2N1307	5/-	2N3856	6/-	AC154	4/6	BCZ11	5/6
2N1308	6/-	2N3856A	6/-	AC176	5/-	BD116	22/6
2N1309	6/-	2N3858	5/-	AC187	12/-	BD118	22/6
2N1507	5/6	2N3858A	6/-	AC188	12/-	BD121	17/6
2N1613	5/-	2N3859	5/6	ACY17	5/-	BD123	21/6
2N1631	8/6	2N3859A	6/6	ACY18	5/-	BD124	12/-
2N1632	8/6	2N3860	6/-	ACY19	5/-	BDY10	27/6
2N1637	8/6	2N3866	30/-	ACY20	5/-	BDY11	37/6
2N1638	7/6	2N3877	9/-	ACY21	5/-	BDY17	37/6
2N1639	7/6	2N3877A	9/6	ACY22	4/-	BDY18	49/6
2N1701	32/6	2N3900	10/6	ACY28	4/-	BDY19	62/6
2N1711	6/6	2N3900A	11/6	ACY40	4/-	BDY20	22/6
2N1889	6/6	2N3901	19/6	ACY41	5/-	BDY38	19/6
2N1893	8/6	2N3903	7/-	ACY44	8/-	BDY60	36/-
2N2147	14/6	2N3094	7/-	AD140	8/-	BDY61	36/-
2N2148	12/6	2N3905	7/6	AD149	11/6	BDY62	27/6
2N2160	11/6	2N3906	7/6	AD150	15/-	BF115	5/-
2N2193	5/6	2N4058	5/6	AD161	7/6	BF117	9/6
2N2193A	10/-	2N4059	5/-	AD162	7/6	BF163	7/6
2N2194A	4/6	2N4060	5/-	AF106	9/-	BF167	5/6
2N2217	5/6	2N4061	4/6	AF114	5/-	BF173	7/6
2N2218	6/6	2N4062	4/6	AF115	6/-	BF177	11/6
2N2219	6/6	2N4244	9/6	AF116	5/-	BF178	10/6
2N2220	5/-	2N4245	8/6	AF117	5/-	BF179	14/6
2N2221	5/-	2N4254	8/6	AF118	12/6	BF180	7/-
2N2222	6/6	2N4255	7/6	AF119	4/-	BF181	6/6
2N2287	21/6	2N4284	3/6	AF124	4/6	BF184	7/6
2N2297	6/-	2N4285	3/6	AF125	4/6	BF185	5/6
2N2303	5/-	2N4286	3/6	AF126	4/-	BF194	5/-
2N2368	5/-	2N4287	3/6	AF127	3/6	BF195	5/6
2N2369	3/-	2N4288	3/6	AF139	7/6	BF196	5/6
2N2369A	5/6	2N4289	3/6	AF178	12/6	BF197	5/6
2N2410	8/6	2N4290	3/6	AF179	14/6	BF198	5/6
2N2483	5/6	2N4291	3/6	AF180	16/-	BF200	10/6
2N2484	6/6	2N4292	3/6	AF181	8/6	BF224	6/-
2N2539	4/6	2N5027	10/6	AF239	7/6	BF225	6/-
2N2540	4/6	2N5028	11/6	AF279	16/6	BF237	6/6
2N2613	7/-	2N5029	9/6	AF280	16/6	BF238	6/6
2N2614	6/-	2N5030	8/6	AFZ11	5/6	BFX12	4/6
2N2646	11/6	2N5172	3/-	ASY26	5/6	BFX13	4/6
2N2696	6/6	2N5174	10/6	ASY27	8/6	BFX29	8/-
2N2711	6/-	2N5175	10/6	ASY28	5/6	BFX30	9/-
2N2712	6/-	2N5176	9/-	ASY29	5/6	BFX43	8/6
2N2713	5/6	2N5232	5/6	ASY36	5/-	BFX44	8/6
2N2714	6/-	2N5232A	6/-	ASY50	5/-	BFX68	13/6
2N2865	12/6	2N5245	12/6	ASY51	6/6	BFX68A	13/6
2N2904	7/-	2N5246	12/6	ASY53	5/-	BFX84	7/6
2N2904A	8/-	2N5249	13/6	ASY54	5/-	BFX85	9/-
2N2905	8/-	2N5249A	13/6	ASY62	5/-	BFX86	6/6
2N2905A	9/-	2N5265	62/6	ASY63	3/6	BFX87	6/6
2N2906	6/-	2N5266	57/6	ASY72	5/-	BFX88	5/-
2N2906A	6/6	2N5267	52/6	ASY83	5/-	BFX89	12/6
2N2907	8/-	2N5305	7/6	ASY86	6/6	BFX92A	12/6
2N2923	3/6	2N5306	8/-	ASZ20	7/6	BFY10	4/6
2N2924	3/6	2N5307	7/6	ASZ21	7/6	BFY11	4/6
2N2925	3/6	2N5308	7/6	AUY10	30/-	BFY17	4/6
2N2926		2N5309	12/6	BC107	3/6	BFY18	4/6
Green	3/-	2N5310	8/6	BC108	3/6	BFY19	4/6
Yellow	2/9	2N5175	5/6	BC109	3/6	BFY20	12/6
Orange	2/9	2N5355	5/6	BC113	6/6	BFY21	8,6
2N3011	12/6	2N5356	10/6	BC115	6/6	BFY24	9/-
2N3014	6/6	2N5365	9/6	BC116	12/6	BFY25	5/-
2N3053	5/6	2N5366	10/-	BC118	6/6	BFY26	4/-
2N3054	12/6	2N5367	11/6	BC121	4/-	BFY29	10/-
2N3055	15/-	2N5457	7/6	BC122	4/-	BFY30	10/-
2N3133	6/-	25005	15/-	BC125	11/-	BFY41	10/-
2N3134	6/-	25020	37/6	BC126	11/-	BFY43	12/6
2N3135	5/-	25102	6/6	BC140	7/6	BFY50	4/6
2N3136	5/-	25103	6/6	BC147	3/6	BFY51	4/6
2N3340	19/6	25104	6/6	BC148	3/6	BFY52	4/6
2N3349	26/-	25501	5/6	BC149	3/6	BFY53	5/6
2N3390	7/6	25502	5/6	BC152	3/6	BFY56A	11/-
2N3391	5/-	25503	5/6	BC157	4/-	BFY75	6/-
2N3391A	6/-	3N83	37/6	BC158	3/6	BFY76	8/6

BFY77	11/6	NKT264	4/-				
BFY90	12/6	NKT271	4/-				
BFW58	5/6	NKT272	4/-				
BFW59	5/-	NKT274	4/-				
BFW60	5/-	NKT275	4/-				
BSX19	3/6	NKT281	5/6				
BSX20	3/6	NKT401	17/6				
BSX21	7/6	NKT402	18/-				
BSX26	10/6	NKT403	15/-				
BSX27	10/6	NKT404	12/6				
BSX28	6/-	NKT405	15/-				
BSX60	19/6	NKT406	12/6				
BSX61	12/6	NKT451	12/6				
BSX76	4/6	NKT452	12/6				
BSX77	6/6	NKT453	9/6				
BSX78	6/6	NKT603F	6/6				
BSY10	5/6	NKT613F	6/6				
BSY11	5/6	NKT674F	5/-				
BSY24	4/-	NKT677F	5/-				
BSY25	4/-	NKT713	5/-				
BSY26	4/-	NKT717	8/6				
BSY27	4/-	NKT734	5/6				
BSY28	4/-	NKT736	7/-				
BSY29	4/-	NKT773	5/-				
BSY32	5/-	NKT781	6/-				
BSY36	5/-	NKT10339	6/6				
BSY37	5/-	NKT10419	6/-				
BSY38	4/6	NKT10439	7/6				
BSY39	4/6	NKT10519	6/6				
BSY40	6/6	NKT20329	9/6				
BSY51	8/6	NKT20339	7/6				
BSY52	9/-	NKT80111	15/6				
BSY53	8/6	NKT80112	19/6				
BSY54	10/6	NKT80113	22/6				
BSY56	18/-	NKT80211	18/6				
BSY78	9/6	NKT80212	18/6				
BSY79	9/6	NKT80213	18/6				
BSY82	10/6	NKT80214	18/6				
BSY90	11/6	NKT80215	18/6				
BSY95A	2/6	NKT80216	18/6				
BSW41	8/6	OC20	15/-				
BSW70	5/6	OC22	8/-				
DI6P1	7/6	OC23	8/-				
DI6P2	8/-	OC24	8/-				
DI6P3	7/6	OC25	8/-				
DI6P4	8/-	OC26	6/6				
GET102	6/-	OC28	10/6				
GET113	4/-	OC29	15/-				
GET114	4/-	OC35	6/6				
GET118	4/-	OC36	6/6				
GET119	4/-	OC38	10/6				
GET120	6/6	OC41	4/6				
GET873	3/-	OC42	5/-				
GET880	6/-	OC44	4/-				
GET887	4/-	OC45	2/6				
GET889	4/6	OC46	3/-				
GET890	4/6	OC70	3/-				
GET896	4/6	OC71	2/6				
GET897	4/6	OC72	2/6				
GET898	4/6	OC74	4/6				
MAT100	6/-	OC75	4/6				
MAT101	6/-	OC76	3/-				
MAT120	6/-	OC77	5/6				
MAT121	6/-	OC81	4/6				
MJ400	21/6	OC81D	4/6				
MJ420	22/6	OC83	4/6				
MJ421	22/6	OC84	5/-				
MJ430	20/6	OC139	6/6				
MJ440	19/6	OC140	6/6				
MJ480	20/6	OC170	6/-				
MJ481	27/6	OC171	6/-				
MJ490	22/6	OC200	6/6				
MJ491	29/6	OC201	7/6				
MJ1800	43/6	OC202	10/6				
MJE340	15/-	OC203	6/6				
MJE520	19/6	OC204	6/6				
MJE521	19/6	OC205	8/6				
MPF102	8/6	OC207	7/6				
MPF103	7/6	OCP71	10/6				
MPF104	7/6	ORP12	12/6				
MPF105	7/6	ORP60	10/-				
MPS3638	6/6	ORP61	10/-				
NKT0013	9/6	P346A	4/6				
NKT124	8/6	TIS34	17/6				
NKT125	5/6	TIS43	9/-				
NKT126	5/6	TIS44	2/6				
NKT128	5/6	TIS45	3/6				
NKT135	5/6	TIS46	3/6				
NKT137	6/6	TIS47	3/6				
NKT210	6/-	TIS48	3/6				
NKT211	6/-	TIS49	3/6				
NKT212	6/-	TIS50	5/6				
NKT213	6/-	TIS51	4/-				
NKT214	4/6	TIS52	4/-				
NKT215	4/6	TIS53	6/-				
NKT216	7/6	TIS60	6/6				
NKT217	8/6	TIS61	6/6				
NKT219	6/-	TIP31A	19/6				
NKT223	5/6	TIP32A	22/6				
NKT224	5/-	ZTX107	3/6				
NKT225	4/6	ZTX108	3/6				
NKT229	6/-	ZTX109	3/6				
NKT237	7/-	ZTX300	4/-				
NKT238	5/-	ZTX301	4/-				
NKT240	5/6	ZTX302	5/-				
NKT241	5/6	ZTX303	5/-				
NKT242	4/-	ZTX304	7/6				
NKT243	12/6	ZTX500	5/-				
NKT244	3/6	ZTX501	5/-				
NKT245	4/-	ZTX502	6/-				
NKT261	4/-	ZTX503	5/-				
NKT262	4/-	ZTX504	12/6				

PANEL METERS
38 Series—FACE SIZE 42 x 42 mm. All prices for 1-9 pieces.

50	Microamp	37/6	5	Milliamp	25/-
100	"	35/-	10	"	25/-
200	"	32/6	50	"	25/-
500	"	27/6	100	"	25/-
50-0-50	"	35/-	500	"	25/-
100-0-100	"	32/6	1	Amp	25/-
500-0-500	"	25/-	5	"	25/-
1	Milliamp	25/-	10	Volts	25/-
			20	"	25/-
			50	"	25/-
			300	"	25/-
			500	"	25/-

SPEAKERS (3ohm)

10" x 6"	..	37/6	3"	..	9/6
9" x 4"	..	23/6	5"	..	14/6
8" x 5"	..	19/6	8"	..	27/6
7" x 4"	..	15/6	12"	..	39/6
5" x 3"	..	12/6	Post and packing 1/6.		

PRESETS Carbon Miniature and Sub miniature. Vertical and Horizontal. 0.1 watt 1/-. 0.2 watt 1/6.

CARBON POTENTIOMETERS
Log. and Lin. Less switch 3/3
Log. and Lin. With switch 4/6

Wire-wound Pots (3 watts) 6/6
Twin Ganged Stereo Pots. Log. and Lin. Less Switch 7/6

HEAT SINKS
4.8" x 4" x 1" Finned. For Two To-3 Trans. .. 9/6
4.8" x 2" x 1" Finned. For One To-3 Trans. .. 6/6
For 5O-1 6d. For TO-5 1/- Finned
For TO-18 1/- Finned For TO-1 1/- Finned

ZENER DIODES

400 m W (from 3.3v to 33v)	..	..	..	..	5/-
1 Watt (from 2.4 to 200v)	..	..	..	..	7/6
10 Watt (from 3.9v to 40v)	..	..	..	..	7/6

CIR-KIT
5 ft. x 1/16 In. and ¼ in. 2/-
D.G. 30 W. Soldering Irons .. .. .. 17/6 each

SPECIAL OFFERS
Bag of transistors (new) approx. 100 pieces @ 10/-
Bag of ¼W mixed resistors approx. (120 pieces) .. 5/-
Bag Miscellaneous Comps (trans. caps. Res. Switches etc.) 15/-

SILICON RECTIFIERS

	50	100	200	400	600	800	1000	12000
PIV								
1A	2/9	3/-	3/3	3/6	3/9	4/-	4/6	—
3A	3/-	—	—	4/6	—	6/-	—	—
6A	—	—	5/-	6/-	6/6	7/-	10/-*	—
10A	8/-	12/6	13/6	16/6	16/6	19/6	23/-	30/-
17A	—	15/6	16/9	21/-	21/-	26/-	32/6	43/6

*5 AMP only. 1 AMP Types are plastic.

DIODES & RECTIFIERS

IN461	1/6	AA119	2/-	BAY38	2/6	OA5	2/6
IN914	1/6	AA129	2/-	BY100	4/6	OA10	2/6
IN916	1/6	AAZ13	2/-	BY103	4/6	OA9	2/-
IN4007	4/6	AAZ15	2/6	BY122	7/6	OA47	1/6
IS010	3/-	AAZ17	2/6	BY124	3/-	OA70	1/6
IS021	4/-	BA100	6/6	BY126	4/-	OA73	2/-
IS025	5/-	BA102	6/6	BY127	4/6	OA79	1/9
IS44	2/-	BA110	7/-	BYX10	5/6	OA81	1/6
IS113	3/-	BA115	1/6	BYX10	9/-	OA85	1/6
IS120	2/6	BA144	5/6	BYZ11	7/6	OA90	1/6
IS121	2/6	BAX13	2/6	BYZ12	6/6	OA91	1/6
IS130	2/6	BAX16	2/6	BYZ13	5/-	OA95	1/6
IS131	3/-	BAY18	3/6	F5T3/4	4/6	OA200	2/-
IS132	2/6	BAY31	1/6	F5T3/8	6/-	OA202	2/-
IS940	1/6						

MAINS TRANSFORMERS

1 amp. Sec. tappings from 6 to 50v	32/6
2 amp. Sec. tappings from 6 to 50v	45/6
1 amp. Sec. tappings 0-3.5-9-17v	13/6
2 amp. Sec. tappings 0-3.5-9-17v	19/6
3 ohm Isolating transformer (R.S. type choke) ..	13/6

PLESSEY

SL402A	42/6
SL403A	54/-
Data & Applicatlon Sheet	2/-

FAIRCHILD

	1-6	7-11	12+
L900 Buffer	11/-	9/6	8/4
L914 Dual Gate	11/-	9/6	8/4
L702C	40/-		
L923 JK Flip Flop	14/-	12/6	11/9
L709 Op Amp	22/6	20/-	18/-

Quantity Prices on Application.

MOTOROLA

MC724P Quad 2 Input Gates	19/6
MC789P Hex Inverter	19/6
MC790P Dual JK Flip Flop	32/6
MC792P	20/-
MC799P Dual Buffer	29/6

MULLARD I.C's Data sheets 1/-

FCH 211	Hextuple DTL Inverter Gate	.. .. ..	28/6
FCH 221	Triple 3 Input DTL Line ..	.. .. ..	28/6
FCJ 101	3 Input JK Flip Flop ..	.. .. ..	38/-
TAA 241	Operational Amplifier ..	.. .. ..	47/6
TAA 243	Operational Amplifier ..	.. .. ..	45/-
TAA 263	Linear A.F. Amplifier ..	.. .. ..	15/6
TAA300	Liner A.F. Amplifier ..	.. .. ..	47/6
TAA 320	Most L.F. Pre Amplifier ..	.. .. ..	15/6
TAA350	Wideband Lim. Dif. Amplifier ..	.. ..	45/-

GENERAL ELECTRIC

PA230	Low Level Amplifier	.. ..	27/6
PA234	1 Watt audio Amplifier	.. ..	26/6
PA237	2 Watt Audio Amplifier	.. ..	45/-
PA246	5 Watt Audio Amplifier	.. ..	57/6

THYRISTORS

	50	100	200	300	400
PIV					
1A	5/-	5/6	7/6	8/-	9/6
3A	6/-	7/6	8/-	9/-	10/6
5A	—	8/-	9/-	—	13/6
7A	—	11/-	13/-	14/-	19/6
25A	27/6	30/-	33/-	—	37/6

TIC47 0.6 amp. 200 PIV 6/6.
Also 12 Amp 100 PIV 15/-, 600 PIV 35/6.

VEROBOARD

	.15 Matrix	.1 Matrix
2½" x 3½"	3/6	4/-
2½" x 5"	4/3	4/9
3½" x 3½"	4/3	4/9
3½" x 5"	5/6	5/6
2½" x 17"	12/6	—
3½" x 17"	16/-	21/6
3½" x 17" (Plain)	—	11/6
5" x 17" (Plain)	17/-	—
2½" x 17" (Plain)	9/6	—
Vero Pins (Bag of 36)	3/-	3/-
Vero Cutter 9/-.		

RESISTORS
Carbon Film
¼ watt 10% .. .. 4d. 1 watt 10% .. 6d.
½ watt 5% .. .. 5d.
2 watt 10% 1/-
Wire Wound
2.5 watt 5% (Up to 270 ohms only) 1/6
5 watt 5% (Up to 8.2k ohms only) 2/-
10 watt 5% (Up to 25k ohms only) 2/9

CAPACITORS. Polyester, ceramic, Polystyrene, silver mica, tantalum, trimmers etc.
Electrolytics

MFD.	V.		MFD.	V.		MFD.	V.	
1	40	1/9	25	50	1/6	320	10	1/6
1.6	25	1/6	32	40	1/6	400	16	2/9
2	350	2/-	32	450	3/9	500	6	2/6
2.5	16	1/9	40	6.4	1/6	500	25	3/9
4	10	1/6	40	16	1/6	500	50	4/9
4	40	4/9	50	12	1/6	640	16	3/6
4	350	2/3	50	25	1/6	640	25	5/-
5	18	1/6	50	50	2/-	1000	16	5/-
5	50	1/6	64	25	1/6	1000	25	5/-
6.4	6.4	1/9	80	16	1/6	1000	50	7/6
8	40	1/6	80	25	1/6	2000	25	8/6
8	450	3/-	100	6.4	1/6	2000	50	12/6
10	12	1/6	100	12	1/6	2500	25	9/6
10	25	1/6	100	25	1/9	2500	50	13/6
12.5	25	1/9	100	50	2/6	3000	25	10/6
16	10	1/6	125	10	1/6	5000	25	12/6
16	15	1/6	200	10	1/6	5000	50	19/6
16	450	3/3	250	25	2/9	16 + 16	450	7/6
25	6.4	1/6	250	50	3/9	32 + 32	450	7/6
25	10	1/6						
25	25	1/6						

THERMISTORS (MULLARD)

R53 (5TC)	25/6	VA1010	2/6	VA1039	3/-	VA1077	4/-
K151 (Siemens) 1K		VA1015	3/9	VA1040	2/6	VA1091	4/6
	2/6	VA1033	2/6	VA1053	2/6	VA1096	4/-
VA1005	3/-	VA1034	2/6	VA1066	3/9	VA1097	4/-
		VA1037	2/6	VA1074	2/6	VA1098	4/-
		VA1038	2/6	VA1075	4/6		

SPECIAL OFFER

To encourage personnel callers we are happy to offer a discount of 5% to all our customers on Saturdays only.
We are happy to quote for quantity supplies to manufacturers etc.
Post and Packing in U.K. 1/6; Europe 5/-; Commonwealth (Air) 13/-.

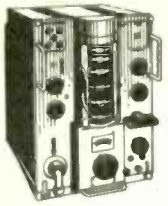
Telex 21-492
Tel: 01-452 0161/2/3

A. MARSHALL & SONS LTD

28 CRICKLEWOOD BROADWAY, LONDON, N.W.2

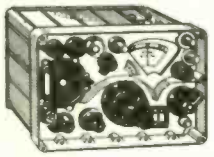
CALLERS WELCOME
Hours 9-5.30 Mon.-Sat.

ADMIRALTY B.40 RECEIVERS



High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 Kc/s-30 Mc/s. I.F. 500/Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker. output for phones. Operation 150/230 volt A.C. Size 19½ x 13½ x 16in. Weight 114lb. Offered in good working condition. £22/10/0. carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17/10/-. Carr. 30/-.

R209 Mk. II COMMUNICATION RECEIVER



11 valve high grade communication receiver suitable for tropical use. 1-20 Mc/s. on 4 bands. AM/CW/FM operation. Incorporates precision vernier drive, B.F.O. Aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked. **£15.0.0** Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES BARGAIN

An excellent general purpose D/B oscilloscope. T.B. 2 cps-750 Kc/s. Bandwidth 5.5 Mc/s Sensitivity 33 Mv/cm. Operating voltage 0/110/200/250 v. A.C. Supplied in excellent working condition, £22/10/-. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.

MARCONI CT44 TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts. £20. Carr. 20/-.

CLASS D. WAVEMETERS

A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 6 v. D.C. Ideal for amateur use. Available in good used condition £5.19.6 Carr. 7/6. Or brand new with accessories £7.19.6 Carr. 7/6.

CLASS D WAVEMETERS No. 2

Crystal controlled. 1.2-19 Mc/s. Mains or 12v. D.C. operation. Complete with calibration charts. Excellent condition £12/10/0. Carr. 30/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

0-20 Kc/s. Output 5K or 500 ohms. 200/250 v. A.C. Offered in excellent condition, £12/10/-. Carriage 10/-.

VOLTAGE STABILISER TRANSFORMERS.

180-260v. input. Output 230v. Available 150w or 225w. £12.10.0. Carr. 5/-.

TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS—1 MHZ. Input imp. 2 meg Ω. 25 PF. Illuminated scale. 2" tube. 115 x 180 x 230 mm. Weight 8lbs. 220/240v. A.C. Supplied brand new with handbook. £22/10/-. Carr. 10/-.

TO-3 PORTABLE OSCILLOSCOPE. 3" TUBE

Y amp. Sensitivity. .1v p-p/CM. Bandwidth 1.5 cps—1.5 MHZ. Input imp. 2 meg Ω. 25 PF. X amp sensitivity. .9v p-p/CM. bandwidth 1.5 cps—800 KHZ. Input imp. 2 meg Ω 20 PF. Time base. 5 ranges 10 cps—300 KHZ. Synchronization. Internal/external. Illuminated scale. 140 x 215 x 330 mm. Weight 15½lbs. 220/240 V. A.C. Supplied brand new with handbook. £37.10.0 Carr. 10/-.

CRYSTAL CALIBRATORS NO. 10

Small portable crystal controlled wavemeter. Size 7in. x 7½in. x 4in. Frequency range 500 Kc/s—10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. 89/6. Carr. 7/6.

MARCONI TF885 VIDEO OSCILLATORS

0-5 mc/s Sine Square Wave £45. Carr. 20/-.

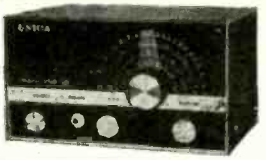
MARCONI TF195M BEAT FREQUENCY OSCILLATORS

0-40 kc/s. £20. Carr. 30/-.

WS62 TRANCEIVERS

Large quantity available for EXPORT! Excellent condition. Enquiries invited.

UNR-30 4 BAND COMMUNICATION RECEIVER



Covering 550 Kc/s-30 Mc/s. Incorporates BFO. Built-in speaker and phone jack. Metal cabinet. Operation 220/240 v. A.C. Supplied brand new, guaranteed with instructions. 13gns. Carr. 7/6.

EDDYSTONE V.H.F. RECEIVERS

770R. 19-165 Mc/s. £150.
Both types in excellent condition.

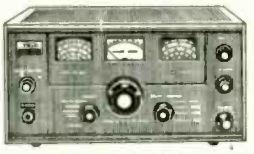
LAFAYETTE SOLID STATE HA600 RECEIVER

5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE. 150 kc/s-400 Kc/s AND 550 Kc/s-30 Mc/s. F.E.T. front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noiselimiter ● S Meter ● 24½in. Bandspread ● 230 v. A.C./12 v. D.C. neg earth operation ● RF gain control. Size 15in. x 9½in. x 8½in. Wt. 18 lbs. EXCEPTIONAL VALUE £45. CARR. 10/-. S.A.E. FOR FULL DETAILS.

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s-30 mc/s continuous. Special features are use of FET transistors, S meter, built-in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandspread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12½" x 4½" x 7". Excellent value. Only £24. carr. 7/6.

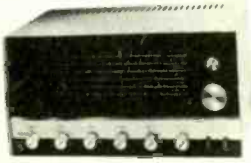
TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver covering 500 Kc/s to 30 Mc/s, continuous and electrical bandspread on 10-15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter. ● Sep. Bandspread dial ● IF 455 Kc/s ● audio output 1.5 w. ● Variable RF and AF gains controls. 115/250 v. A.C. mains. Beautifully designed. Size 7 x 15 x 10in. With instruction manual and service data. £42. Carriage paid Trio Communication Type Headphones. Normally £5.19.6. Our price £3.15.0 if purchased with above receiver.

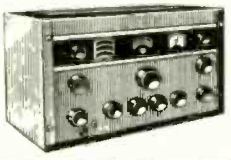
TRIO TS 510 Amateur Transceiver with speaker and mains P.S.U. £212
TRIO JR 500SE 10-80 Metre Amateur Receiver £65

LAFAYETTE HA.800 SOLID STATE AMATEUR COMMUNICATION RECEIVER SIX BANDS 3.5-4, 7-7.3, 14-14.35, 21-45, 28-29.7, 50-54 Mc/s.



Dual conversion on all bands. 2 x 455 Kc/s mechanical filters. Product detector. Variable B.F.O 100 Kc/s crystal calibrator. 'S' meter. Huge slide rule dial. Operation 230v AC or 12v DC. Size 15" x 9½" x 8½". Complete with instruction manual. £57.10.0. Carr. Paid. (100 Kc/s Crystal 39/6 extra.)

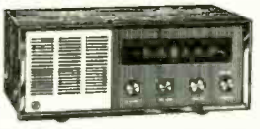
TRIO JR-310 NEW AMATEUR BAND 10-80 METER RECEIVER IN STOCK £77.10.0



RCA COMMUNICATIONS RECEIVERS AR88D

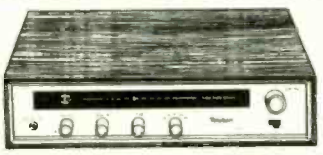
Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s—32 Mc/s continuous. Output impedance 2.5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £87.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER



A completely new transistorised receiver covering 152-174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built-in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone jack. Operation 230 v. A.C./12 v. D.C. Neg. earth. £37/10/-. Carr. 10/-.

TELETON MODEL CR-10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4+4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600 KHz. FM 88-108 MHz. Automatic FM Stereo reception. Stereo Indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size 13¾in. x 3½in. x 9¼in. approx. Price £34/0/0. Carr. 7/6.

SEW PANEL METERS

Type MR.38P. 1 21/32in. square fronts.

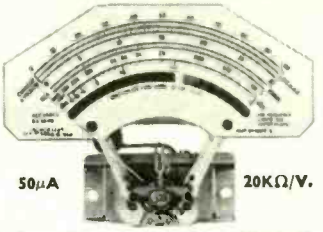
50μA	40/-	50mA	27/6	100V. D.C.	27/6
50-0-50μA	37/6	100mA	27/6	150V. D.C.	27/6
100μA	37/6	150mA	27/6	300V. D.C.	27/6
100-0-100μA	35/-	200mA	27/6	500V. D.C.	27/6
200μA	35/-	300mA	27/6	750V. D.C.	27/6
500μA	30/-	500mA	27/6	15V. A.C.	27/6
500-0-500μA	27/6	750mA	27/6	50V. A.C.	27/6
1mA	27/6	1 amp	27/6	150V. A.C.	27/6
1-0-1mA	27/6	2 amp	27/6	300V. A.C.	27/6
2mA	27/6	5 amp	27/6	500V. A.C.	27/6
5mA	27/6	3V. D.C.	27/6	8 meter 1mA	32/-
10mA	27/6	10V. D.C.	27/6	VU meter	42/-
20mA	27/6	20V. D.C.	27/6		

FULL RANGE OF OTHER SIZES IN STOCK—SEND SAE FOR LEAFLET

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms. 14/6, P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms, 21/-. P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms, 27/6. P. & P. 1/6.

AVOMETER MOVEMENTS



50μA 20KΩ/V.

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed 69/6 P. & P. 3/6

MARCONI TF.142E DISTORTION FACTOR METERS

Excellent condition. Fully tested £20. Carr. 15/-.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: .01/.03/.1/.3/1/3/10/30/100/300 v. R.M.S. 4 cps.-1.2 Mc/s. Decibels −40 to +50 dB. Supplied brand new complete with leads and instructions. Operation 230 v. A.C. £17/10/-. Carr. 5/-.

PLESSEY SL 403A

3-watt. Integrated amplifier circuit.
49/6 post paid.

TE-65 VALVE VOLTMETER

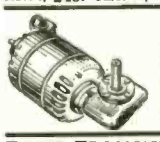
High quality instrument with 28 ranges.
D.C. volts 1.5-1,500 v.
A.C. volts 1.5-1,500 v.
Resistance up to 1,000 megohms.
220/240v. A.C. operation.
Complete with probe and instructions £17/10/0. P. & P. 6/-.
Additional Probes available; R.F. 35/- H.V. 42/6.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.C. coupled. Band width 1 Kc/s. Perfect order. £25. Carr. 30/-.

AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the Ministry by Airmec. Frequency coverage 20-80 Mc/s. AM/CW/FM. Incorporates precision dial, level meter, precision attenuator 1μV-100Mv. Operation from 12 volt D.C. or 0/110/200/250 v. A.C. Size 12 x 8½ x 9in. Supplied in brand new condition complete with all connectors, fully tested, £45. Carr. 20/-.



GEARED MAINS MOTOR

Paralux type 8D19 230/250 v. A.C. Reversible. 30 r.p.m. 40 lb. ins. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

TE-16A TRANSISTORISED SIGNAL GENERATOR

5 Ranges 400 KHZ-30 MHZ. An inexpensive instrument for the handyman. Operates on 9v. battery. Wide easy to read scale. 800 KHZ modulation. 5½" x 5½" x 3½". Complete with instructions and leads. £7/19/6. P/P 4/-.

TRANSISTORISED L.C.R. A.C MEASURING BRIDGE.

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω—11.1 MEG Ω 6 Ranges ± 1%. L. 1μH—111 HENRIES. 6 Ranges — 2%. C. 10PF ± 1110MFD. 6 Ranges ± 2%. TURNS RATIO 1:1/1000—1:11100. 6 Ranges ± 1%. Bridge voltage at 1,000 CPS. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7½" x 5" x 2". £20. P. & P. 5/-.

AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded
150 W. 42/6, P. & P. 3/6
300 W. 59/6, P. & P. 4/6
500 W. £4/10/0, P. & P. 6/6
1,000 W. £6/10/0, P. & P. 7/6
1,500 W. £7/19/6, P. & P. 8/6
7,500 W. £15/10/0, P. & P. 20/-.

G. W. SMITH & Co. (Radio) Ltd.

ALSO SEE OPPOSITE PAGE

ARF-100 COMBINED AF-RF SIGNAL GENERATOR

AF. SINE WAVE 20-200,000 cps. Square wave 20-30,000 cps. O/P HIGH IMP. 21 v. P/P 600Ω 3.8 v. P/P. R.F. 100 kc/s-300 Mc/s. Variable R.F. attenuation. Int./Ext. Modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F. 220/240 v. A.C. £32.10.0 Carr. 7/6.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s-260 Mc/s. on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Brand new with instructions. £15.

P. & P. 7/6. S.A.E. for details.

PEAK SOUND PRODUCTS

Full range of Amplifiers, kits, Speakers in stock.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20 cps to 200 kc/s. on 4 bands. Square 20 cps to 30 kc/s. Output impedance 5,000 ohms, 200/250 v. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £16.10.0. Carr. 7/6.

LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

2 pf-2,000 mfd. 2 ohms-200 megohms. Also checks impedance turns ratio insulation. 200/250 v. A.C. Brand New. £17.10 Carr. 7/6.

TY75 AUDIO SIGNAL GENERATOR

Sine Wave 20 CPS—200 Kc/s. Square Wave 20 CPS—30 Kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts A.C. Brand new with instructions. £16. Carr. 7/6. Size 210 × 150 × 120 mm.

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s—500 Mc/s on 6 bands. Directly calibrated. Variable RF. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 7/6. Size 140 x 215 x 170 mm.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

JIB. AUDIO SIGNAL GENERATOR
15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. £30.0.0.

VM79. UHF MILLIVOLT METER
100 Kc/s to 1,000 Mc/s. A.C. 10 mV to 3v. D.C. 10 mV. to 3v. Current 0.01 uA to 0.3 mA. Resistance 1 ohm to 10 megohm. £125.0.0.

TTIS. TRANSISTOR TESTER
Full range of facilities for testing PNP or NPN transistors in or out of circuit. £37.10.0.
Carriage 10/- per item.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A. B and Ico.
Equally adaptable for checking diodes, etc.
Spec.: A: 0.7-0.9967. B: 5-200. Ico: 0/50 micro-amps. 0.5 mA. Resistance for diode 200Ω +1 MEG. Supplied complete with instructions, battery and leads. £5/19/6. P. & P. 2/6.

CAR LIGHT FLASHERS

Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As Inset.) Housed in strong plastic case. Flashing rate between 60-120 per minute. 12 volt D.C. operation. Maximum load 6 amps. Size 2 11/16 in. dia. by 4in. Supplied brand new at a fraction of original cost. 6/6 each, P. & P. 2/6. (3 for 17/6, P. & P. 4/6.)

Latest Catalogue

The latest edition giving full details of a comprehensive range of HI FI EQUIPMENT, COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT. . . . Nearly 200 pages, fully illustrated and detailing thousands of items — many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.

SEND NOW—ONLY 7/6 P & P 1/-

GARRARD

Full current range offered brand new and guaranteed at fantastic savings

1025 Stereo	£7.19.6	AP75	£16.19.6
2025 T/C		8L75	£25.19.6
Stereo	£8.17.6	8L75B	£28. 0.0
3000 Stereo	£9.19.6	8L95B	£35. 0.0
SP25 Mk II	£11. 9.6	A70/11	£11.19.6
8L55	£11.12.6	401	£25. 0.0
8L65B	£14.19.6	8L55 with Sonotone	
8L72B	£25. 0.0	9TAHCD	£12.10.0

Carriage 7/6 extra each item.

TEAK BASES AND PERSPEX COVERS
1. For SP25, 8L65, 8L55, 3000, 2025T/C, 2025, 1000, £4.10.0.
2. For AP75, 8L75, 8L95, £5.19.6.
3. For SP25 etc. to operate with lid in place £5.19.6. Carriage 7/6 extra each type.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

19 transistors, 8 diodes, IHF music power 30 watts at 8 ohms. Res. 30-20,000 ±2 dB at 1 w. Distortion 1% or less. Inputs 3 mV and 250 mV. Output 3-16 ohms. Separate L and R volume controls. Treble and bass controls. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with metal case. Size 10½in. × 3 5/8 in. × 7 11/16 in. Operation 115/230 volt A.C. £24. Carr. 7/6.

Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230 v. 50-60 cycles.
Output full variable from 0-260 volts. Bulk quantities available.
1 amp.— £5/10/-; 2.5 amp.— £6/15/-; 5 amp.— £9/15/-;
8 amp.—£14/10/-; 10 amp.—£18/10/-; 12 amp.—£21; 20 amp.—£37

MULTIMETERS *for EVERY purpose!*

TE-300 20,000Ω/VOLT GIANT MULTIMETER Mirror scale and overload protection. 6in. full view meter. 2 colour scale. 0/2.5/10/250/1,000/5,000 v. A.C. 0/25/12.5/10/50/250/1,000/5,000 v. D.C. 0/50μA/110/300/500mA/10 amp. D.C. 02K/200K/20 MEG. OHM. £15/-/-. P. & P. 5/-.

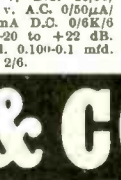
MODEL AS-100D. 100KΩ/Volt. 5in., mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/20MΩ. —20 to +17dB. £12/10/-. P. & P. 3/6.

MODEL TE-90 50,000 O.P.V. Mirror scale overload protection. 0/3/12/60/300/600/1,200 v. D.C. 0/6/30/120/300/1,200. v D.C. .03/6/60/600 MA. D.C. 16K/160K/1.6/16 MEG Ω. —20 — + 63db. £7/10/0. P. & P. 3/-.

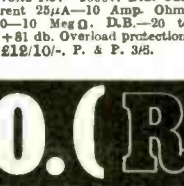
MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/30μA/3/30/300mA. 0/16K/160K/1.6M/16 Meg Ω. £5/10/-. P. & P. 3/-.

MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000 v. A.C. 0/5/25/50/250/500/1,000 v. D.C. 0-50μA. 5/50/500mA. 0/6K/60K/600K/6 meg. £4/17/6. P. & P. 3/-.

MODEL TE-12. 20,000 O.P.V. 0/0.6/6/30/120/300/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/50μA/6/60/600 mA. 0/6K/600K/6 Meg./60 Meg.Ω. 50 PF. .2 MFD £5/19/6. P. & P. 3/6.

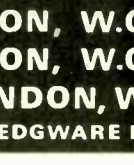


TE-51. NEW 20,000Ω/VOLT MULTIMETER. with overload protection and mirror scale. 0/6/60/120/1,200 v. A.C. 0/3/30/60/300/600/3,000v. D.C. 0/60μA/12/300m A.D.C. 0/60K/6 meg. ohm. 92/6. P. & P. 2/6.



MODEL PT-34. 1,000 O.P.V./0/10/50/250/500/1,000V. a.c. and d.c. 0/1/100/500 mA. d.c. 0/100 K Ω 39/6. P. & P. 1/6.

MODEL TE-10A. 20kΩ/Volt 5/25/50/250/500/2,500 v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2.5 mA/250 mA D.C. 0/6K/6 meg. ohm. —20 to +22 dB. 10-0, 100 mfd. 0.100-0.1 mfd. 69/6. P. & P. 2/6.



LAFAYETTE 57 Range Super 50KΩ/V. Multimeter. D.C. volts 125mv—1000v. A.C. volts 1.5v—1000v. D.C. Current 25μA—10 Amp. Ohms 0—10 Meg Ω. D.B.—20 to +81 db. Overload protection. £12/10/-. P. & P. 3/6.

TRANSISTOR FM TUNER

6 TRANSISTOR HIGH QUALITY TUNER SIZE ONLY 6in. × 4in. × 2½in. 3 I.F. stages. Double tuned discriminator, ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. £6/7/6. P. & P. 2/6.
STEREO MULTIPLEX ADAPTORS, 99/6.

SINCLAIR EQUIPMENT

Project 60 range of new models now in stock

Z30 Amplifier	£4.9.6
Stereo 60 Control Unit	£9/19/6
PZ5 Power Supply	£4/19/6
PZ6 Power Supply	£7/19/6
Q16 Speakers	£8/19/6

All Post Paid

SPECIAL PACKAGE OFFER!
2 × Z20 Amplifier, Stereo 60 and PZ5 Power Supply (Carr. 7/6) £19
or with 2 × Q16 Speakers (Carr. 7/6) £35
Micromatic Radio Kit 49/6
Micromatic Radio Built 59/6
Sinclair IC/10 in stock 59/6
2000 Amplifier £23/10/0. Carr. 7/6.
Neoteric Amplifier £42/10/0. Carr. 7/6.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband, 6ft. cable and stereo jack plug, 25-17,000 cps., 8Ω imp. 67/6. P. & P. 2/6.

HOSIDEN DH04S 2-WAY STEREO HEADPHONES

Each headphone contains a 2½in. woofer and a 1in. tweeter. Built in individual level controls. 25-18,000 c.p.s. 8Ω imp. with cable and stereo plug. £5/19/6. P. & P. 2/6.

HOSIDEN DH-02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable headband. 8 ohm impedance. 20-12,000 cps. Complete with lead and stereo jack plug. ONLY 47/6 P. & P. 2/6.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £6/19/6 pair. P. & P. 3/6.

TE111 DECADE RESISTANCE ATTENUATOR

Variable range 0-111 db. Connections. Unbalanced T and Bridge T. Impedance 600 ohms. Range (0.1 db × 10) + (1 db × 10) + 10 + 20 + 30 + 40 db. Frequency: DC to 200 KHZ (—3db). Accuracy: 0.05 db. + indication db × 0.01. Maximum input less than 4 watts (50 volts). Built in 600 Ω load resistance with internal/external switch. Brand new £27/10/-. P. & P. 5/-.

RECORDING HEADS

Cosmocord ¼ track heads: Post extra.

Record/replay. High imp.	65/-
Erase. Low imp.	20/-
Marriott ¼ track heads. Post extra.	
Record/Playback, high imp.	65/-
Erase, low imp.	20/-

AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities. Postage 2/-. Over £3 post paid.	3in. 225ft. L.P. Acetate	3/6
	3½in. 600ft. T.P. Mylar	10/-
	5in. 600ft. Std. plastic	8/6
	6in. 900ft. L.P. acetate	10/-
	5in. 1,200ft. D.P. Mylar	15/-
	5½in. 1,200ft. L.P. acetate	12/6
	5½in. 1,200ft. L.P. Mylar	16/-
	5½in. 1,800ft. D.P. Mylar	22/6
	5½in. 2,400ft. T.P. Mylar	39/6
	7in. 1,200ft. Std. acetate	12/6
	7in. 1,800ft. L.P. acetate	15/-
	7in. 1,800ft. L.P. Mylar	20/-
	7in. 2,400ft. D.P. Mylar	25/-
	7in. 3,600 ft. T.P. Mylar	45/-

TAPE CASSETTES

Top quality in plastic library boxes.
C60— 60 min. 8/6; 3 for 24/6.
C90— 90 min. 12/6; 3 for 36/-.
C120—120 min. 15/-; 3 for 43/6.
Cassette Head Cleaner 11/3 All Post Extra.

G.W.SMITH & CO.(RADIO) LTD

All Mail Orders to—
147, Church Street, London, W.2
Tel: 01-262 6562
(Trade supplied)

3, LISLE STREET, LONDON, W.C.2 Tel: 01-437 8204
34, LISLE STREET, LONDON, W.C.2 Tel: 01-437 9155
311, EDGWARE ROAD, LONDON, W.2 Tel: 01-262 0387
OPEN 9-6 MONDAY TO SATURDAY (EDGWARE ROAD ½ DAY THURSDAY)

SUPER-BARGAIN STOCKTAKING SALE!!

Use form below for your order. CONDENSERS MUST BE ORDERED BY STOCK NUMBER ONLY. If any sale item is 'sold-out' when order received we shall substitute items of equal value.

ELECTROLYTIC CAPACITORS

Stock No.	Capacity	Voltage	Price s.	Price d.	No. Required	£ s. d.
1	1 uf	6		4		
2	4 uf	25		4		
3	4 uf	4		4		
4	6 uf	6		4		
6	64 uf	9		4		
7	20 uf	6		4		
11	8 uf	6		4		
16	32	150		9		
17	64	2.5		3		
18	100/200/200/50	275	7	6		
19	50/80	300	3	0		
21	24	275	1	0		
22	10	25		3		
23	125	2.5		3		
25	16/32	350	2	6		
26	32	275	1	6		
28	75/75/75/75	150	2	6		
30	12.5	40		9		
32	3,000	35	7	6		
33	3,000	15	3	0		
34	3,000	30	7	0		
35	250	70	2	0		
36	2,500	9	2	0		
38	750	12	1	9		
39	100 uf	275	2	6		
40	30 uf	10		3		
42	16 uf	50 REV	2	0		
43	16/16	275	2	0		
44	16	275	1	0		
45	350	12		9		
46	20/4	275	1	0		
47	250	50	2	0		
48	500	25	1	6		
49	400	15	1	0		
50	400	2.5		3		
51	64	275	1	9		
52	32/32	350	2	6		
53	8/8/8	275	1	9		
54	500	6		6		
55	64	275	1	3		
56	25	6		3		
57	100	9		6		
58	400	50	2	0		
59	400	30	1	6		
60	500	4		3		
61	150	30	1	6		
62	64/32/8	275	2	6		
64	40	6.4		3		
67	30	6		3		
68	100/100/50	275	5	0		
69	50/50/50	350	4	0		
70	40/40/20	275	2	0		
71	400	6.4		3		
72	320	10		3		
73	32/32 + 25	275 25	2	6		

Total:

RESISTORS. EXCELLENT QUALITY. MAINLY 5%. 7/6d. per 100 of any one value. 2/- per dozen of any one value. Smaller quantities 3d. each.
Tick the values required:

13 ohms	560 ohms	3.3 k ohm	10 k ohm	39 k ohm	91 k ohm	1.2 meg ohm	8.2 meg ohm
22 ohms	750 ohms	3.6 k ohm	16 k ohm	43 k ohm	130 k ohm	1.5 meg ohm	9.1 meg ohm
36 ohms	1 k ohm	4.3 k ohm	18 k ohm	47 k ohm	360 k ohm	1.8 meg ohm	10 meg ohm
47 ohms	1.5 k ohm	4.7 k ohm	22 k ohm	51 k ohm	430 k ohm	3.6 meg ohm	
91 ohms	1.8 k ohm	5.6 k ohm	24 k ohm	62 k ohm	470 k ohm	5.1 meg ohm	
220 ohms	2.2 k ohm	6.8 k ohm	27 k ohm	75 k ohm	560 k ohm	6.2 meg ohm	
470 ohms	2.4 k ohm	7.5 k ohm	30 k ohm	82 k ohm	620 k ohm	7.5 meg ohm	

or our selection (mixed) 6/6d. per 100.

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS. 10/- per 100 of any one value. 3/- per dozen of any one value. Smaller quantities 6d. each. As available. In following values. Tick those required.

2 pf	5 pf	12 pf	25 pf	50 pf	80 pf	135 pf	180 pf	250 pf	680 pf	1,000 pf	2,500 pf
3.9 pf	6 pf	15 pf	27 pf	58 pf	82 pf	140 pf	190 pf	330 pf	800 pf	1,100 pf	2,700 pf
4 pf	8 pf	18 pf	30 pf	62 pf	100 pf	158 pf	200 pf	450 pf	820 pf	1,500 pf	3,000 pf
4.7 pf	10 pf	22 pf	39 pf	72 pf	125 pf	170 pf	240 pf	600 pf	900 pf	2,200 pf	6,200 pf

Total:

COMPARE THESE PRICES!!

MULLARD POLYESTER CONDENSERS

		No.	Price
1,000 pf	3d. each	400V	
1,500 pf	3d. each		
1,800 pf	3d. each		
2,200 pf	3d. each		
.15 uf	6d. each	160V	
.22 uf	6d. each	160V	
.27 uf	6d. each	160V	
1 uf	1/- each	125V	

Total:

25% discount lots of 100 per type.
50% discount lots of 1,000 per type.

TRANSISTOR BARGAIN! THEY CAN'T GET ANY CHEAPER! ! ! ! !
P.N.P. Audio. Untested, unmarked. MAINLY O.K. .. **10/-** per 100
N.P.N. Silicon. R.F. types unmarked ALL USEABLE .. **10/-** per 50
POWER OUTPUT (Similar OC35) ALL TESTED .. **4/-** each **£2** dozen

SILICON PLANAR TRANSISTORS. ALL TESTED. NO LEAKS OR SHORTS. Gain of 20/50 6d. each, 50/100 9d. each, 100/200 1/- each.

LIGHT SENSITIVE TRANSISTORS, 2/- each.

LIGHT SENSITIVE DIODES
Can be used to control any transistorised device, **1/-** each.
75/- per 100. **£25** per 1,000.

THYRISTORS. 400 volt BTY 79 **7/6d.** each. SCR 51 (10 amp) **£1** each.

RECTIFIERS. Latest type. All marked. 800 volt peak, 1 amp mean current type 1N4006. **2/6** each, **24/-** dozen, **£7/10/-** 100. S.T.C. **3/4** (400 volt) **2/6** each, **24/-** dozen, **£7/10/-** 100. BYZ 13 or 19 (6 amp) **2/6** each, **24/-** dozen, **£7/10/-** 100.

BY 127 2/6d. each. **24/-** dozen. **£7/10/-** per 100. **£50** per 1,000.

RECORDING TAPE GIVE-AWAY! ALL BRITISH MADE, BEST QUALITY!

5" Standard	**7/6d.**				
5½" Standard	**9/-**	5½" Long-play	**12/-**		
7" Standard	**12/-**	7" Long-play	**16/3**		
3" "Oddends" Minimum 150	**2/3d.**				

MAINS DROPPER TYPE RESISTORS. Hundreds of types from .7 ohm upwards. 1 watt to 50 watts. A large percentage of these are Multi-tapped droppers for radio/television. Owing to the huge variety these can only be offered "assorted". **10/-** per dozen.

GIANT SELENIUM SOLAR CELLS. Last few to clear at half price! Circular, 67 mm. diameter **5/-** each. 50 mm. × 37 mm. **3** for **10/-**.

SKELETON PRESETS. Mixed. **6/-** dozen.

VOLUME CONTROLS. ¼ meg. 1 meg. with D.P. switch 5k. (No switch) all **2/-**

RECORD PLAYER AMPLIFIERS. All transistor. Complete with screened input lead, volume control and speaker leads. This excellent unit also has built-in rectifier and smoothing components enabling same to be used direct on 6 to 9 volt A.C. supply. Small number only! Cannot be repeated at this price! **30/-** ea.

TRANSISTOR RADIOS. Fantastic bargain! Tremendous value! Superb quality sound from large speaker! Excellent sensitivity! Complete with earpiece, battery and plastic carrying case, all packed in a colourful presentation box. You would expect to pay £5—but our price due to huge purchase is only **37/6d.**!

CO-AXIAL CABLE. Semi-air spaced. **8d.** yard. 60 yd. rolls **30/-** Postage **4/6d.**

CRYSTAL TAPE-RECORDER MIKES, 12/- each. **CRYSTAL EAR-PIECES WITH PLUG, 5/-** each. Magnetic earpieces. No plug. **1/6d.** each.

THIN CONNECTING WIRE. 10 yds **1/-**, 100 yds **7/6d.**, 1,000 yds. **50/-**.

RECORD PLAYER CARTRIDGES

ACOS GP67/2 **15/-** (Mono)	GP94/1 **30/-** (Stereo, ceramic)
ACOS GP91/3 **20/-** (Compatible)	ACOS GP93/1 with diamond needle **32/6d.**
ACOS GP93/1 **25/-** (Stereo)	ACOS GP94/1 with diamond needle **37/6d.**

TRANSISTORISED FLUORESCENT LIGHTS. 12 VOLT
8 watt 12" tube, Reflector type **59/6** 15 watt 18" tube, Batten type **79/6**
Complete with tube. Postage **3/-**

TRANSISTORISED SIGNAL INJECTOR KIT **10/-**
TRANSISTORISED SIGNAL TRACER KIT **10/-**
TRANSISTORISED REV. COUNTER KIT (CAR) **10/-**

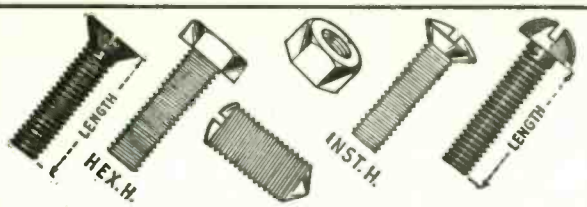
VERO-BOARD

2½" × 1" × .15	**1/3**	17" × 3½" × .15	**14/8**		
3½" × 2½" × .15	**3/3**	3½" × 2½" × .1	**4/2**		
3½" × 3½" × .15	**3/11**	3½" × 3½" × .1	**4/9**		
5" × 2½" × .15	**3/11**	5" × 2½" × .1	**4/7**		
5" × 3½" × .15	**5/6**	5" × 3½" × .1	**5/6**		
17" × 2½" × .15	**11/-**				

Spot Face Cutter **7/6d.** Pin Insert Tool **9/6d.** Terminal Pins **3/6d.** for 36. Spot Face Cutter and 5 2½" × 1" boards **9/9d.**

These prices cannot be repeated. Order now. Don't forget to add your name and address! Please include suitable amount to cover post and packing. Minimum 2'-.

G. F. MILWARD, DRAYTON BASSETT, near TAMWORTH, STAFFS. Phone: TAMWORTH 2321



We supply B.A. Screws, etc. in brass, steel, stainless, phosphor bronze and nylon to laboratories throughout the Commonwealth.

We can also offer early delivery for many sizes of screws, etc. with Metric Threads

Please send for List W2/69 (WW)

WALKER-**SPENCER COMPONENTS** LTD.

5, High Street, Kings Heath, Birmingham, 14.

Telephone: 021-444 3155 (Sales) and 5278

WW—124 FOR FURTHER DETAILS

MODEL 360-YTR

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-1B	£3 7 6	Model K-30THD	£12 0 0
Model JP-50	£5 10 0	Model F-80TRD	£13 15 0
Model U-50DN	£7 10 0	Model 380-CE	£15 2 6
Model 360-YTR	£7 17 6	Model 430-ES	£19 0 0
Model A-303TRD	£10 10 0	Model EM-700	£51 0 0
Model AT-1	£11 7 6		

Cases available with most meters

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—125 FOR FURTHER DETAILS

4-STATION INTERCOM

Our Price Only **£7/15/0**

Solve your communication problems with this new **4-Station Transistor Intercom** system (**1 master** and **3 subs**), in de luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master.** Operates on one 9 v. battery. On/off switch. Volume control. Ideally suitable to modernise Office, Factory, Workshop, Warehouse, Hospital, Shop, etc., for instant inter-departmental contacts. Complete with 3 connecting wires, each 66ft. and other accessories. Nothing else to buy. P. & P. 7/6 in U.K.

INTERCOM/BABY ALARM

OUR PRICE ONLY **3 gns.**

Same as 4-Station Intercom for two-way instant conversation from MASTER to SUB and SUB to MASTER. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

MAINS INTERCOM

No wires—no batteries. Just plug in and it is ready to use. Room to room or house to house. Both units must be on the same side of power line distribution. Lock button. Useful as baby alarm. Price per pair **£11.19.6.** P. & P. 8/6.

Transistor TELEPHONE AMPLIFIER

59/6

Why not increase efficiency of Office, Shop and Warehouse with this incredible De-Luxe Portable Transistor **TELEPHONE AMPLIFIER** which enables you to take down long telephone messages or converse without holding the handset. A useful office aid. A must for every telephone user. Useful for hard of hearing persons. On/off switch. Volume Control. Operates on one 9 v. battery which lasts for months. Ready to operate. P. & P. 3/6 in U.K. Add 2/6 for Battery.

Full price refunded if returned in 7 days.

WEST LONDON DIRECT SUPPLIES (W.W.), 169 Kensington High Street, London, W.8

ATES

PRONOUNCED R-TEZ

SEMICONDUCTORS

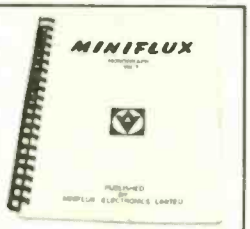
Write now for catalogue

ATES ELECTRONICS LTD., MERCURY HOUSE, PARK ROYAL, LONDON W5

TEL: 01-998 6171 TELEX: ATES LONDON 262401

WW—119 FOR FURTHER DETAILS

MINIFLUX audio magnetic recording MANUAL VOL. 1.



A complete set of Laboratory Application Reports on the replay of audio magnetic recordings.

Packed with hitherto unpublished information. Full constructional details are included for several high quality pre-amplifiers of advanced design as well as multi-channel integrated circuit modules. Each design step is thoroughly discussed and supported by detailed test measurements and calculations.

Size A4. 131 Pages. Price 31s. 6d. inc. UK postage.

Direct from the Publishers:

MINIFLUX ELECTRONICS LIMITED,
8 Hale Lane, London, N.W.7, ENGLAND.

WW—120 FOR FURTHER DETAILS

Lasky's

AUDIO TRONICS 1970

The 1970 edition of Lasky's famous Audio Tronics catalogue is now available—FREE on request. The 28 tabloid pages—equal to over 100 pages of our normal "WW" advertising—are packed with 1,000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast. Electronics Hobbyist, Servicemen and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals), tape recording and Audio accessories **PLUS Lasky's amazing money saving vouchers worth over £25.** All the goods shown are available from any of our branches or by Mail Order—bringing the benefits of shopping at Lasky's to you in the comfort of your home. Over 150,000 customers have already received their copy of the "Audio Tronics" catalogue—don't delay.

Send: Your name, address and 2/- to cover post only and the inclusion of your name on our regular mailing list.

Lasky's Radio Limited
3-15 Cavell Street, London, E.1.

FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. **19/6**. Kit B—30-40 w. **19/6**. Kit C—80 w. **23/6**. Kit E—65 w. **19/6**. Kit MF1 is for 6in., 9 in. and 12in. miniature tubes, **19/6**. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:
Miniature. 1in. long × approximately ¼in. diameter. Will make and break up to ½A up to 300 volts. Price **2/6** each. **24/-** dozen.
Standard. 2in. long × 3/16in. diameter. This will break currents of up to 1A, voltages up to 250 volts. Price 2/- each. **18/-** per dozen.
Flat. Flat type, 2in. long, just over 1/16in. thick, approximately ¼in. wide. The Standard Type flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1 amp 200 volts. Price **6/-** each. **£3** per dozen.
Small ceramic magnets to operate these reed switches **1/9** each. **18/-** dozen.

TELESCOPIC AERIAL

For portable, car radio or transmitter. Chrome-plated—six sections extends from 7½ to 47in. Hole in bottom for 6BA screw. **7/6**.

TOGGLE SWITCH

3 amp 250v. with fixing ring. **1/6** each **15/-** doz.

MINIATURE EAR PIECE

As used with imported pocket radios. **1/6** each **15/-** doz.

ISOLATION SWITCH

20 Amp D.P. 250 Volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on. **4/6** **48/-** per dozen.

15/20 AMP CONNECTORS

Polythene insulated 12-way strip. **2/6** each **24/-** doz.

13 AMP FUSED SWITCH

Made by G.E.C. For connecting water heater etc., into 13 amp ring main. Flush type **3/6** each **30/-** doz. Metal boxes for surface mounting **1/6** each **15/-** doz.

MICRO SWITCH

5 amp. changeover contacts. **1/9** each **18/-** doz. 15 amp model **2/-** ea. or **21/-** doz.

SUPPRESSOR CONDENSER TCC

.1 mfd. 250v. A.C. working metal cased with fixing lug. **1/9** each **18/-** doz.

REED RELAY

Glass encapsulated reed switch in 24-volt solenoid, neatly enclosed in neat metal case, size 2½in. × ⅞in. × ⅛in. **3/6** each. Operates from 24 volts D.C or from A.C. mains using rectifier, resistor and condenser (**3/6** extra).

SHEET PAXOLIN

Ideal for transistor projects, panels 12in. × 6in., 1/9 each. **15/-** per dozen.

G.E.C. MULTIPLE SWITCHES

Metal boxes (with cable knockouts) sprayed silver with cover and switch mounting grid. For 12 switches **6/-**, 6 switches **5/-**, 4 switches **4/-**, 2 switches **3/6**.

G.E.C. Clipper Switches
For the above boxes, 5 amp A.C. rating, one-way **1/6**, 2-way **2/-**, Bell push **2/-**, intermediate **2/6**, secret **2/6**, 15 amp one-way **2/6**.

THERMOSTAT

Continuously variable 30°-90°C. Has sensor bulb connected by 33in. of flexible tubing. On operation a 15 amp 250 volt switch is opened and in addition a plunger moves through approx. ¼in. This could be used to open valve on ventilator etc. **29/6** plus 4/6 p. & ins.

HI FI BARGAIN

FULL FI 12-INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.
Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S.—Cone moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms—Main resonance 60 c.p.s.—Chassis Diam. 12in.—12⅛ over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4, holes—¼in. diam. on pitch circle, 11¼in. diam.—Overall height 5¼in. A £6 speaker offered for only **£3.19.6** plus 7/6 p. & p. Don't miss this offer. 15in. 25 watt **£7.19.6**. 18in. 100 watt **£19.10.0**.

RING MAIN JUNCTION BOXES

Made by Rock. This won Designs Award for making quick and neat junctions in 9.029 twin and earthed cable as used for ring main circuits. Our price **1/6** each, **15/-** per dozen.

ERGOTROL UNITS

These units made by the Mullard Group are for operating and controlling d.c. Motors and equipment from A.C. mains.
Thyristors are used and these supply a variable d.c. resulting in motor speed control and operating efficiency far superior to most other methods.
The units are contained in wall mounting cabinets with front control panel on which are fuses—push buttons for on/off and the variable thyristor firing control.
4 models are available—all are brand new in makers cases:

Model 2410 for up to	5 amps	**£17.10.0**
Model 2411 for up to	10 amps	**£27.10.0**
Model 2413 for up to	45 amps	**£47.10.0**
Model 2415 for up to	80 amps	**£95. 0.0**

Note: 2415 is a floor mounting unit.

MINIATURE EXTRACTOR FAN

Beautifully made by famous German Company. PAPST System, 230/240 A.C. Mains operated, size 3½in. × 3½in. × 2in. Made for instrument cooling but ideal to incorporate in a cooker hood, etc. **65/-** P. & p. 2/9.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work **39/6** less plug. **45/-** with fitted 13 amp plug. **47/6** with fitted 15 amp plug, plus 4/6 P. & I.

STANDARD WAFER SWITCHES

Standard size 1½ wafer—all silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	10 way	12 way
1 pole	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
2 poles	6/6	6/6	6/6	6/6	6/6	6/6	10/6	10/6
3 poles	6/6	6/6	6/6	6/6	10/6	10/6	14/6	14/6
4 poles	6/6	6/6	6/6	10/6	10/6	10/6	18/6	18/6
5 poles	6/6	6/6	10/6	10/6	14/6	14/6	22/6	22/6
6 poles	6/6	10/6	10/6	10/6	14/6	14/6	26/6	26/6
7 poles	6/6	10/6	10/6	14/6	18/6	18/6	30/6	30/6
8 poles	10/6	10/6	10/6	14/6	18/6	18/6	34/6	34/6
9 poles	10/6	10/6	14/6	14/6	22/6	22/6	38/6	38/6
10 poles	10/6	10/6	14/6	18/6	22/6	22/6	42/6	42/6
11 poles	10/6	14/6	14/6	18/6	26/6	26/6	46/6	46/6
12 poles	10/6	14/6	14/6	18/6	26/6	26/6	50/6	50/6

24 HOUR TIME SWITCH

Mains operated. Adjustable Contacts give on/off per 24 hours. Contacts rated 15 amps, repeating mechanism so ideal for shop window control, or to switch hall lights (anti-burglar precaution) while you are on holiday. Made by the famous Smiths Company. This month only **39/6** complete with perspex cover, new and unused, plus 3/6 postage and insurance, a real snip which should not be missed.

THIS MONTHS SNIP

1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4½in. × 3½in., which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. **22/6**.

1 WATT AMPLIFIER & PRE-AMP

5 transistors—highly efficient made for use with tape-head G4 but equally suitable for microphone or pick up. Limited quantity **29/6**. Full circuit diag. also shows tape controls 5/-.

VARIAC CONTROLLERS

With these you can vary the voltage applied to your circuit from zero to full mains without generating undue heat. One obvious application therefore is to dim lighting. We offer a range of these, ex-equipment but little used and in every way as good as new. Any not so, will be exchanged or cash refunded. 2 amp **£4.19.6**. 5 amp **£7.19.6**. 8 amp **£12.19.6**. 10 amp **£15.19.6**.

HOUR COUNTERS

If you wish to know how long your equipment has been switched on then this is what you need. Counts running time up to 999 hours. 50 c/s mains operation. **49/6** plus 3/6 post and insurance. Resettable type **69/6** plus 3/6 post and insurance.

THE PECTRON HEATING/VENTILATING CONTROL

This neat unit contains all the controls needed for a gas-fired central heating system as follows:—
(*a*) A clock switch giving 2 on/off periods per 24 hours.
(*b*) A thermal delay switch to prevent cold air being blown while fire warms up.
(*c*) Auto transformer to vary voltage and thus control fan speed.
(*d*) A 24-volt transformer to provide the low voltage necessary to operate solenoid of gas valve.
(*e*) A changeover switch to bypass the clock.
(*f*) Changeover switch to cut off heat so allowing cold air to be blown for Summer ventilation.
(*g*) Neon indicator and fuses.
The unit has a circuit diagram and five leads labelled "Mains," "Fan," "Thermostat 1," "Thermostat 2," "Gas valve." **£5.19.6** plus 4/6 postage and insurance.

See in the dark

INFRA RED MONOSCOPE

This equipment is complete and portable. Basically it consists of an infra red image converter tube with optical lenses for focusing the image and a Zambini pile to provide the necessary E.H.T. The monoscope is housed in a hide case size 9 × 6 × 4in. approx.
Made originally for the army for night observations, sniping etc., this equipment has many scientific and practical applications; a limited quantity only is available in original sealed carton. Price **£9.19.6**.
NOTE. Although unused in fact still in original sealed cartons. The equipment is approx. 25 years old and consequently the Zambini pile may not now be operative. Drying out might help but a better idea might be to replace it with a battery operated power unit; there is plenty of room.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at **3/6** each, **36/-** dozen, your assortment.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 10/- post free.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions **19/6**, plus 2/6 post and insurance. Made up model also available **37/6** plus 2/6 p. & p.

MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **9/6**. Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only **39/6**, less than the value of the clock alone—post and insurance 2/9.

COOKER CLOCK with temperature contoller

Cooker clock with temperature controller. This is as the clockswitch described above but with additional panel which incorporates oven thermometer and thermostatic switch. The thermostat switch may be set anywhere between 50°C. and 90°C. Made for high-class continental cooker, this is a very fine instrument. **£4.19.6**, plus **£1.10.0** for oven sensor unit.

THERMAL CUTOUT

A miniature device ½in. dia. on one screw fixing mount—can be used for motor overload protection—fire alarm—soldering iron switch off, etc., etc.—15 amp contacts open with flame radiant or conducted heat. **1/6** each, **15/-** doz. **£5** 100.

COPPER CLAD ELEMENT

1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above. **12/6** each, plus 4/6 post. **£6** doz. post paid.

0·0005mFd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits **2/6** each. **24/-** doz.

SUB-MINIATURE MOVING COIL MICROPHONE

as used in behind the ear deaf aids

Acts also as earphone size only ½in. × ⅝in. × ¼in. Regular price probably £3 or more. Our price **19/6**. Note these are ex-equipment but if not in perfect working order they will be exchanged.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **16/6**, plus 3/6 postage.

PP3 BATTERY ELIMINATOR

Run your small transistor radio from the mains—full wave circuit. Made up ready to wire into your set and adjustable high or low current. **8/6** each.

85 Watt Tubular Element. Very well made unit. The element is wound on a porcelain former then encased in a brass tube terminated with beaded leads 12in. long. Normal mains voltage. Price **5/-** each or **54/-** per doz.

250V AC working condensers for power factor correction, motor starting etc. 3.5 mfd. **6/6** ea., 6.5 mfd. **8/6** ea., 8 mfd. **9/6** ea.

3 amp battery charger kit comprises copper backed circuit board, 3 amp mains transformer, regulator resistors and smoothing condenser **29/6** inc. wiring diagram, post & ins. 4/6.

BALANCED ARMATURE

500 ohm, operates speaker or microphone, so useful in intercom or similar circuits. **6/6** ea., **£3.10.0** doz.

Acos crystal microphone. Adjustable stand converts this from hand mic. to desk mic. **19/6** ea.

HEAVY DUTY POWER PACK

40V 6 amps DC output—comprises 1st class mains transformer with normal primary, screen 20-0-20 6-amp output. Fully smoothed. Completely wired ready to work **£3.19.6** + 8/6 p. & i.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LTD
Dept. WW, 266 London Road, Croydon CRO-2TH
Also 102/3 Tamworth Road, Croydon

ISOLATING/STEP DOWN TRANSFORMER
Primary 0, 240v., Sec. 0, 115, 240v. 10a. Ideal for workshop supply, only 6in. × 7in. × 7in. **£8**, carr. 20/-.

STEP DOWN TRANSFORMER
Primary 0, 240v., Secondary 0, 115v. 300 watts (conservatively rated). 4½in. × 4in. × 4in. **45/-**, p. & p. 8/-.

12v. 4a. POWER SUPPLY

Brand new, weighs 11 lb. Constant voltage transformer, input 0 – 112.5 – 123.5 – 195 – 220 – 235v., produces 12v. 4a. capacitor smoothed output. **£9.10.0** plus 10/– carr.

EX-COMPUTER POWER SUPPLIES
Reconditioned, fully tested and guaranteed. These very compact units are fully smoothed with a ripple better than 10mv. and regulation better than 1%. Over voltage protection on all except 24v. units. 120v. – 130v. a.c. 50c/s input. Mains transformer to suit **£3** extra if required.

We offer the following types:

6v. 8a.	**£10**	20v. 15a.	**£15**
6v. 15a.	**£14**	30v. 7a.	**£12**
12v. 20a.	**£16**	24v. 4a.	**£14**

Carriage 15/– per unit

DIODES EX EQUIP, SILICON

150 PIV 10 amp.	4 for **10**/–
150 PIV 20 amp.	4 for **20**/–
400 PIV 35 amp.	4 for **45**/–

p. & p. 1/–

LARGE CAPACITY ELECTROLYTICS
4½in., 2in. diam. Screw terminals. Top quality German manufacture. Will withstand short circuit discharge.
4,000µF 72v. d.c. wkg.
16,000µF 12v. d.c. wkg.
7/6 each, p. & p. 1/–
£3.10.0 doz., p. & p. 10/–.

PYE CAR RADIO
Push Button Tuning Heart

This PRESTOLOCK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6½in. × 4in. × 2in. **25**/–plus 3/– p. & p.

RELAY OFFER
Single pole changeover. 2in. × 0.6in. × 0.75in. 50v. 2.5KΩ coil, operates on 24v. 8 for **10**/–. 5,000 available, p. & p. 1/6.

MEMORY CORE STORE PLANES
160 BITS **£1.** P. & P. 2/–
4,000 BITS **£4.** P. & P. 4/–
1,000 BITS **£8.** P. & P. 8/–

EXTENSION TELEPHONES

Why get out of the bath when the phone rings. Install one in the bathroom.
19/6 each, p. & p. 5/–.
35/– for 2, p. & p. 8/–.
These are extension phones and do not have bells.

1,750 COMPONENTS FOR 65/– ? ?
YES, QUITE TRUE,
READ ON
BUMPER BARGAIN PARCEL
We guarantee that this parcel contains at least 1,750 components. Short-leaded on panels, including a minimum of 350 transistors (mainly NPN and PNP germanium, audio and switching types—data supplied). The rest of the parcel is made up with: Resistors 5% or better (including some 1%) mainly metal oxide, carbon film, and composition types. Mainly ⅛ and ¼ watt . . . diodes, miniature silicon types OA90, OA91, OA95, IS130, etc. . . . capacitors, including tantalum, electrolytics, ceramics and polyesters . . . inductors, a selection of valves . . . also the odd transformer, trimpot, etc., etc. . . . These are all miniature, up to date, professional, top quality components. Don't miss this, one of our best offers yet!! Price **65**/–, post and packing 6/6 U.K., New Zealand 20/–. Limited stocks only.

9 OA5, 3OA10, 3 Pot Cores, 26 Resistors, 14 Capacitors, 3 GET 872, 3 GET 872B, 1 GET 875. All long leaded on panels 13in. × 4in. 2 for **10**/–, p. & p. 3/6d. 4 for **20**/–, post free.

EX COMPUTER PRINTED CIRCUIT PANELS
2in. × 4in., packed with semi-conductors and top quality resistors, capacitors, diodes, etc. Our price, 10 boards **10**/–, p. & p. 2/–. With a guaranteed minimum of 35 transistors.
25 boards for **£1**, p. & p. 3/6. With a guaranteed minimum of 85 transistors. Transistor data included.

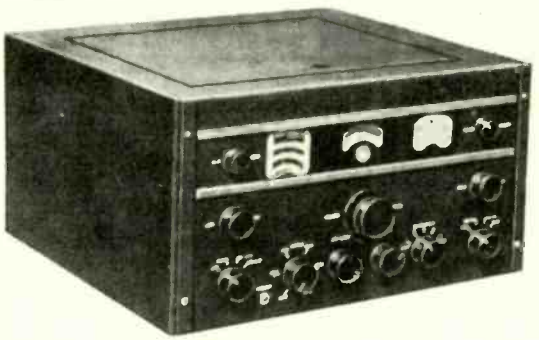
COMPONENT PACKS
200 capacitors, electrolytics, paper, silver mica, etc. **10**/–. Postage on this pak 2/6.
250 mixed resistors **10**/–, post & packing 2/–
40 wirewound resistors, mixed types and values. **10**/–, postage 1/6.


QUANTITIES AVAILABLE
EXTRACTOR/BLOWER FANS (Papst)
100 c.f.m. 4½ × 4½ × 2in. 2,800 r.p.m., 240v. A.C. Precision made in West Germany by Papst. These Fans are the best available. Genuine bargain at **50**/- each.

KEYTRONICS
52 Earls Court Road, London, W.8
Tel. 01-478 8499
MAIL ORDER ONLY. Retail and Trade supplied. Export enquiries particularly welcome. S.A.E. FOR LIST

LATEST RELEASE OF

RCA COMMUNICATION RECEIVERS AR88



BRAND NEW and in original cases—A.C. mains input. 110V or 250V. Freq. in 6 bands 535 Kc/s-32 Mc/s. Output impedance 2.5-600 ohms. Complete with crystal filter, noise limiter, B.F.O., H.F. tone control, R.F. & A.F. variable controls. Price **£87/10/-** each, carr. **£2**.

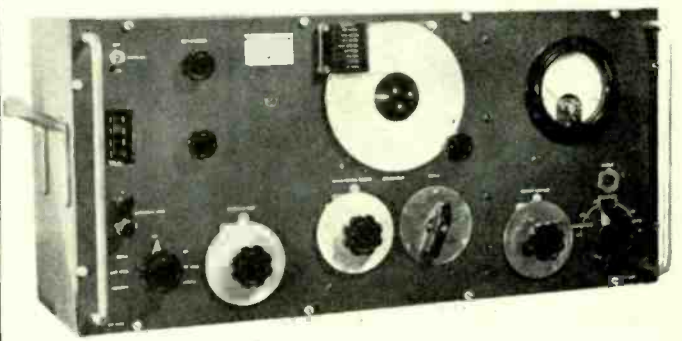
Same model as above in secondhand cond. (guaranteed working order), from **£45** to **£60**, carr. **£2**.

***SET OF VALVES:** new, **£3/10/-** a set, post 7/6; **SPEAKERS:** new, **£3** each, post 10/-. ***HEADPHONES:** new, **£1/5/-** a pair, 600 ohms impedance. Post 5/-.

AR88 SPARES. Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L55. Price **10/-** each, post 2/6. RF Coils 13 & 14; 17 & 18; 23 & 24; and 27 and 28. Price **12/6** each. 2/6 post. By-pass Capacitor K.98034-1, 3×0.05 mfd. and M.980344, 3×0.01 mfd., 3 for **10/-**, post 2/6. Trimmers 95534-502, 2-20 p.f. Box of 3, **10/-**, post 2/6. Block Condenser, 3×4 mfd., 600 v., **£2** each, 4/- post. Output transformers 901666-501 **27/6** each, 4/- post.

** Available with Receiver only.*

S.A.E. for all enquiries. If wishing to call at Stores, please telephone for appointment.



MARCONI SIGNAL GENERATORS

TYPE TF-144G

Freq. 85Kc/s-25Mc/s in 8 ranges. Incremental: +/— 1% at 1Mc/s. Output: continuously variable 1 microvolt to 1 volt. Output Impedance: 1 microvolt to 100 millivolts, 10 ohms 100mV-1 volt-52.5 ohms. Internal Modulation: 400 c/s sinewave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100 c/s. Consumption approx. 40 watts. Measurements: 19¼ × 12¼ × 10 in. The above come complete with Mains Leads, Dummy Aerial with screened lead, and plugs. As New, in Manufacturer's cases, **£40** each. Carr. 30/-. DISCOUNT OF 10% FOR SCHOOLS, TECHNICAL COLLEGES, etc.

W. MILLS
3-B TRULOCK ROAD, TOTTENHAM, N.17
Phone: 01-808-9213

HRO RECEIVER. Model 5T. This is a famous American High Frequency superhet, suitable for CW, and MCW, reception crystal filter, with phasing control. AVC and signal strength meter. Complete HRO 5T SET (Receiver, Set of 5 Coils & Power Unit) for **£27/10/-**, carr. 30/-.

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.

RECEIVERS: Type BC-348, operates from 24 v D.C., freq. range 200-500 Kc/s, 1.5-18 Mc/s. (New) **£35.0.0** each; (second hand) **£20.0.0** each, good condition, carr. 15/- both types.

MARCONI RECEIVER 1475 type 88: 1.5-20 Mc/s, second-hand condition **£10.0.0** each. New condition **£25.0.0** each, carr. 15/-.

RACAL EQUIPMENT: Frequency Meter type SA20: **£35** each, carr. £1. Frequency Counter type SA21: **£65** each, carr. 30/-. Converter Frequency Electronic VHF Type S.A.80 (for use with the SA.20): 25 Mc/s-160 Mc/s, **£40** each, carr. £1.

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. 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, 2Kv, **4/-** each, 1/6 post. 0.01 mfd. MICA 2.5 Kv. Price **£1** for 5. Post 2/6. Capacitor: 0.125 mfd, 27,000v wkg. **£3.15.0** each, 10/- post.

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.
COSSOR 1035 OSCILLOSCOPE, £30 each, 30/- carr.
COSSOR 1049 Mk. 111, £45 each, **30/-** carr.

RELAYS: 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/-**.
Many types of American Relays available, i.e., Sigma; Allied Controls; Leach; etc. Prices and further details on request 6d.

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.

SYNCHROS: and other special purpose motors available. British and American ex stock. List available **6d.**

TCS MODULATION TRANSFORMERS, 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price 25/-, post 5/-.

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.

OHMITE VARIABLE RESISTOR: 5 ohms, 5½ amps; or 2.6 ohms at 4 amps. Price (either type) £2 each, 4/6 post each.

TX DRIVER UNIT: Freq. 100-156 Mc/s. Valves 3 × 3C24's; complete with filament transformer 230 v. A.C. Mounted in 19in. panel, **£4/10/-** each, 15/- carr.

POWER SUPPLY UNIT PN-12A: 230V a.c. input 50-60 c/s. 513V and 1025V @ 420 mA output. With 2 smoothing chokes 9H, 2 Capacitors, 10Mfd 1500V and 10Mfd 600V. Filament Transformer 230V a.c. input. 4 Rectifying Valves type 5Z3. 2 × 5V windings @ 3 Amps each, and 5V @ 6 Amp and 4V @ 0.25 Amp. Mounted on steel base 19"Wx11"Hx14"D. (All connections at the rear). Excellent condition **£8.10.0.** each, Carr. £1.

AUTO TRANSFORMER: 230-115V, 50-60c/s, 1000 watts. mounted in a strong steel case 5" × 6½" × 7". Bitumin impregnated. £5 each, Carr. 12/6. 230-115V, 50-60c/s, 500 watts. 7" × 5" × 5". Mounted in steel ventilated case. £3 each, Carr. 10/-.

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.

MODULATOR UNIT: 50 watt, part of BC-640, complete with 2 × 811 valves, microphone and modulator transformers etc. **£7/10/-** each, 15/- carr.

NIFE BATTERIES: 4 v. 160 amps, new, in cases, **£20** each, £1 10/- carr.

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/-.

FREQUENCY METERS: BC-221, meter only **£30** each, BC-221 complete with stabilised power supply **£35** each, carr. 15/-. LM13, 125-20,000 Kc/s., **£25** each, carr. 15/-. TS.175/U, **£75** each, carr. £1. 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.

AUDIO OSCILLATOR 382/F: Input 115 v. A.C., 50 c/s, 20-200,000 c/s per sec. in 4 ranges. Cont. wave. Output 0-10 v. in 7 ranges. Power output 100 mW. Output impedance 1,000Ω. **£27/10/-** each, £1 carr.

RACK CABINETS (totally enclosed) for std. 19in. panels. Size: 6ft. high × 21in. wide × 16in. deep. With rear door. **£12** each, £2/10/- carr. OR 4ft. high × 23in. wide × 19in. deep. With rear door. **£8/10/-** each, £2 carr.

CATHODE RAY TUBE UNIT: With 3in. tube, Type 3EG1 (CV1526) 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/-.

TEST EQUIPMENT

MARCONI	TF-1274	VHF Bridge Oscillator	£75 each
	TF-1275	VHF Bridge Detector	£75 each
	TF-1067/1	Heterodyne Frequency Meter	£85 each
	TF-899	Valve Millivoltmeter	£35 each
	TF-978	VHF Admittance Bridge	£85 each
	TF-894A	Audio Tester	£55 each
	TF-329G	Circuit Magnification Meter	£45 each
	TF-428/2	Valve Voltmeter	£12/10/- each
	TF-428/1	Valve Voltmeter	£8/10/- each
	TF-726C	UHF Signal Generator	£65 each
	TF-934	Deviation Test Meter	£35 each
	6075A	Deviation Test Meter	£65 each
	TF-987/1	Noise Generator	£20 each
	TF-956	(CT.44) A.F. Absorption Wattmeter	£20 each
FIRZ HILL	V.200	Sensitive Valve Voltmeter	£35 each
	B.810	Incremental Inductance Bridge	£75 each
SOLATRON	CD-513	Oscilloscope	£45 each
	CD-513-2	Oscilloscope	£47/10/- each
	AW-553	Power Amplifier	£30 each
AIRMEC	Type 701 Signal Generator		£50 each
PHILLIPS	Type GM-6008 Valve Voltmeter		£35 each
DAWE	Type 402C Megohm Meter		£12 each

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.** Carr. £2/10/-. Power Unit for Rec., new **£3/5/-.** Carr. 10/-.

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.

TELESCOPIC ANTENNA: In 4 sections, adjustable to any height up to 20 ft. Closed measures 6 ft. Diameter 2 in. tapering to 1 in. **£5** each + 10/- carr. Or **£9** for two + £1 carr. (brand new condition).

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.

PRD Electronic Inc. Equipment: 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/-.

FOR EXPORT ONLY
BRITISH & AMERICAN COMMUNICATION EQUIPMENT

Type B.44 Tx/Rx, Crystal controlled, 60-95 Mc/s, 12V. d.c. operation. W.S. Type 88, Crystal controlled, 40-48 Mc/s. W.S. Type HF-156, Mk. II, Crystal controlled, 2.5-7.5 Mc/s. W.S. Type 62, tunable, 1.5-12 Mc/s. C.44, Mk. II, Radio Telephone, Single Channel, 70-85 Mc/s, 50 watts, output, 230V. a.c. input. G.E.C. Progress Line Tx Type DO36, 144-174 Mc/s, 50 watt, narrow band width. A.C. input 115V. BC-640 Tx, 100-156 Mc/s, 50 watt output, 110V or 230V input. STC Tx/Rx Type 9X, TR1985; RT1986; TR1987 and TR1998, 100-156 Mc/s. TRC-1 Tx/Rx, Types T.14 and R.19, FM 60-90 Mc/s. With associated equipment available. Redifon GR410 Tx/Rx, SSB, 1.5-20 Mc/s. Sun-Air Tx/Rx Type T-10-R. Collins Tx/Rx/Type 18S4A. Collins Tx/Rx Type ARC-27, 200-400 Mc/s, 28V d.c. With associated equipment available. ARC-5; ARC-3; and ARC-2 Tx/Rx. BC-375; 433G; 348; 718; 458; 455 Tx/Rx. Directional Finding Equipment CRD.6 and FRD.2 complete Sets available and spares. Telephone Installation type XY, (U.S.A.), 600 Line Automatic Telephone Exchange. Complete system with full set of Manuals. Mobile Communications Installation mounted in a trailer with 4 × pneumatic tyres. Consisting of 3xARC-27 Tx/Rx with all associated equipment (as new).

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: 01-808 9213

ELECTROVALUE

EVERYTHING BRAND NEW AND TO SPECIFICATION • LARGE STOCKS

BARGAINS IN NEW TRANSISTORS

ALL POWER TYPES SUPPLIED WITH FREE INSULATING SETS

2N696	5/6	2N3707	4/-	AF127	7/-
2N697	5/6	2N3708	3/-	BA102	9/-
2N706	2/9	2N3709	3/-	BC107	2/9
2N1132	9/9	2N3710	3/6	BC108	2/6
2N1302	4/-	2N3711	3/11	BC109	2/9
2N1303	4/-	2N3904	7/6	BC147	3/6
2N1304	4/6	2N3906	7/6	BC148	3/3
2N1305	4/6	2N3731	24/-	BC149	3/6
2N1306	6/9	2N4058	5/3	BC153	10/-
2N1307	6/9	2N3325	10/9	BC154	11/-
2N1308	8/9	2N3794	3/3	BC157	3/9
2N1309	8/9	2N4284	3/3	BC158	3/6
2N1613	6/-	2N4286	3/3	BC159	3/9
2N1711	7/-	2N4289	3/3	BC167	2/6
2N2218	9/3	2N4291	3/3	BC168	2/3
2N2147	18/9	2N4292	3/3	BC169	2/6
2N2369A	5/3	2N4410	4/9	BC177	6/3
2N2646	10/9	2N5192	25/-	BC178	5/8
2N2924	4/-	2N5195	28/3	BC179	6/-
2N2925	4/6	40361	12/6	BD121	18/-
2N2926R	2/3	40362	16/-	BD123	24/3
2N2926O	2/3	AC126	6/6	BF178	10/6
2N2926Y	2/3	AC127	6/-	BFX29	10/9
2N2926G	2/3	AC128	6/-	BFX85	8/3
2N3053	5/6	AC176	11/-	BFX88	6/9
2N3054	14/3	ACY22	3/9	BFY50	4/6
2N3055	16/-	ACY40	4/-	BFY51	4/3
2N3391A	6/3	AD140	19/-	BSX20	3/9
2N3702	3/6	AD149	17/6	MJ480	21/-
2N3703	3/3	AD161 } 16/- comp. pr.		MJ481	27/-
2N3704	3/9	AD162 }		MJ491	30/-
2N3705	3/5	AF118	16/6	NKT403	15/6
2N3706	3/3	AF124	7/6	NKT405	15/-

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below).	100 up
C	1/20W	5%	82Ω–220K Ω	E12	18	16	15
C	1/8W	5%	4·7Ω–330K	E24	2·5	2	1·75
C	1/4W	10%	4·7Ω–10M Ω	E12	2·5	2	1·75
C	1/2W	5%	4·7 Ω–10M Ω	E24	3	2·5	2·25
MO	1/2W	2%	10 Ω–1M Ω	E24	9	8	7
C	1W	10%	4·7 Ω–10M Ω	E12	6	5	4·5
WW	1W	10% ±1/20 Ω	0·22 Ω–3·3 Ω	E12		15d. all quantities	
WW	3W	5%	12 Ω–10K Ω	E12		15d. all quantities	
WW	7W	5%	12 Ω–10K Ω	E12		18d. all quantities	

Codes: C = carbon film, high stability, low noise. MO = metal oxide, Electrosil TR5, ultra low noise. WW = wire wound, Plessey.

Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of one penny on total resistor order.)

Values:
E12 denotes series: 1, 1·2, 1·5, 1·8, 2·2, 2·7, 3·3, 3·9, 4·7, 5·6, 6·8, 8·2 and their decades.
E24 denotes series: as E12 plus 1·1, 1·3, 1·6, 2, 2·4, 3, 3·6, 4·3, 5·1, 6·2, 7·5, 9·1 and their decades.

NEW PLESSEY INTEGRATED CIRCUIT POWER AMPLIFIER TYPE SL403A. Only 48/6 nett. Operates with 18V power supply. Sensitivity 20mV into 20M Ω, 3 watts into 7·5 Ω.
Supplied complete with application Data on orders for 2 or more.

PE NOV. 69 STEREO AMPLIFIER KIT
less metalwork .. **£11/18/- NET complete**

CARBON SKELETON PRE-SETS
Small high quality, type PR: Linear only: 100 Ω, 220 Ω, 470 Ω, 1K Ω, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M Ω, 2M2, 5M, 10M Ω vertical or horizontal mounting .. 1/- each

S-DeCs PUT AN END TO "BIRDS-NESTING". Components just plug in. Saves valuable time. Use components again and again.
S-DeC .. .. .. Only 30/6 post free
Compact T-DeC, increased capacity, may be temperature-cycled.
T-DeC .. .. .. only 50/- post free

WAVECHANGE SWITCHES
1P 12W; 2P 6W; 3P 4W; 4P 3W—long spindles .. .. 4/9 each
SLIDER SWITCHES
Double pole, double throw .. .. 3/- each

MULLARD SUB-MIN ELECTROLYTICS C426 RANGE .. .. .. **Price 1/3 each**
Axial leads. Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

LARGE CAPACITORS. ALL NEW STOCK
High ripple current types: 2000μF 25V 7/4; 2000μF 50V 11/4; 5000μF 25V 12/6; 5000μF 50V 21/11; 1000μF 100V 16/3; 2000μF 100V 28/9; 5000μF 70V 36/-; 5000μF 100V 58/3; 1000μF 50V 8/2; 2500μF 64V 15/5; 2500μF 70V 19/6.

MEDIUM RANGE ELECTROLYTICS
Axial leads. Values (μF/V): 50/50 2/-; 100/25 2/-; 100/50 2/6; 250/25 2/6; 250/50 3/9; 500/25 3/9; 1000/10 3/3; 500/50 4/6; 1000/25 4/-; 1000/50 6/-; 2000/25 6/-; 330/25 2/6.

SMALL ELECTROLYTICS
Axial leads: 5/10, 10/10, 25/10, 50/10 1/- each
25/25, 47/25, 100/10, 220/10 .. .. 1/3 each

COMPONENT DISCOUNTS
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
(No discount on nett items)

POSTAGE AND PACKING
Free on orders over £2.
Please add 1/6 if order is under £2.
Overseas orders welcome: carriage charged at cost.

PEAK SOUND ENGLEFIELD KITS

Build it 12+12 or 25+25

Brilliant new styling and available in two forms:
STEREO 15 WATTS PER CHANNEL
Supplied in kit form with complete amplifier and pre-amplifier modules and power supply components. Output per channel into 15Ω —13 watts R.M.S. Price **£38.9.0 Nett**

STEREO 25 WATTS PER CHANNEL
Supplied in kit form with complete amplifier, pre-amplifier and regulated power supply modules. Output per channel into 15Ω —28 watts R.M.S. Price **£58.15.0 Nett**

Specifications on these amplifiers in accordance with the Specifications in Guarantee published in Peak Sound advertisements.

Inputs:

Magnetic, RIAA	3·5mV	Tape	100mV
Ceramic	35mV	Radio	100mV

Signal to noise ratios: Better than 60dB all inputs.

ENGLEFIELD CABINET to house either above assemblies (as illustrated) **£6.0.0. Nett**
Other Peak Sound Products as advertised.

ZENER DIODES: Full range of 5% 400 mV available in E24 series, 2.7 V to 30 V .. .. **4/6 each**

COLVERN 3 WATT WIRE-WOUND POTENTIOMETERS: 10 Ω, 15 Ω, 25 Ω, 50 Ω, 100 Ω, 150 Ω, 250 Ω, 500 Ω, 1K Ω, 1·5K Ω, 2·5K Ω, 5K Ω, 10K Ω, 15K Ω, 25K Ω, 50K Ω.
Price .. .. only 5/6 each

CARBON TRACK POTENTIOMETERS
Double wiper ensures minimum noise level. Long plastic spindles.

Single gang linear ..	220 Ω, 470 Ω, 1K, etc. to 2M2 Ω	2/6
Single gang log. ..	4K7, 10K, 22K, etc. to 2M2 Ω ..	2/6
Dual gang linear ..	4K7, 10K, 22K, etc. to 2M2 Ω ..	8/6
Dual gang log. ..	4K7, 10K, 22K, etc. to 2M2 Ω .	8/6
Log/Anti-log. ..	10K, 47K, 1M Ω only	8/6
Dual anti-log ..	10K only	8/6

Any type with ½ amp double pole mains switch .. extra 2/3
Please Note—only decades of 10, 22 and 47 are available with range quoted.

FETS n-channel

Low cost general purpose 2N5163, 25 volt ..	only	5/- each
Audio/r.f. Texas 2N3819		8/6 each
Motorola 2N5457 (MPF103)		9/9 each
Motorola 2N5459 (MPF105)		9/9 each

30 WATT BAILEY AMPLIFIER COMPONENTS:
Transistors for one channel £7/5/6 list, with 10% discount .. .. only £6/11/-
Transistors for two channels £14/11/- list, with 15% discount .. .. only £12/7/5
Capacitors and resistors for one channel, Nov. '68 circuit list £2.
Printed circuit board free with each transistor set.
Complete unregulated power supply kit £4/17/6 mono or stereo, subject to discount.
Complete regulated power supply kit Nov. '68 circuit £9/5/- subject to discount.
Further details on application.

MAIN LINE AMPLIFIER KITS AS ADVERTISED. PRICES NET AUTHORISED DEALER

SINCLAIR IC.10 INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMPLIFIER
This remarkable monolithic integrated circuit amplifier and pre-amplifier is now available for despatch from stock. It is the equivalent of 13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is d.c. coupled and applicable to an unusually wide range of uses all of which are detailed in the manual provided with it. **59/6 NETT**
Sinclair products as advertised post free

ELECTROVALUE

DEPT. WW.704, 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY,
Hours: 9-5.30 daily; 1.0 p.m. Saturdays. ***Telephone: Egham 5533 (STD 0784-3)***

BI-PRE-PAK LIMITED

FULLY TESTED AND MARKED

AC107	3/-	OC170	3/-
AC126	2/6	OC171	4/-
AC127	3/6	OC200	3/6
AC128	2/6	OC201	7/-
AC176	5/-	2G301	2/6
ACY17	3/-	2G303	2/6
AF114	4/-	2N711	10/-
AF115	3/6	2N1302-3	4/-
AF116	3/6	2N1304-5	5/-
AF117	3/6	2N1306-7	6/-
AF239	12/6	2N1308-9	8/-
AF186	10/-	2N3819 F.E.T.	9/-
AF139	10/-	Power Transistors	
BFY50	4/-	OC20	10/-
BSY25	7/6	OC23	10/-
BSY26	3/-	OC25	8/-
BSY27	3/-	OC26	5/-
BSY28	3/-	OC28	7/6
BSY29	3/-	OC35	5/-
BSY95A	3/-	OC36	7/6
OC41	2/6	AD149	10/-
OC44	2/6	2S034	10/-
OC45	2/6	2N2287	20/-
OC71	2/6	2N3055	15/-
OC72	2/6	Diodes	
OC73	3/6	AAY42	2/-
OC81	2/6	OA95	2/-
OC81D	2/6	OA79	1/9
OC83	4/-	OA81	1/9
OC139	2/6	IN914	1/6
OC140	3/6		

FREE!

PACKS OF YOUR OWN CHOICE UP TO THE VALUE OF **10/-** WITH ORDERS OVER **£4**

TRY OUR X PACKS FOR UNEQUALLED VALUE

XA PAK

Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.

PRICE £5 PER 1000

POST & PACKING 4/6 U.K.

XB PAK

Silicon TO-18 CAN type transistors NPN/PNP mixed lots, with equivalents to OC200-1, 2N706a, BSY27/29, BSY95A.

PRICE £4-5 PER 500
PRICE £8 PER 1000

POST & PACKING 2/6 U.K.

XC PAK

Silicon diodes miniature glass types, finished black with polarity marked, equivalents to OA200, OA202, BAY31-39 and DK10, etc.

PRICE £4-10 PER 1000

POST & PACKING 2/6 U.K.

ALL THE ABOVE UNTESTED PACKS HAVE AN AVERAGE OF 75% OR MORE GOOD SEMICONDUCTORS. FREE PACKS SUSPENDED WITH THESE ORDERS. ORDERS MUST NOT BE LESS THAN THE MINIMUM AMOUNTS QUOTED PER PACK.

NEW TESTED & GUARANTEED PAKS

B2	4	PHOTO CELLS, SUN BATTERIES. .3 to .5 volts .5 to 2mA	10/-
B77	2	AD161—AD162 NPN/PNP TRANS. COMP. OUTPUT PAIR	10/-
B81	10	REED SWITCHES MIXED TYPES LARGE & SMALL	10/-
B89	2	5 SP5 LIGHT SENSITIVE CELLS LIGHT RES. 400 Ω DARK 1 M Ω	10/-
B91	8	NKT163/164 PNP GERM. TO—5 EQUIVALENT TO OC44, OC45	10/-
B92	4	NPN SIL. TRANS. AO6 = BSX20, 2N2369, 500MHz, 360mW	10/-
B93	5	GET113 TRANS. EQUIV. TO ACY17-21 PNP GERM.	10/-
B96	5	2N3136 PNP SIL. TRANS. TO—18 HPE100-300 IC, 600mA, 200MHz	10/-
B98	10	XB112 & XB102 EQUIV. TO AC126 AC156, OC81/2, OC71/2, NKT271, ETC.	10/-
B99	200	CAPACITORS, ELECTROLYTICS, PAPER, SILVER MICA, ETC. POSTAGE ON THIS PAK 2/6.	10/-
H4	250	MIXED RESISTORS POST & PACKING 2/-	10/-
H7	40	WIREWOUND RESISTORS MIXED TYPES & VALUES. POSTAGE 1/6	10/-

LOOK! TRANSISTORS ONLY 6d EACH

TYPE A
PNP SILICON ALLOY
TO-5 CAN
Spec:—
ICER AT VCE = 20v
1mA MAX.
HFE, 15-100
These are of the 2S300 type which is a direct equivalent to the OC200/205 range.

TYPE B
PNP SILICON
PLASTIC ENCAPSULATION
Spec:—
ICER AT VCE = 10v
1mA MAX.
HFE, 10-200
These are of the 2N3702/3 and 2N4059/62 range.

TYPE E
PNP GERMANIUM
FULLY MARKED
& TESTED

Return of the unbeatable P.1 Pak. Now greater value than ever

Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

Please ask for Pak **P.1.** Only **10/-**
2/- P & P on this Pak.

Make a Rev. Counter for your Car. The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a perfectly linear and accurate rev. counter for any car. 20/- each

NEW UNMARKED UNTESTED PAKS

B78	12	INTEGRATED CIRCUITS. DATA & CIRCUITS OF TYPES, SUPPLIED WITH ORDERS	10/-
B80	8	DUAL TRANS. MATCHED O/P PAIRS NPL-SIL IN TO—5 CAN.	10/-
B82	10	OC45, OC81D & OC81 TRANS. MULLARD GLASS TYPE	10/-
B83	200	200 TRANSISTORS. MAKERS REJECTS. NPN-PNP. SIL. & GERM.	10/-
B84	100	SILICON DIODES DO—7 GLASS EQUIV. TO OA200, OA202	10/-
B66	150	HIGH QUALITY GERM. DIODES MIN. GLASS TYPE	10/-
B86	50	SIL. DIODES SUB. MIN. IN914 & IN916 TYPES	10/-
B87	100	GERM. PNP TRANS. EQUIV. TO OC44, OC45, OC81, ETC.	10/-
B88	50	SIL TRANS. NPN, PNP, EQUIV. TO OC200/1, 2N706A, BSY95A, ETC.	10/-
B60	10	7 WATT ZENER DIODES. MIXED VOLTAGES	10/-
H5	16	1 AMP. PLASTIC DIODES 50–1000 VOLTS	10/-
H6	40	250mW. ZENER DIODES DO-7 MIN. GLASS TYPE	10/-

FREE CATALOGUE AND LISTS for: —

ZENER DIODES
TRANSISTORS, RECTIFIERS
FULL PRE-PAK LISTS
& SUBSTITUTION CHART

MINIMUM ORDER 10/- CASH WITH ORDER PLEASE. Add 1/- post and packing per order. OVERSEAS ADD EXTRA FOR AIRMAIL.

P.O. RELAYS
VARIOUS CONTACTS AND COIL RESISTANCES.
NO INDIVIDUAL SELECTION.
POST & PACKING 5/-
8 for **20/-**

FREE! A WRITTEN GUARANTEE WITH ALL OUR TESTED SEMICONDUCTORS

BI-PRE-PAK LTD DEPT. B, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX
TELEPHONE: SOUTHEND (0702) 46344

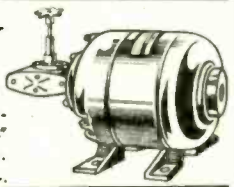
Electro-Tech Sales

NEW HYSTERESIS MOTORS BY WALTER JONES. Type 14050/12, 240v. 50 c/s 1500 RPM cont. rating; output 2.0 oz./in. Size: Length (less spindle) 3¼". Width 2¼"×2¼". Spindle 1"×3/16". Weight 3 lb. Maker's price in region of £22.10.0. Our price **£6.10.0.** each.

K.L.G. Sealed Terminals. Type TLS1 AA, overall length 11/16", box of 100, **25s.** Type TLS1 BB, overall length 1", box of 100, **35s.**

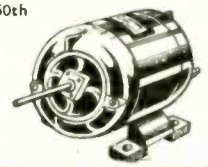
"Parvalux" Reversible 100 RPM Geared Motor

Type S.D.14, 230/250v. A.C. 22 lb./in. Standard foot mounted, variable angle final drive. Removable 9-tooth chain spiggot on 3/16" spindle. 1st class condition. **£7.10.0** each. P. & P. 10/-.



PARVALUX TYPE S/D23 GEARED MOTORS. 240v. A.C. 1 RPM. 14 lbs./in. Also 240v. A.C. 2 RPM. 11 lbs./in. Continuous rating. Standard foot mounting. **£4.15.0** each. P. & P. 10/-.

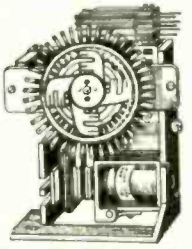
NEW "CROYDON" 240v. A.C. reversible motors. Choice of 1/50th HP, 1,500 RPM, or 1/100th HP, 750 RPM (identical in appearance). Size 3¼" high × 5" long plus spindle 1⅛"×¼" dia. A beautiful motor at less than half maker's original price. **£6.10.0** each.



English Electric ¼ h.p. Motors. 240v. single-phase, standard foot mounted, 1,425 r.p.m., continuous rating. **£4.15.0.** Carriage 20/-.

Isolation Transformers. 1 to 1 ratio. 240v. input, 240v. centre tapped out, at 2 K.V.A., mounted in metal case measuring 8¼"×8¼"×11" high. Weight 65lb. **£16.10.0.** Plus £1 carriage.

SCHRACK ROTARY STEPPING RELAY RT304 48v. coil (28 ohm). The relay has 48 basic segments shorted in step by the 4 sweep contacts to 4 pole-plates (banks of 12). There are 2 secondary switches: (1) one c/o H/Duty contact set which changes over and back with each step; (2) two H/Duty changeovers which changeover on each 12th step and return on the following pulse. Size: Base 3¼"×1¾"×4½" high. New in maker's packing, also, as above, but 110v. (1,290 ohm coil), **£4.15.0** each.



Welwyn high value Resistors Type GA 36501. Values between 9.4 and 10.9 kilo-meg ± 1%, glass encapsulated 15/-.

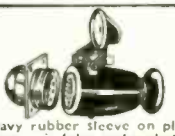
Victoreen "Hi-Meg" Resistors. One value only 50,000 meg ± 2%, glass encapsulated 15/-.

THORN DIGITAL INDICATOR designed as a modular unit for easy mounting where 1st class numerical readout is required. Easily read through a wide angle of view and under bright ambient lighting. 12 characters, 0 to 9, decimal point and minus sign. Characters 13/16" high engraved on acrylic slides and individually edge-lit by 1 watt midget-panel lamps. Overall size of front panel 4¾" high × 1⅞" overall depth 1" finished in matt black supplied with 12 lamps, choice of following ratings—6v. .1A. or 12-14 v. .08A. **£4.0.0** each, spare lamps 24/- per dozen.

ATLAS SUB-MINIATURE LAMPS type L1122 and L1123—a high efficient light-source with excellent light-output and low power demand. Ratings 5v. 60 ma. .35± 25% lumens. Life expectancy 60,000 hours or at 6 v. 70 ma. .75± 25% lumens 5,000 hours. Dimensions: Uncapped 6.3 × 3.1 mm. leads 12.7 mm. capped 9.1 × 3.1 mm. Ideal for instrument lighting normally sold in excess of 12/- each, our price 30/- per dozen or boxes of 50 at £5 per box.

ATLAS MIDGET PANEL LAMPS unrivalled for indication purposes requiring a brilliant but tiny light source. Available with flange cap or wire ended in the following ratings: Capped: 6v. .1A and 12-14v. .08A. Uncapped: 4v. .25A., 6v. .1A., 6v. .2A. 24/- per dozen or boxes of 50 at £4 per box. **INDICATOR LAMP HOLDERS AND CAPS** for **MIDGET PANEL LAMPS** (as above) available red, green, blue. 2/6 each (complete) minimum order 4 units.

THORN TRAILER CONNECTORS—These special 12 way connectors are for heavy vehicle applications and allow uncoupling by strain on the cable. Spring loaded protection caps give a full weather insulation sealing immediately on uncoupling. Heavy rubber sleeve on plug ensures maximum safety **£3.0.0** per pair (plug and socket).



THORN ILLUMINATED PRESS SWITCH for 250v. operation. M.E.S. Pressure on cap completes a second circuit. Very robust. Length 44.5 mm. dia. 30.5 mm. in amber, green or red. **10/6** each.

"Tansitor" (U.S.A.) Tantalum, Wet Sintered Anode Polarised Capacitors. 1200 UF. 6v. D.C. size: 1½" long × ¾" dia. 200 UF. 25v. D.C. size: ¾" long × ½" dia. 180 UF. 25v. D.C. size: ¾" long × ½" dia. 150 UF. 30v. D.C. ¾" long × ½" dia. 33UF. .75v. D.C. size: ½" long × 9/32" dia. One wire each end. All types 5/- each. Also few only, Tansistor "MICRO-MODULE" capacitors 0.2 Mfd. 15v. wire-ended, size: 3/32" dia. (disc) 5/- each.

American "Powerstat" Variable Voltage Transformer by Superior Electric Co. Input 120v. 50/60 c.p.s. Output 0–120v. at 2·25 amps. ¼" spindle with alternative pre-set locking device. Size (approx.) 3" dia. × 2" long. First class condition. **£2.15.0.** P. & P. 5/-.

Berco Rotary "Regavolt," variable voltage transformers input 240v. 50/60 cps., output 0-240v. C.T. at 6 amps. Not new, but in 1st class condition. Few only, **£8.10.0.** P. & C. 10/-.

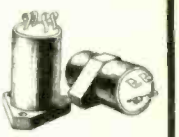
Gardner Transformer Type I.T.N. 876 (new). Enclosed in ventilated metal case. Prim 200/250, sec. 2× 12v. windings rated 4 amps each (96 v.a. in series/parallel). **£3.2.6.**

WE WELCOME OFFICIAL ORDERS FROM ESTABLISHED COMPANIES, EDUCATIONAL DEPTS., ETC.

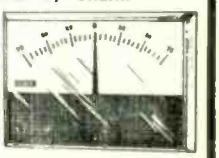
SYLVANIA MAGNETIC SWITCH—a magnetically activated switch operating in a vacuum. Switch speed—4ms. temperature −54 to + 200° C. Silver contacts normally closed rated 3 amps. at 120v. 1.5 amp. at 240v. 10/- each. **£4.10.0** per dozen. Special quotations for 100 or over. Reference Magnets available 1/6 each.

SYLVANIA CIRCUIT BREAKERS gas filled providing a fast thermal response between 80° and 180°C. Will withstand pressures up to 2,000 lb. sq./in. rated 10 amp. at 240v. continuous. Fault currents of 28 amps. at 120v. or 13 amp. at 240v. silver contacts. Supplied in any of the following opening temperatures (degs. cent.) 80, 85, 95, 100, 105, 110, 120, 125, 130, 135, 140, 145, 150, 155, 160, 170, 175, 180. 10/- each or **£4.10.0** per dozen.

MINIATURE "LATCH-MASTER" RELAY 6, 12, or 24v. D.C. operation. One make one break, contacts rated 5 amps. at 30v. Once current is applied, relay remains latched until input polarity is reversed. Manufactured for high acceleration requirements by Sperry Gyroscope Co. Size: Length ¾", dia. 9/16" (including mount). Please state vertical or horizontal mount and voltage. **£2.5.0** each.



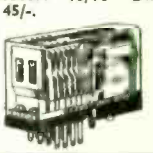
New 75-0-75 Micro-ammeter by Sifam. 750 ohm movement, clear reading, 5μa divisions × ¾"; plastic front, projection ¾" (tapering forward). Size: 4¾"×3¾", **57/6** each.



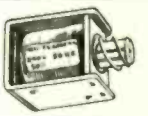
Ernest Turner 5" × 4" 0-1 Ma. calibrated 0-10 in 50 divisions mirrored scale, handsome chrome escutcheon for flush mounting. A quality instrument. **£6.10.0.**

MINIATURE B.P.L. 500-0/500 Micro-Ammeter. 13/16" Diam. scale. Through-Panel mounting, 45/-.

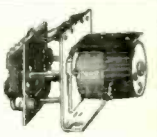
"AUTOMATIC ELECTRIC" ENCLOSED RELAYS
6v. 50Ω 2 c/o, 12/6
24v. 470Ω 4 c/o, 13/6
48v. 2,780Ω 4 c/o, 13/6
48v. 1,260Ω 6 c/o, 15/-



New "Magnetic Devices" solenoid 240v. A.C. Type 42117, 1 to 3 lb. pull, frame size 1⅛"×1¼"×1". 20/- each.



Motor Driven Variable Voltage Transformers by Ohmite (U.S.A.). Input 120/240v., 50/60. c.p.s. Output 0-240v. at 480 v.a. A reversible 115v. a.c. geared motor drives the contact sweep arm in the direction required. There is a micro switch mounted at each end of the track which is cam-operated and intended to be connected as a safety-stop. First class condition. £8.15.0. P. & P. 10/-.



We have a considerable range of glassware, many grades of filter paper, balances, centrifuges, ovens, pumps. etc., etc., for personal callers.

WHERE NO CARRIAGE CHARGE IS INDICATED PRICE IS INCLUSIVE. PERSONAL CALLERS WELCOME.

ELECTRO-TECH SALES

BUSINESS HOURS: 9.30-6 (1 p.m. Sats.)

264 PENTONVILLE ROAD, LONDON, N.1
(ONE MIN. FROM KINGS X STATION) Tel. 01-837 7401

R+TV

RADIO & TV COMPONENTS (Acton) LTD

21a High Street, Acton, London, W.3.
also 323 Edgware Road, London, W.2.
Goods not dispatched outside U.K. Terms C.W.O. All enquiries S.A.E.

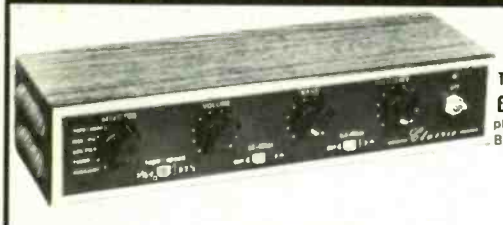
Complete stereo system–£29 10s.

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:
Impedance 3, 8, or 10 ohms (please state impedance required). It incorporates high flux 6" x 4" speaker and 2½" tweeter. Teak finish 12" x 6¾" x 5¾", 4 guineas each. 7/6 p. & p.
Type 2 as type 1. Size 17½" x 10¾" x 6¾". Incorporating 10½" x 6½" bass unit and 2½" tweeter. 3 ohms impedance. 6 guineas plus 15/- p. & p.
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

Duetto Integrated Transistor Stereo Amplifier **£9 10s.** plus 7/6d. p. & p.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.
SPECIFICATION:
R.M.S. power output: 3 watts per channel into 10 ohms speakers
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1 Kc/s.
CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on off switch. A preset balance control.

These 5 items can be purchased together for £29 10s+£1 10s p. & p.



The Classic
TEAK FINISHED CASE
£9
plus 7/6 p. & p.
Built and tested.

SPECIFICATION

Sensitivities for 10 watt output at 1 KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.). Mag. P.U.: 2 mV. Cer. P.U.: 80 mV. Tuner: 100 mV. Aux. 100 mV. Tape/Rec. Output: Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20 Hz to 20KHz. Tone Control Range: Bass ±13 dB at 60 Hz. Treble ±14 dB at 15 KHz. Total Distortion: (for 10 watt output) <1.5%. Signal Noise: <−60dB. AC Mains 200-250v. Size 12½" long. 4½" deep. 2¾" high.

The Viscount
INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFIER
£14 5s. + 7/6 p. & p.
SIZE: 12½" x 6" x 2¾" in teak-finished case.
Built and tested.

SPECIFICATION

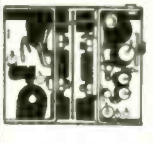
OUTPUT: 10 watts per channel into 3 to 4 ohms speakers (20 watts) monoral.
INPUT: 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U. Tuner. Tape and Tape Rec. out Sensitivities: All Inputs 100 mV into 1.8M ohm.
FREQUENCY RESPONSE: 40Hz-20KHz±2DB.
TONE CONTROLS: Separate bass and treble controls. TREBLE 13dB lift and cut (at 15KHz) BASS: 15dB lift and 25dB cut (at 50Hz).
VOLUME CONTROLS: Separate for each channel. AC MAINS INPUT: 200-240v. 50-60Hz.
Viscount Mark II for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum output of 4mV/cm/sec at 1kc. Input impedance 47k. **£15 15s.** plus 7/6 p. & p.

THE RELIANT MK.II
Solid State
General Purpose Amplifier
In teak-finished case
£6 16s.
+7/6 p. & p.

SPECIFICATION

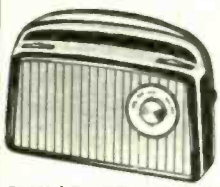
OUTPUT: 10 watts into a 3 ohms speaker.
INPUTS: (1) for mike (10 m.v.). Input (2) for gram. radio (250 m.v.) individual bass and treble control.
TRANSISTORS: 4 silicone and three germanium.
MAINS INPUT: 220/250 volts.
SIZE: 10½" x 4¾" x 2½".
Mk. 1 £5 18s. + 7/6d. p. & p. less Teak-finished case.

X101 10w. SOLID-STATE HI-FI AMP
With Integral Pre-amp.



Specifications: Power Output (into 3 ohms speaker) 10 watts. Sensitivity (for rated output): 1mV into 3K ohms (0.33 microamp) Total Distortion (at 1 KHz): At 5 watts 0.35%: At rated output 1.5% Frequency Response: Minus 3 dB points 20 Hz and 40 KHz. Speaker: 3-4 ohms. (3-15 ohms may be used). Supply voltage: 24v D.C. at 800 mA. (6-24v may be used).

69/6 plus 2/6 p. & p.
CONTROL ASSEMBLY: (including resistors and capacitors). 1. Volume: **Price 5/-.** 2. Treble: **Price 5/-.** 3. Comprehensive bass and treble: **Price 10/-.** The above 3 items can be purchased for use with the X101. **POWER SUPPLIES FOR X101:** P101 M (mono) **35/-** p. & p. 4/6: P101 (stereo) **42/6** p. & p. 4/6.



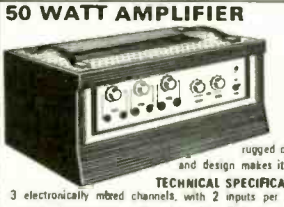
THE DORSET
(600mW Output)
£5.5.0
plus 7/6 p. & p.
Circuit 2/6. FREE WITH PARTS
MAINS POWER PACK KIT: 9/6 extra.

7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulized and pre-alignment techniques makes this simple to build. Sizes: 12" x 8" x 3".

ELEGANT SEVEN MK. III
(350mW Output)
£5.5.0
plus 7/6 p. & p.
Circuit 2/6. FREE WITH PARTS
MAINS POWER PACK KIT: 9/6 extra.

7-transistor fully tunable M.W.-L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.

50 WATT AMPLIFIER



AC MAINS 200-250V
£28 10s.
plus 20/- p. & p.

An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.

TECHNICAL SPECIFICATIONS

3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES.** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300mV at 1m. Suitable for most high output instruments (gram. tuner, organ, etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost** +12dB at 60 Hz. **Bass Cut**—13dB at 60 Hz. **Treble Boost** +11dB at 15 KHz. **Treble Cut** —12dB at 15 KHz. With bass and treble controls central —3dB points are 30 Hz and 20 KHz. **POWER OUTPUT:** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sine wave 38.5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3.2% at 1KHz. Total distortion at 20 watts 0.15% at 1KHz. Output to match into 8 or 15 ohms speaker system. **NEGATIVE FEEDBACK** 20dB at 1 KHz. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES** adjustable from 200-250V. A.C. 50-60 Hz. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

NEW COMPLETE HI-FI STEREO SYSTEM £41

comprising SP25 Garrard Mk II with diamond stereo cartridge or 2025TC. Viscount amplifier Mk I. Two type 2 speakers, plinth and cover.
£41 plus £2.10s. p. & p.

SPECIAL OFFER

Complete stereo systems, comprising BALFOUR 4 speed auto player with stereo head 2 DUO speaker systems size 12 x 6¾ x 5¾. Plinth (less cover) and the DUETTO stereo amplifier. All above items
£25 plus £2 p. & p.

A WIDE SELECTION OF SERVOMOTORS NOW AVAILABLE INCLUDES THE FOLLOWING TYPES:

Mil size 11-400 Hz versions for 26 and 115v. operation with 10/20, 13/26 and 57.5/115v. control phase windings.
Mil size 08, 10, 11, 15 and 18 motor generators for 400 Hz operation with 26 and 115v. energised tacho generators.
Mil size 08, 10, 15 and 18 two phase servometers also available with 400 Hz windings and a limited range in 50 Hz types.
Mil Permanent Magnet Field Servometers Size 08, 11, 15 and 18 with supply voltages from 6 to 50v. D.C.
Mil Tachogenerators Size 08 and 10 for 400 Hz supply.
Mil Size 11 Servomotor gearheads available in various ratios from 10:1 to 1000:1.
All items available ex stock and at extremely competitive prices.
Eversheds and Vignoles' Servomotors and Servomotor-generators—we hold stocks of this well known manufacturer's items amounting to about 100 different types—an enquiry stating your broad design considerations will bring a reply by return indicating ex stock availability of the motor most nearly meeting your requirements.
Write for our Data Sheets A 131 onwards for details of available Servomotors.
MIL SYNCHROS available ex stock in sizes 08, 11, 15, 16, 18 and 23 for 50, 60 and 400 Hz operation.
Synchro Control Transformers
Synchro Control Transmitters
Synchro Control Differential Transmitters
Synchro Torque Transmitters and Receivers
Synchro Resolvers
Equivalent MAGSLIP ELEMENTS more suitable for educational use also in stock.
Write for our Data Sheets A 001 onwards for Synchro and Magslip information.
400 Hz. MOTOR ALTERNATOR SETS Input 400/440v. 50 Hz 3 ph. output 115v. 400 Hz 150VA. (coml. rating) for external excitation £15.

PRECISION POTENTIOMETERS

Numerous instrument types, continuous rotation potentiometers for control application and HELIPOTS in stock. List on application.

Gertsch COMPLEX RATIO BRIDGE Model CRB2B. Six digits in phase, four digits in quadrature. **Our Price £200.**

DRY REED INSERTS Overall length 1.85" (Body length 1.1") Diameter 0.14" to switch 500mA at up to 250v. D.C. Heavily gold clad contacts. **12/6d.** per doz., **75/-** per 100, **£27.10.0** per 1000 for quantities over 1000. **£25.0.0** per 1000 for quantities over 10,000. All carriage paid.
REED RELAYS Low voltage 200 ohm coil, 4 make contacts **7/6d.** each (P. & P. 1/-). Send for our list of several other reed relays available.
I.S.E.P. CONNECTORS Quantities of 11-way male P.C. version in stock.
TRANSISTORS Manufacturers' quantities of the following available: BSX76 (CV8615) fast switching silicon n-p-n. For q'ties 100-999 **2/-** ea., 1000-4999 **1/9d.**, over 5000 **1/7d.** ea. ACY20 medium power a.f. germanium. For q'ties 100-999 **1/10d.** ea., 1000-4999 **1/8d.** ea., over 5000 **1/6d.** ea. Both items in makers' packs.
CAMBRIDGE DYNAMOMETER VOLTMETERS in as new condition. 10 range up to 150v. In as new condition **£45.0.0** ea. plus carriage.
NOISE GENERATORS CT82 15KHz-160MHz into 43, 75 or 400 ohms **£22.10.0.**
OSCILLOSCOPES Solartron Type CD568 **£27.10.0.** Fully serviced.
EVERSHED 500v. WEE MEGGER in leather case. Fully checked **£14.0.0** (Carr. Pd.).

PLUGS, SOCKETS AND CONNECTORS

Large stocks of PLESSEY Mk. IV or VI, 104; PAINTON ELECTROMETHODS; CANNON; BELLING LEE; AMPHENOL; TRANSRADIO items.
Enquiries to Orpington or Lydd.

TANTALUM CAPACITORS

Send for Stock list with lowest prices!

We hold large stocks by S.T.C. T.C.C. DUBILIER KEMET PLESSEY GENERAL ELECTRIC

Immediate delivery!

G.E.C. SEALED RELAYS

A very wide range of these difficult-to-obtain items in stock. List available.

Carriage extra at cost on all items.

Servo and Electronic Sales Ltd.

Electrical and Servo Control Engineers - Electrical Suppliers - Engineering Stockists - Aeronautical Suppliers
43 HIGH STREET, ORPINGTON, KENT. Phone: Orpington 31066/33976/33221
19 MILL ROAD, LYDD, KENT (Works). Phone: Lydd 252
67 LONDON ROAD, CROYDON, SURREY (Retail Branch and Instrument Repairs). Phone: 01-688-1512 (Croydon)

PRESENTING
THE AUDIO *Executive* SIXTY

A high output all-silicon AMPLIFIER of advanced design

We have incorporated into an amplifier all the desirable features that we would always have liked to offer during our several years experience of selling amplifiers—we now have a design incorporating the latest solid state all-silicon circuitry and the result is—

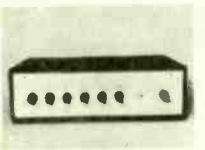
THE AUDIO EXECUTIVE SIXTY!

This creation, while being reasonably priced, provides the following desirable features:—

1. A true 60 Watt R.M.S. continuous rating into 8 ohms.
2. True High Fidelity Performance.
3. Built-in filters to protect speakers.
4. Three independently mixed inputs which can be high or low impedance microphone, crystal ceramic or magnetic cartridge from disc, or from tape, tuner or other auxiliary equipment.

The amplifier is built into a luxurious, supple black semi-quilted plastic covered timber cabinet; the chassis, backed by a massive heat sink carrying the output transistors, input jacks, output sockets, mains voltage adjuster, mains and output fuses, carries the driver transistors mounted on their own substantial heat sink, the input and output controls and the on/off switch. The power supply components are mounted direct on the sturdy chromatised cadmium plated chassis. The Audio Executive Sixty fully meets the requirements for

Discotheques.
General Sound Reinforcement Systems.
High Power HiFi Systems.
Vocal and Guitar Amplification.



Price **£58.15.0**

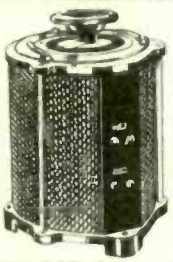
Guaranteed for six months. **Individually packed in cartons. Trade Supplied**

SPECIFICATION

Power Output: 60 watts continuous sine wave into 8 ohms (resistive). 40 watts continuous sine wave into 15 ohms (resistive). 5A fuse incorporated in output circuit.
Damping Factor: 30 (source impedance 0.5 ohm approx.).
Distortion: Total Harmonic Distortion at 1KHz at 60 watts into 8 ohms less than 1%, at 40 watts into 15 ohms less than 0.3%.
Frequency Response: ± 1db 40 Hz to 15 KHz.
Hum and Noise: —70 db.
Sensitivity: Input 1a 15mV Z=50K ohms flat.
1b 1.5mV Z=5K ohms flat.
Input 2a 4.5mV Z=50K ohms RIAA compensated.
2b 200mV Z=100K ohm. flat.
Input 3 200mV Z=100K ohm. flat.
Inputs 1 and 2 and 3 operate simultaneously offering full mixing facilities: choice of either a or b inputs, automatically disconnects the other. Alteration in level from any two inputs on altering the third from zero to maximum is typically —1 db.
Overload Capacity: Input 1 26 db. Input 2 26 db. Input 3 Infinity.
Power Bandwidth: —3 db. (8 ohms) 50Hz—18KHz.
Tone Control: Bass + 13 db to — 16 db at 50 Hz.
Treble + 16 db to — 13 db at 10 KHz.
Filters: —1 db points at 40 HZ and 15 KHz.
Mains Supply: 110, 120, 220, 240v 40-60 Hz.
Input fused at 2A.

NO EXCUSES! NO DELAYS! FROM STOCK!

VARIABLE VOLTAGE TRANSFORMERS



INPUT 230 v. A.C. 50/60
OUTPUT VARIABLE 0/260 v. A.C.

BRAND NEW. Keenest prices in the country. All Types (and spares) from ½ to 50 amp. available from stock.

0–260 v. at 1 amp.	£5 10 0
0–260 v. at 2·5 amps. ..	£6 15 0
0–260 v. at 5 amps.	£9 15 0
0–260 v. at 8 amps.	£14 10 0
0–260 v. at 10 amps. ...	£18 10 0
0–260 v. at 12 amps. ...	£21 0 0
0–260 v. at 15 amps. ...	£25 0 0
0–260 v. at 20 amps. ...	£37 0 0
0–260 v. at 37·5 amps. .	£72 0 0
0–260 v. at 50 amps. ...	£92 0 0

50 AMPS

1 AMP

20 DIFFERENT TYPES AVAILABLE FOR IMMEDIATE DELIVERY.

Double Wound Variable Transformers

Fully isolated, low tension Secondary winding. Input 230 v. A.C. OUTPUT CONTINUOUSLY VARIABLE 0-36 v. A.C.

0-36 v. at 5 amp. £9.12.6— p. & p. 8/6

0-36 v. at 20 amp. £21.0.0— 15/- p. & c.

These fully shrouded Transformers, designed to our specifications, are ideally suited for Educational, Industrial and Laboratory use.

INSULATION TESTERS *(NEW)*

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8in., W. 4in., H. 6in. Weight 6lb.

500 VOLTS, 500 megohms. Price **£28** carriage paid.

1,000 VOLTS, 1,000 megohms, **£34** carriage paid.

5Amp. AC/DC VARIABLE VOLTAGE OUTPUT UNIT

Input 230 v. A.C. Output 0-260 v. A.C. Output 0-240 v. D.C. Fitted large scale ammeter and voltmeter. Neon indicator, fully fused. Strong attractive metal case 15in. × 8¾in. × 6in. Weight 24 lb. Infinitely variable, smooth stepless voltage variation over range. **Price £38 plus 30/- p. & c.** Similar in appearance to illustration below.

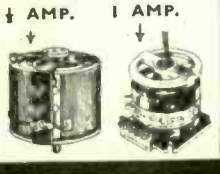
OPEN TYPES

Designed for Panel Mounting.
Input 230 v. A.C. 50/60
Output variable.
0-260 v.

½ amp	£3 10 0
1 amp.	£5 10 0
2½ amp.	£6 12 6

P. & P. 7/6

½ AMP. 1 AMP.



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. Lit. on req.

CONSTANT VOLTAGE TRANSFORMER

Input 185-250 v. A.C. Output **constant at 230 v. AC.** Capacity 250 watt. Attractive metal case. Fitted red signal lamp. Rubber feet. Weight 17lbs. Price **£11/10/-**, P. & P. 10/-.

LATEST TYPE SOLID STATE VARIABLE CONTROLLER

Ideal for lighting and heating circuits, compact panel mounting. Built in fuse protection. CONTINUOUSLY VARIABLE.
Input 230v AC output 25-230v AC
5 amp model **£8. 7. 6**
10 amp model **£13. 5. 0**

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 7/6 p. & p.**

36 volt 30 amp. A.C. or D.C. Variable L.T. Supply Unit

INPUT 220/240 v. A.C.
OUTPUT CONTINUOUSLY VARIABLE 0-36 v.

Fully isolated. Fitted in robust metal case with Voltmeter, Ammeter, Panel Indicator and chrome handles. Input and Output fully fused. Ideally suited for Lab. or Industrial use. £55 plus 40/- p. & c.

SERVICE TRADING COMPANY

SERVICE TRADING CO

Postage and Carriage shown below are inland only. For Overseas please ask for quotation. We do not issue a catalogue or list.

LARGE DIGIT 12-18 v. D.C. MAGNETIC COUNTER

4in. drum, calibrated 0-9. Figures 1¼in. high ⅜in. wide. Set of 1m, 1b, 1c/o contacts operated by drum cam. The units which can be used in multiples are ideally suited for batch or lap recording or for the many purposes where large easily read numerals are required. Price 18/6, P. & P. 2/6.

VEEDER ROOT COUNTER

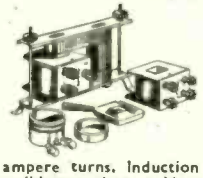
230 v A.C. 50 cycle 5 figure counter (non resetable). 18/6, P. & P. 1/6.

RING TRANSFORMER

Functional Versatile Educational

This multi-purpose Auto Transformer, with large centre aperture, can be used as a Double wound current Transformer, Auto Transformer, H.T. or L.T. Transformer, by simply hand winding the required number of turns through the centre opening. E.g. Using the RT.100 V.A. Model the output could be wound to give 8V. @ 12½Amp., 4V. @ 25Amp. or 2V. @ 50Ampi, etc. Price: RT.100VA 3.18 turns per volt, £2 5 0+3/6 p. and p.
RT.300VA 2.27 turns per volt, £4 4 0+5/6 p. and p.
RT. 1KVA 1.82 turns per volt, £6 10 0+6/6 p. and p.

DEMONSTRATION TRANSFORMER (STENZYL TYPE)



Two removable coils are tapped at 0, 110, 220 volts, and 6. 12. 36 volts respectively. A composite apparatus designed for class demonstration. Electro magnetic induction, jumping ring, induction lamp, relationship between field intensity and ampere turns. Induction melting, are just a few of the possible experiments. New modified model. £14/10/-. P. & P. 10/-.

L.T. TRANSFORMERS

All primaries 220-240 volts.

Type No.	Sec. Taps	Price	Carr.
1	12 v. at 5A	£1 17 6	5/6
2	30, 32, 34, 36 v. at 5 amps.	£4 13 6	6/-
3	30, 40, 50 v. at 5 amps.	£6 17 6	6/6
4	10, 17, 18 v. at 10 amps.	£4 19 0	4/6
5	6, 12 v. at 20 amps.	£6 8 6	6/6
6	17, 18, 20 v. at 20 amps.	£7 5 6	6/6
7	6, 12, 20 v. at 20 amps.	£6 17 6	7/6
8	24 v. at 10 amps.	£5 4 6	5/6
9	4, 6, 24, 32 v. at 12 amps.	£7 3 0	6/6

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £3/10/- each, P. & P. 4/6. 500 watt type £4/12/6 each, P. & P. 6/6. 1,000 watt type £5/15/- each, P. & P. 7/6.

LATEST TYPE SOLID STATE DEVICES

R.C.A. plastic Triac 400 PIV 8 amp. Price **25/6**. R.C.A. Diac for above, price **6/-**. *Price includes data sheet and circuit.*

R.C.A. 40432 Triac and Diac in TO5 can 6 amp. **35/-**.

G.E. P.U.T., D13, T1, **12/-**. Texas F.E.T. 2N3819, **7/6**.

All above prices plus 1/6 P. & P.

INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New 2/- each.

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.

LIGHT SENSITIVE SWITCHES

Kit of parts including ORP.12 Cadmium Sulphide Photocell. Relay Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operations. **Price 25/-, plus 2/6 P. & P. ORP. 12 and Circuit 12/6 post paid.**

220/240 A.C. MAINS MODEL

Incorporates mains transformer rectifier and special relay with 2 × 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.

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/-

BELLIN MULTI WAY PLUGS AND SOCKETS

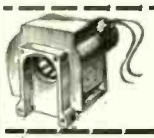
10 way plug and socket. (Socket chassis mounted.)
7 way reversed plug and socket. (Plug chassis mounted.)
Price: either type 3/6 pair. 9d. P. & P.

BURGESS MICRO SWITCH

Lever operated c/o contacts. Price 4/- plus 9d. P. & P. 10 in maker's carton. 35/- post paid.

MOTORISED SWITCHING UNIT (Ex-W.D.)

Powerful, precision-made, ex-W.D., 12 v. D.C., reversible motor, drives multiple gear train with outputs approx. 4 r.p.m. and 5 r.p.m. Price 25/- P. & P. 4/6.



Ex. W.D. MINIATURE BLOWER UNIT

18-24 v. D.C. operation, overall length 3¾ in. Blower 2⅜ × 2⅜ in., 20/-. P. & P. 2/6.

POWER RHEOSTATS

(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty. **AVAILABLE FROM STOCK IN THE FOLLOWING 11 VALUES: 100 WATT 1 ohm 10a., 5 ohm 4.7a., 10 ohm 3a., 25 ohm 2a., 50 ohm 1.4a., 100 ohm 1a., 250 ohm ·7a., 500 ohm ·45a., 1k ohm 280mA., 1·5k ohm 230mA., 2·5k ohm ·2a., 5k ohm 140mA.,** Diameter 3¼in. Shaft length ⅜in. dia. ⅛in., 27/6. P. & P. 1/6. **50 WATT** 1/5/10/25/50/100/250/500/1K/1·5K/2·5K/5K ohm. All at 21/-, P. & P. 1/6. **25 WATT** 10/25/50/100/250/500/1K/1·5K/2·5K ohm. All at 14/6, P. & P. 1/6.

Black Silver Skirted knob calibrated in Nos. 1-9. 1¼ in. dia. brass bush. Ideal for above Rheostats, 3/6 each.

STROBE! STROBE! STROBE!

★ THREE EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES. SOLID STATE TIMING + TRIGGERING CIRCUITS. PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION. The Strobe is one of the most useful and interesting instruments in the laboratory or workshop. It is invaluable for the study of movement and checking of speeds. Many uses can be found in the psychiatric and photographic fields, also in the entertainment business. It is used a great deal in the motor industry and is a real tool as well as an interesting scientific device.

★ **EXPERIMENTERS "ECONOMY" KIT** 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.

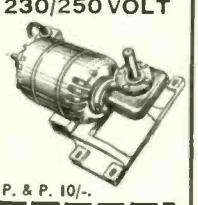
★ **NEW INDUSTRIAL KIT** Ideally suitable for schools, laboratories etc. Roller tin printed circuit. New trigger coil, plastic thyristor 1-80 f.p.s. Price 9 gns. 7/6 P. & P.

★ **HY-LYGHT STROBE** This strobe has been designed for use in large rooms, halls and the photographic field. It has 4 times the light output at 30 f.p.s. and utilizes a silica tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Light output approx 4 joules. Price £10.17.6. P. & P. 7/6.

★ **7-INCH POLISHED REFLECTOR.** Ideally suited for above Strobe Kits. Price 10/6 & 2/6 p. & p. or post paid with kits.

★★★★★★★★★★★★★★★★★★★★★★★★★★

PARVALUX TYPE SDI9 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/-.

DRY REED SWITCHES

2 × 1 amp Dry Reeds (make contacts) mounted in 870 ohm 9-18v coil. Size 3in. × 3¼in. × ⅛in. New. Price 8/6 per pair. Post Paid.
6 of the above mentioned units (12 Reeds, 6 coils) fitted in metal box. Size 4in. × 3¼in. × 1¼in. Mfg. by Elliott Bros. New 45/- each. Post Paid.

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.

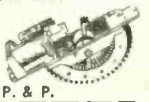
UNISELECTOR SWITCHES *NEW*

4 BANK 25 WAY FULL WIPER

25 ohm coil, 24 v. D.C. operation. £5.17.6, plus 2/6 P. & P.

6 BANK 25 WAY FULL WIPER

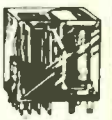
25 ohm coil, 24 v. D.C. operation. £6.10.0, plus 2/6 P. & P.



8-BANK 25-WAY FULL WIPER

24 v. D.C. operation, £7/12/6, plus 4/- P. & P.

RELAYS



NEW **SIEMENS PLESSEY,** etc. MINIATURE RELAYS AT A HIGHLY COMPETITIVE PRICE.

COIL Ω	WORKING D.C. VOLT	CONTACTS	PRICE
170	9—12	4 c/o H.D.	14/6
170	9—12	3 c/o + 1 H.D. c/o	12/6
230	6—12	2 c/o	12/6
280	6—12	2 c/o incl. base	14/6
700	12—24	2 c/o incl. base	12/6
700	16—24	4 c/o incl. base	15/6
700	16—24	4M 2B incl. base	12/6
2500	30—50	2 c/o H.D. Incl. base	12/6
9000	40—70	2 c/o incl. base	10/-

H.D. = Heavy Duty POST PAID

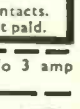
MINIATURE RELAYS

9—12 volt D.C. operation. 2 c/o 500 M.A. contacts. Size only 1in. × ⅝ × ⅝in. Price 11/6 Post paid.

30-36 v. D.C. operation. 2 c/o 500 M.A. contacts. 3,200 ohm coil. Size only 1 × ⅝ × 1⅛in. 8/6 post paid.

230 VOLT AC RELAY LONDEX four c/o 3 amp contacts. 18/6, incl. base. Post Paid.

SANWA MULTI RANGE TESTERS



NEW MODEL U-50D MULTI TESTER, 20,000 O.P.V. MIRROR SCALED WITH OVERLOAD PROTECTION. Ranges: D.C. volts: 100mV., 0.5 v., 5 v., 250 v., 1,000 v. A.C. volts. 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 5μA. 0.5 mA., 5 mA., 50 mA., 250 mA. Size: 5⅛ × 3⅛ × 1⅞ in. **Complete with batteries and test prods. £7.5.0** Post paid

PANEL METERS AT BARGAIN PRICES

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 ..... 45/-

FOOT SWITCH

Suitable for Motors, Drills, Sewing Machines, etc. 5 amp. 250 volts. Price 17/6 plus 2/6 P. & P.

230 v. A.C. SOLENOID. Heavy duty type. Approx. 3lb. pull. 17/6 plus 2/6 P. & P. **12 v. D.C. SOLENOID.** Approx. 1lb. pull. 10/6, P. & P.1/6.
50 v. D.C. SOLENOID. Approx. 1lb. pull. 10/6, P. & P. 1/6.
50 v. D.C. SOLENOID. Approx. 2lb. pull. 12/6, P. & P. 1/6.

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.

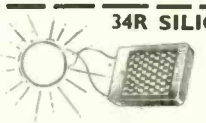
SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY

7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2½lb. £4/12/6 post paid.

NICKEL CADMIUM BATTERY

1.2 v. 35 AH. Size 8⅜ high × 3 × 1⅛. 30/- each, plus 4/- P. & P.
Sintered Cadmium Type 1.2 v. 7AH. Size: height 3⅛ in., width 2⅜in. × 1⅞in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6. P. & P. 2/6.

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. 45/-. P. & P. 1/6d.

ALL MAIL ORDERS. ALSO CALLERS AT:
57 BRIDGMAN ROAD, LONDON, W.4. Phone: 995 1560
Closed Saturdays.

SERVICE TRADING CO.
SHOWROOMS NOW OPEN
AMPLE PARKING

PERSONAL CALLERS ONLY
9 LITTLE NEWPORT STREET, LONDON, W.C.2.
Tel.: GER 0576

HI-FI, AUDIO AND TAPE RECORDER DEALERS AROUND THE BRITISH ISLES

CHESHIRE Stockport

AUDIO CENTRE
We stock the full range of HI-FI Tape Recorders and special Transistor Radios
Fairbotham and Co. Ltd.
58/62 Lr. Hillgate, Stockport
Tel: 480-4872
FULL SERVICE FACILITIES

Southport

Hi-Fi in West Lancashire
WAYFARERS RADIO LTD
18-20/29 BURTON ARCADE,
LORD ST., SOUTHPORT · Tel. 4070

OXFORDSHIRE Oxford

HIGH FIDELITY IN OXFORD
HORNS
SIX SOUTH PARADE OXFORD
Telephone: Oxford 55360
Information • Demonstration • Installation

ESSEX Ilford

UNIQUE RADIO LTD.
HI-FI & PUBLIC ADDRESS
6 THE FACADE, HIGH ROAD
GOODMAYES, ESSEX
SEVEN KINGS 590 8277

St. Helens

HAROLD STOTT LTD.
18 Westfield Street, St. Helens
Hi-Fi Consultant
Agents for leading makes of Tape Recorder, etc.
Equipment Planned and Supplied.
Telephone · · ST. HELENS 26791 or 23105

SURREY Guildford

MERROW SOUND LTD.
Specialists in Hi-Fi & Tape Recording
Fully equipped for comparative demonstrations.
Leading Agents for: B & O and TANDBERG.
Open 9.30 a.m. to 5.30 p.m. daily incl. Sats.
Early closing Wed. 1 p.m. EASY PARKING
229 Epsom Road, Merrow, Guildford.
Tel: Guildford 64171
GUILDFORD

Loughton

SOUND SUPPLIES (Loughton) CO. LTD.
TEL: 01-508-2715
HI-FI Showroom
BROOKLANDS PARADE,
309 HIGH ROAD, LOUGHTON
Spares and Repairs
12 SMART'S LANE, LOUGHTON, ESSEX.

LONDON South East

G.A. ELECTRIC
81 Portland Road
South Norwood
01-654 3200
Hi-Fi and Public Address Equipment
Rogers and other leading makes

SUSSEX Brighton

LANES (RADIO) LTD.
LARGEST STOCKIST OF ALL HI-FI EQUIPMENT IN THIS AREA
94 CHURCH ROAD, HOVE
TEL. Brighton 738517

Romford

We Give the Finest Hi-Fi Service in the Area
Romford Sound & Vision Service Ltd.
7Ba BRENTWOOD ROAD
ROMFORD
TEL. ROMFORD 41644 OR COME AND SEE

South West

In South London it's
FRANCIS OF STREATHAM
169-173 STREATHAM HIGH ROAD, S.W.16
Phone: 01-769 0192 · 01-769 0466
Leading stockists for Tandberg, Akai, Ferrograph, Quad, Rogers, Leak, Shure, Garrard, etc., etc.

WARWICKSHIRE Birmingham

GRIFFIN RADIO LTD.
021-692 1359 021-643 0867
94 Bristol Street · Birmingham 5
★ Complete advisory facilities for all makes of equipment.
★ Full range of Classical and Light Music LPs.

GLAMORGANSHIRE Cardiff

J. GOUGH & CO. LTD.
DESIGNERS OF THE FAMOUS GOUGH LOUDSPEAKERS
THE LARGEST STOCKIST OF HI-FI EQUIPMENT AND FOR DEMONSTRATION IN SOUTH WALES
148-154 NORTH ROAD, CARDIFF
Telephone: 28473

South West

TAPE RECORDER HI-FI CENTRE (SHEEN) LTD
SPECIALISTS IN TAPE RECORDERS, ACCESSORIES, HI-FI EQUIPMENT
YOUR CENTRE FOR FRIENDLY HELP, SALES AND SERVICE
3 & 4 STATION PARADE, SHEEN LANE, SHEEN, LONDON, S.W.14
Tel. 876 0985
Opposite Mortlake Station, S.R.
Closed Wednesdays

Coventry

ELECTRONIC SERVICES
HI-FI SPECIALISTS
33 CITY ARCADE
COVENTRY
TEL: 24632

HAMPSHIRE Southampton

High Fidelity Specialists
Hamilton Electronics HE
Hamilton Electronics (Southampton) Ltd
35 London Road Southampton Phone 28622 3 Lines

West

Lasky's Radio
Stockist for all the leading makes of Hi-Fi Audio Equipment

33 TOTTENHAM CT. RD., W.1	01-636 2605
207 EDGWARE ROAD, W.2	01-723 3271
152/3 FLEET STREET, E.C.4	01-353 2833
109 FLEET STREET, E.C.4	01-353 5812
Hi-Fi Centres	
42-45 TOTTENHAM CT. RD., W.1	01-580 2573
118 EDGWARE ROAD, W.2	01-723 9789

WORCESTERSHIRE Worcester

HIGH-FIDELITY SPECIALISTS
JOHNSONS SOUND SERVICE
43 Friar Street, Worcester
Worcester 25740

LANCASHIRE Bury

J. SMITH & SON
HI-FI EQUIPMENT • STEREOGRAMS
TAPE RECORDERS • 2 SHOWROOMS
B. & O. Dynatron, Hacker Quad, Leak, B. & W., Tandberg, Sony, Rogers, Stax, Armstrong, Ferrograph, Garrard, Thorens, Goodmans, etc. Comparator Dems.
Closed all Tuesday
Specialists in 'SOUND' for 36 years
184 THE ROCK, BURY. Tel: 1242

West Central

The best in Tape & TAPE RECORDERS At lowest prices
R.E.W. AUDIO VISUAL Co
Interest FREE offers!
Call write or Phone
148 CHARING CROSS RD LONDON WC2 Tel 01 836 3365

SCOTLAND Glasgow

G. H. STEEL LTD.
Scotland's leading Tape Recorder, Video and Hi-Fi Specialists. Agents for: B & O, Armstrong, Leak, Fisher, Arena, Dynatron, Rogers, Quad, Truvox, Philips, Sony, Akai, Sanyo, Revox, Tandberg, Brenell, Ferrograph, Uher, Grundig, Goldring, Garrard, Thorens, Connoisseur, Goodmans, Wharfedale, KEF, Celestion, Decca, Scott. Equipment Cabinets, Earphones, Tapes, Accessories, Repairs and Servicing. Credit Terms, Part Exchanges.
141 St. Georges Road, Glasgow C.3. Tel. Douglas 7124

VALVES

CY31	7/-	PL84	6/6	6K8GT	7/3
DAF96	7/9	PL500	14/9	6X25G	14/-
DF96	7/6	PL504	19/-	6L6	14/6
DK96	7/6	PL509	30/-	6L6GA	9/6
DL92	6/6	PX4	14/-	6P25	11/-
DL94	6/6	PX25	12/6	6BA7	7/-
DM70	6/-	PY33	12/-	6BA7GT	6/6
DM71	7/6	PY80	6/6	6BC7GT	5/-
DY86	6/-	PY81	5/6	6BG7	6/-
DY87	6/6	PY82	5/6	6BJ7	6/-
DY802	9/9	PY83	7/-	6BJ7GT	6/6
EABC80	6/6	PY88	7/6	6BJ7Y	6/6
EAF42	10/-	PY800	9/6	6BK7	7/-
EB91	2/-	PY801	9/6	6BK7GT	6/6
EBC33	8/-	PY802	13/6	6BL7GT	6/6
EBC41	10/6	QQV03-10		6BN7GT	6/-
EBC81	6/6		25/-	6BQ7GT	7/9
EBF80	7/6	QQV06-40		6V6G	3/6
EBF83	8/6		85/-	6V6GT	6/3
EBF89	6/-	QQV06-40A		6X4	4/9
EC91	6/-		100/-	6X5G	5/-
EC92	5/9	R10	17/6	6X5GT	5/6
EC83	5/6	R17	8/-	676G	11/-
EC84	6/-	R19	7/6	6-30L2	14/-
EC86	7/6	8TV280/80		6Z4	5/-
EC88	7/-		80/-	7B7	7/-
ECC189	9/9	U25	14/6	7C5	14/6
ECF80	6/6	U26	14/6	7C6	6/-
ECF82	6/6	U27	8/-	7H7	5/6
ECF83	15/6	U191	14/-	7Y4	9/3
ECF801		U301	11/6	9D6	2/6
	12/6	U801	20/-	11E2	30/-
ECF802		UABC80	6/6	12AT6	4/6
	12/6	UAF42	10/6	12AT7	4/-
ECH35	11/-	UBC41	9/6	12AU7	5/9
ECH42	13/-	UBF80	7/-	12AV6	5/6
ECH81	5/9	UBF89	7/-	12AX7	6/-
ECH83	8/6	UCF80	10/-	12BA6	6/-
ECH84	7/6	UCH42		12BE6	6/-
ECH200			12/6	12BH7	3/6
	12/6	UCH81	7/-	12C8	3/-
ECL80	9/-	UCL82	7/6	12E1	17/-
ECL82	6/6	UCL83	12/-	12K5	10/-
ECL83	10/6	UF41	9/6	12K7GT	6/9
ECL86	8/6	UF80	7/3	12K8GT	7/6
EF36	3/6	UF89	6/9	12Q7GT	5/6
EF37A	7/-	UF41	11/6	12BG7	4/6
EF39	6/-	UL84	6/6	1487	15/-
EF40	10/-	UU5	7/-	19AQ5	5/9
EF41	12/6	UY41	8/6	19G3	60/-
EF80	5/-	UY85	5/9	19G6	20/-
EF83	9/7	VR105/30		19H4	70/-
EF85	6/6		6/-	20P4	20/6
EF86	6/3	VR150/30		25L6GT	7/3
EF89	5/3		6/-	30C15	15/-
EF91	3/-	Z800U	29/-	30C17	16/-
EF92	2/6	Z801U	25/-	30C18	15/-
EF95	5/-	Z900T	12/-	30F5	16/9
EF183	6/6	1L4	2/6	30FL1	15/-
EF184	7/-	1R5	6/-	30FL12	18/6
EF800	20/-	1S4	5/-	30FL13	9/3
EF812	15/6	1S5	4/6	30FL14	15/6
EFL200		1T4	3/-	30L15	17/-
	15/6	1X2A	7/6	30L17	17/-
EL34	10/6	1X2B	7/6	30P12	16/-
EL41	11/6	3A4	4/-	30P19	14/-
EL42	10/6	3D6	3/-	30PL1	15/6
EL84	4/9	3Q4	7/6	30PL13	18/6
EL85	8/-	3S4	6/9	30PL14	17/-
EL86	8/-	3V4	8/-	35L6GT	9/6
EL90	6/-	5B254M	36/-	35W4	5/-
EL91	5/-	5B/255M		3524GT	7/-
EL95	7/-		35/-	42	5/-
EL500	12/-	5R4GY	10/6	50C5	6/-
EL8035	17/-	5U4G	5/6	50CD6G	27/6
EM31	5/-	5V4G	7/6	50EH5	12/-
EM80	7/6	544G	7/-	75	5/6
EM84	7/-	5Y3GT	6/-	76	5/-
EM87	11/-	5Z4	14/-	78	5/-
EY51	8/-	5Z4G	7/6	80	7/6
E781	7/-	6AB7	4/-	803	34/-
EY86	7/-	6AC7	3/-	807	9/-
EY88	8/6	6AH6	11/6	813	75/-
EZ41	8/6	6AK5	5/-	8020	35/-
EZ80	5/-	6AK8	6/-	832A	45/-
EZ81	5/-	6AL5	3/-	866A	15/-
GZ34	10/6	6AL5W	7/-	954	4/6
KT66	27/6	6AM5	5/-	955	2/8
KT88	32/-	6AM6	3/-	956	2/-
N78	25/-	6AN5	20/-	957	5/-
OA2	6/-	6AN8	10/-	991	6/-
OB2	6/-	6AQ5	6/-	1622	17/-
PABC80	7/6	6AQ5W	9/-	2051	5/-
PC97	9/-	6AS6	6/-	3505	13/-
PC900	9/6	6AS7G	16/-	5933	22/6
PCC84	6/6	6AT6	4/6	6057	10/-
PCC89	9/6	6AU6	5/-	6060	7/6
PCC189	11/6	6AX4	8/-	6064	7/-
PCE800		6AX5GT		6065	8/-
	15/-		13/-	6080	27/6
PCF80	6/6	6B7	5/6	6146	28/-
PCF82	6/9	6BK7	8/-	9001	3/-
PCF84	9/3	6BA6	4/6	9002	4/6
PCF86	10/-	6BE6	5/-	9003	8/6
PCF200		6BG6G	11/-	9004	2/6
	15/6	6BJ6	8/6	9006	2/6
PCF201		6BQ7A	6/9	C.R. Tubes	
	15/6	6BR7	16/-	VCR97	32/6
PCF801	9/9	6BW6	16/-	VCR517C	150/-
PCF802	9/9	6BW7	13/-	VCR517B	
PCF805		6C4	5/9		55/-
	14/6	6C6	4/-	VCR517C	
PCF806		6CH6	7/-		45/-
	13/-	6CL6	9/9	5FP7	26/7
PCF808		6D6	3/-	8BJ	80/-
	14/6	6EA8	9/-	8BL	90/-
PCH200		6EU7	7/-	Photo Tubes	
	12/6	6F23	15/-	G816	12/6
PCL81	9/6	6F33	20/-	CMG25	25/-
PCL82	7/6	6H6M	3/-	931A	62/6
PCL83	13/-	6J4WA	12/-	6097C	350/-
PCL84	8/6	6J5	7/-	Special Vlvs.	
PCL85	9/3	6J5GT	5/-	CV1031	70/-
PCL86	9/-	6J6	5/6	CV2339	£20
PFL200	12/-	6J7G	5/-	JP9/7D	£33
PL36	10/9	6J7M	8/-	3J/92/E	
PL81	8/9	6K6GT	8/-		£3710/-
PL82	8/-	6K7	6/6	5C22	£15
PL83	7/3	6K7G	2/-	714AY	£4
		6K8G	4/-	725A	£10

P. C. RADIO LTD.
170 GOLDHAWK RD., W.12
01-743 4946

MARCONI TEST EQUIPMENT

SIGNAL GENERATOR TF 801/A. 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.** DITTO but **801/A/1** with additional high level output. **£89.** Both P. & P. 20/-, including necessary connectors, plugs, and instruction manual.

VALVE VOLTMETER TYPE TF 958. Measures AC 100mV; 20 c/s to 100 mc/s, DC 50mV to 100V, multiplier extends ac range to 1·5kV. Balanced input and centre-zero scale for DC. AC up to 100MHz. **£32.10.0.**

DISTORTION FACTOR METER TYPE TF 142E. Frequency range: 100-8,000Hz in four ranges. Distortion range: 0.05 to 50%. Input impedance 600Ω, attenuation 0-60db continuously variable. Sensitivity 1mW. **£42.10.0.** Carriage 20/-.

TF 899 VALVE VOLTMETER, 10mV to 2V, **£17.10.0.** Carriage 30/-.
F.M. DEVIATION METER TF 934, £57.10.0. Carriage 30/-.
VIDEO OSCILLATOR TF 885A & 885A/1, £55 and **£85** resp. Carr. 30/-.

FM DEVIATION METER TYPE TF 791B. Frequency range: 4-250MHz, deviation 1-75kHz. Specification and price on application.

PULSE GENERATOR TYPE TF 675F. Repetition frequency: 50Hz to 50kHz. Pulse duration: 0.15 to 100Ω sec; built in 0.1 and 0.5μ sec delay lines. **£40.10.0.** Carriage 20/-.

CIRCUIT MAGNIFICATION METER TYPE TF 329F. Frequency range: 50kHz to 50MHz. Magnification 10 to 500 Q, Tuning Capacitor: 40 to 450pF with ±3pF vernier. Fully overhauled and calibrated, **£70.** Carriage 30/-.

LIMITED QUANTITY ONLY SIGNAL GENERATOR TYPE TF 937 (CT 218). Frequency range: 35 kHz-30mHz. 50 ft. Frequency scale. 200 kHz to 2mHz. Built-in Crystal calibrator Sinewave A.M. V.F.M. Output: D.19V-1V. **Price on application.**

HEWLETT-PACKARD TEST EQUIPMENT

MODEL 524B ELECTRONIC COUNTER WITH MODEL 525B PLUG IN UNIT. Basic counter measures frequencies from 10Hz to 10MHz and time from 0 to 10 kHz. Automatic positioning of decimal point, eight place registration. Full self check facility from built in frequency standards. Plug In unit extends requency range of basic counter to 100 to 220MHz. Full specification and price on request.

AVO VALVE CHARACTERISTIC METER complete with manual, **£45** Carriage. 30/-.

SPECIAL OFFER
09J TUBE 35/-

PHASE MONITOR ME-63/U. Manufactured recently by Control Electronics Inc. Measures directly and displays on a panel meter the phase angle between two applied audio frequency signals within the range from 20-20,000 c.p.s. to an accuracy of ± 1.0°. Input signals can be sinusoidal or non-sinusoidal between 2 and 30 v. peak. In excellent condition. **£75.** Carriage 30/-.

AVO'S METERS
Model 85X with leads, **£18.**
Model 7X with leads **£15.10.0.**
Model 7 with leads, **£14.10.0.**
Model 47A complete with multiplier shunts, etc., in special fitted wooden case, **£12.**
Model 48A equipped as 47A, **£14.10.0.** Carriage for each of above 7/6.

WEE MEGGER 500v., £14.10.0.
TF 144G SIGNAL GENERATOR offered unchecked but in very good condition, rack model, mounted complete with cables, etc., **£20.** Carriage 20/-

FOR EXPORT ONLY
53 TRANSMITTERS. All spares available. COLLINS TCS. Complete installations and spare parts. 62 WIRELESS SETS. Complete installations and spare parts. P.S.U. for C42 & C45 12v and 24v R.C.A. TRANSMITTERS ET 4336. Complete installations and all spares. BC 610E & 1 TRANSMITTERS. Complete installations and all spares. No. 19 WIRELESS SETS. H.P. SETS and all spares R.210 RECEIVERS with all necessary accessories.
PYE PTC 2002N A.M. Ranger Mobile Radio Telephone, brand new and complete, **£45.**

4, 5 and 8 bank 25 way uniselectors, 24V, guaranteed perfect, **£3.15.6; £4.10.0; £6.17.6** respectively.

DAWE STORAGE OSCILLOSCOPE complete with trace shifter, complete as new, specification and price on request.

SPARES FOR AR.88D. RECEIVERS. Ask for your needs from our huge selection.

HARNESS "A" & "B" control units, junction boxes, headphones, microphones, etc.

SOLARTRON EQUIPMENT

LAB. AMP AWS 151A, Frequency: 15Hz to 350kHz. Metered output, 'scope viewing, etc. **£29.10.0.** Carriage 20/-.
Regulated and stabilised **P.S.U. SRS 151A,** 20 to 500V positive at 300mA in two ranges. Variable and fixed 170V negative output, **£35.** Carriage 20/-.
CD 711S.2. Double beam, DC to 7MHz 'scope, **£85.** Carriage 30/-.
CD 643.2. Single beam Laboratory Model, DC to 14MHz price upon application.
QD 910. Storage Oscilloscope, as new. Price on request.

29/41FT. AERIALS each consisting of ten 3ft., ⅜in. dia. tubular screw-in sections. 11ft. (6-section) whip aerial with adaptor to fit the 7in. rod, insulated base, stay plate and stay assemblies, pegs, reamer, hammer, etc. Absolutely brand new and complete ready to erect, in canvas bag, £3/9/6. P. & P. 10/6.

FIELD TELEPHONE TYPE "F". Housed in portable wooden cases. Excellent for communication in and outdoors for up to 10 miles. Pair including batteries, fully tested. **£6.10.0,** or with 220 yds field cable in drum **£7.10.0.**

END OF RANGE ITEMS in 'as seen' condition: H.R.O.—**£10;** Coils at 15/-; Furzhill VTVM 10mV to 100V—**£15.**

PANEL METERS
Just a few from our huge stock:

25μA round pj M.C. 2½"	27/6
50μa round M.C. 2½"	32/6
100μA round M.I. 2½"	32/6
100μA round M.C. 3½"	35/-
200μA round N.C. 2½"	27/6
500-0-500μA round M.C. 2½"	22/6
500μA round M.C. 1" (calibrated 1mA)	22/6
1mA round M.C. 2½"	25/-
5mA round M.C. 2" clip fit	22/-
10mA round M.C. 2½"	22/6
10-0-10mA round M.C. 2½"	20/-
20mA round M.C. 2"	20/-
25mA round M.C. 2½"	22/6
25-0-25mA round M.C. 2½"	22/6
30mA round M.C. 2½"	22/-
30-0-30mA round M.C. 2½"	19/6
50mA round pj M.C. 2½"	19/-
100mA square M.C. 2"	22/6
200mA square M.C 2½"	20/-
10-0-10mA round M.C. 2½"	20/-
100-0-100mA round M.C. 2½"	22/6
400mA round M.C. 2½"	18/-
3 amp round R.F. 2½"	27/6
6 amp round M.C. 2½"	18/-
9 amp round R.F. 2½"	32/-
25 amp round M.C. pj 3½"	27/6
25amp round M.C. 3½"	19/-
8V square M.C. 3"	27/6
15V round M.I. 2½"	30/-
20V square M.C. 2" clock scale	17/6
50V round M.C. 2½" black face	20/-
100V round M.C. 4"	25/-
300V round M.I. 2½"	19/-
1500V round electrostatic, plug-in 2½"	32/6
7KV round electrostatic 3½"	27/6
59-63 cycles 2½" freq. meter	32/6

and very many others, full list of meters upon request.

TELEPHONE ENQUIRIES relating to **TEST EQUIPMENT** should be made to 01-748 8006 Extension 23.
To view **TEST EQUIPMENT** please phone for appointment

INTEGRATED CIRCUITS MANY OTHERS IN STOCK

RCA CA 3005 wide band RF Ampl 300mW diss	27/-
CA 3012 wide band ampl 150mW diss	22/-
CA 3020 Audio power ampl	30/-
CA 3036 Audio pre-ampl	19/-
STC MIC 9301B Digital dual 4 imput gates	86/-
MIC 709-IC Linear operational ampl	190/-
MIC 9005D Highspeed flip-flop	54/-

Plessey A.F. Amps with PRE-AMP 2.5W. **£2.2.6.** 3.5W. **£2.12.6.** Mono with tone controls **£6.2.6.** Stereo with tone controls **£12.19.6.**

PLEASE NOTE
Unless offered as "as seen" all equipment ordered from us is completely overhauled mechanically and electrically, thus ensuring that our equipment is in "connect and use" condition.

AIRMEC INSULATION TESTER O-5KV built-in ionisation amplifier, **£28.**

BOONTON SIGNAL GENERATOR TS 497/B/URR, 2-400MHz. £95.

TS 418 B/U SIGNAL GENERATOR, 400-1000MHz. **£105.** Carr. 30/-.

AVO SIGNAL GENERATOR CT 378, 2-225MHz. £38.10.0. Carr. 18/-.

TRANSISTORS, ZENER DIODES

OA5	2/6	OC35	8/6	OC201	7/6	3FR5	6/6	AF178	12/6
OA10	6/-	OC38	8/6	OC206	10/-	3N128	17/6	AFY19	22/6
OA70	2/-	OC44	4/-	IN21	3/6	3N139	35/-	ASY26	5/6
OA71	2/-	OC45	2/6	IN21B	5/-	3N140	19/6	ASY28	5/6
OA79	1/9	OC70	3/-	IN25	12/-	3N154	19/-	BAW19	5/6
OA81	1/6	OC71	2/6	IN43	4/-	3N159	29/-	BC107	3/6
OA200	1/9	OC72	4/-	IN70	4/-	6FR5	7/9	BC108	4/-
OA202	2/-	OC73	11/-	IN702-725		12PR60	14/9	BCY10	9/-
OA210	7/6	OC75	4/6		7/3	10D1	3/4	BCY72	7/9
OA211	9/6	OC76	5/-	IN746A		40594	27/6	BFY51	4/6
OAZ200	11/-	OC81	4/-	series 5/3		40595	27/6	BFY52	4/6
OAZ201	10/-	OC81D	3/-	IN821A	21/-	40636	29/-	B8O5	7/6
OAZ202	to	OC81DM	3/-	IN823A	26/-	40668	27/-	B8	9/1
OAZ206	8/6	OC82	5/-	IZMT5	7/-	40669	29/-	B82	9/3
OAZ207	9/6	OC82DM	3/-	IZMT10	6/9	AC126	4/8	BU100	36/-
OAZ208	to	OC83	4/6	IZT5	13/6	AC127	4/6	BYZ13	5/-
OAZ213	6/6	OC83B	3/-	IZT10	12/9	AC128	4/-	BYZ16	15/-
OAZ223	to	OC84	5/-	2N1306	6/6	AC176	7/6	CR81 10	5/-
OAZ225	10/-	OC122	10/-	2N1307	6/6	ACY28	4/-	CR81/20	9/6
OC16	15/-	OC139	6/6	28303	10/-	AD149	11/-	CR81/30	
OC22	8/6	OC140	8/-	2N3053	6/6	AD161	7/-		10/-
OC25	7/6	OC170	5/-	2N3054	12/6	AD162	7/-	CR81/35	
OC26	5/-	OC171	6/-	2N3055	15/-	AF117	4/9		11/6
OC28	8/-	OC172	7/6	2N5109	41/-	AF118	10/-	CR81/40	
OC29	15/-	OC200	6/-	3P100	12/6	AF139	10/-		12/6

CR83/05 6/-
CR83/20 10/-
CR83/30 11/6
CR925/025 15/-
CR83/40 12/6
GET103 4/-
GET115 9/-
GET116 8/-
8D918 5/3
8D928 6/3
8D938 6/6
8D94 4/4
8D968 7/3
8D988 9/3
V405A 7/9
Z Range Zener diodes 3/6 ea.
Z2A range 7/6 ea.
Z3B range 5/1 ea.
ZL range 5/- ea.
Z8 range 7/6 ea.

MANY OTHERS IN STOCK include Cathode Ray Tubes and Special Valves. U.K. P. & P. up to 10/- 1/-; to £1 2/-; over £1 2/- in £, over £3 post free. C.O.D. 4/- extra.

Open 9-12.30, 1.30-5.30 p.m. except Thursday 9-1 p.m.

All overseas enquiries & orders please address to:
COLOMOR (ELECTRONICS) LTD.
170 Goldhawk Rd., London, W.12
Tel. 01-743 0899

Z AND I AERO SERVICES LTD

ZaeruX BRAND

INTEGRATED CIRCUIT AMPLIFIERS

CA3005 RF Amplifier with 100mc/s bandwidth. Max. dissipation 26mW. For use as RF amplifier, balanced mixer, product detector or self-oscillating mixer. **27/–**

CA3012 Wide Band Amplifier (up to 20mc/s), suitable as IF Amplifier for VHF/FM receivers. **22/–**

CA3020 General Purpose Audio Amplifier of 550mW output. **30/–**

CA3036 Buffer Amplifier consisting of two "super-alpha" pair of transistors suitable for stereo pick-up systems. **19/–**
The above four I.C's are in TO5 encapsulation.

PA222 Audio Amplifier providing a max. output of 1.2 watts. **65/–**

PA234 Audio Amplifier providing a max. output of 1 watt **27/6**

PA237 2 watts Audio Amplifier. **40/–**
The above three I.C's are in epoxy moulded double four-in-line package.

MC1709CG General Purpose operational amplifier in TO-99 case. **40/–**

TAA263 3-stage direct coupled amplifier for use from DC to 600kc/s; 70mW dissipation. Output 10mW into 150Ω load. **15/–**

TAA293 3-stage amplifier with connection brought out to the individual leads. Bandwidth 600kc/s. 160mW dissipation. Output 10mW into 150Ω load. **20/–**

TAA320 MOST input stage followed by a bi-polar transistor stage. 200mW dissipation. **13/–**

TAD100 All active components required for an A.M. Receiver comprising mixer, oscillator, i.f. amplifier, a.g.c. and pre-amplifier stages. To build complete receiver only coils, capacitors and resistors are required and output stage for which one of the above described I.C.s can be used. Dual seven-in-line package. **45/–**
Data sheet available for all the above I.C.s.—free with I.C's or **1/-** per data sheet if ordered separately.

TRANSISTORS

2N404 3/6	2N2923 3/-	AC126 5/-	ASY77 7/-	BSY95A			
2N410 3/6	2N2924 3/-	AC127 5/6	ASY82 4/-	3/9			
2N412 3/6	2N2926'b'	AC128 4/6	ASY86 4/6	D29A4 3/6			
2N444A 5/-	3/-	AC153 5/-	BC107 3/-	OC16 15/-			
2N696 4/6	2N2926'r'	AC154 3/-	BC108 3/-	OC22 13/-			
2N697 4/6	3/-	AC176 6/9	BC109 4/-	OC23 12/6			
2N698 8/6	2N2926'o'	ACY17 6/-	BC118 8/6	OC24 15/-			
2N705 15/-	3/-	ACY18 4/-	BC147 4/6	OC25 7/6			
2N706 3/-	2N2926'y'	ACY19 4/9	BC148 3/3	OC26 6/-			
2N708 3/6	3/-	ACY20 4/-	BC149 3/6	OC28 14/6			
2N753 4/9	2N2926 'g'	ACY21 3/11	BC152 3/2	OC29 14/9			
2N929 6/-	5/6	ACY22 2/8	BC175 5/6	OC30 15/-			
2N930 6/8	2N3053 6/3	AD140 16/-	BCY30 7/-	OC35 11/3			
2N987 6/6	2N3055 15/-	AD149 12/6	BCY31 5/-	OC36 12/6			
2N1131 8/6	2N3133 7/-	AD161 9/-	BCY33 5/-	OC42 6/6			
2N1132 9/6	2N3134 8/6	AD162 9/-	BCY34 5/-	OC44 4/-			
2N1184 25/-	2N3391 4/-	AF102 15/6	BCY39 5/-	OC45 3/6			
2N1301 7/-	2N3392 3/2	AF114 6/-	BCY72 3/10	OC71 3/6			
2N1302 7/-	2N3393 2/6	AF115 6/-	BCZ11 7/6	OC72 5/-			
2N1304 4/6	2N3394 2/6	AF116 5/6	BD121 18/-	OC73 7/6			
2N1305 4/6	2N3395 3/6	AF117 4/6	BD123 25/-	OC75 5/-			
2N1306 5/-	2N3402 5/-	AF118 10/-	BF167 5/-	OC76 5/-			
2N1307 6/-	2N3403 5/-	AF125 6/-	BF173 6/-	OC78 5/-			
2N1308 7/6	2N3404 6/6	AF126 5/3	BF184 7/6	OC78D 3/3			
2N1309 9/6	2N3414 4/-	AF127 5/3	BF194 3/6	OC81 4/6			
2N1756 15/-	2N3415 4/3	AF178 12/6	BF195 3/-	OC81D 3/-			
2N2147 14/9	2N3416 4/6	AF186 11/-	BFX88 5/4	OC83 4/6			
2N2160 23/-	2N3417 5/2	AF239 10/-	BFY17 8/6	OC84 5/-			
2N2217 6/6	2N3702 4/6	AFY19 22/6	BFY18 5/-	OC139 7/6			
2N2218 7/9	2N3703 3/10	AFZ11 8/-	BFY19 5/-	OC140 9/6			
2N2219 8/6	2N3704 5/6	ASY26 6/-	BFY50 5/-	OC170 5/-			
2N2569A 4/6	2N3707 4/-	ASY27 6/8	BFY51 4/6	OC171 5/6			
2N2477 12/6	2N3709 3/5	ASY28 6/6	BFY52 4/10	OC200 4/4			
2N2646 12/6	2N3710 3/-	ASY29 6/-	BSY26 5/-	OC201 10/-			
2N2905 10/-	2N3819 12/-	ASY54 6/-	BSY27 5/6	OC202 13/-			
	2N3906 6/-	ASY73 10/-	BSY28 5/-	OC203 16/3			
	AC113 3/-	ASY74 16/-	BSY65 4/6	OC204 6/-			
	AC125 6/6			OC205 13/-			
				OC206 14/-			

PLESSEY SL403A INTEGRATED CIRCUIT AUDIO AMPLIFIER

Dual-in-line 10-lead flat package with heat sink strip. Maximum audio output 3 watts into 7.5Ω loudspeaker. Circuit consists of a pre-amplifier followed by a main amplifier. Distortion 0.3% at 1 watt increasing to 0.5% at full output. Frequency response 20 c/s to 20 mc/s. Operating voltage 18v. Built-in overvoltage cut-out. Price, complete with application sheet **49/6**

SILICON MATCHED DIODE PAIRS

1N4951 Two diodes in common TO92 epoxy case. Separate anode leads and joint cathode. Diodes are statically and dynamically balanced. Max. reverse voltage 20V. Max. dissipation 200mW. Suitable for TV horizontal phase discriminators and similar applications. Price **3/-** each. Considerable discount for quantities.

ZENER DIODES

BZY88 series, from 3.3V to 9.1V ± 5% 400mW .. **3/6** each
BZY94 series, from 10.0V to 12.0V ± 5% 400mW .. **3/6** each
D814 series, from 7.5V to 13.0V ± 10% 340mW .. **3/-** each
D815 series, from 4.7V to 18.0V ± 10% 8 Watts .. **7/6** each
D816 series, from 22V to 47V ± 10% 5 Watts .. **7/6** each
D817 series, from 56V to 100V ± 10% 5 Watts .. **7/6** each

Outlines: BZY series—miniature—wire ended
D814—'Top Hat' type
D815-D817—stud mounted, supplied complete with hardware

Please state voltage required—nearest standard voltage will be supplied.

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 — ZaeruX BRAND — FIRST QUALITY VALVES

OA2 6/6	5B/254M	6BN6 8/-												PD500 30/-	QY4-250A 230/-	UF9 11/-
OA3 9/- 45/-		6BQ5 5/-												PEO6-40N 80/-	QY4-400A 300/-	UF11 10/-
OA4G 22/-	5B/255M	6BQ6GTB 13/-												PEN4DD 8/-	R10 20/-	UF41 10/-
OB2 6/6														PEN45 7/-	R18 9/-	UF42 12/-
OB3 10/-	5D21 80/-	6BQ7A 7/6												PEN45DD 14/-	RG3-250A 15/-	UF43 11/-
OC2 17/-	5J6 8/-	6BR7 17/-												PEN46 7/6	RL18 10/-	UF80 7/6
OC3 7/-	5R4GY 11/-	6BR8 13/-												PEN383 10/-	S130 35/-	UF85 8/-
OD3 6/6	5U4G 6/-	6BS7 26/-												PEN384 10/-	S130P 35/-	UF89 7/-
1A3 5/-	5U4GB 7/6	6BW6 16/-												PEN453DD 11/-	SP2 9/-	UL41 12/-
1A5GT 5/6	5V4G 8/-	6BW7 13/6												PF86 11/-	SP4 9/-	UL84 6/6
1A7GT 7/6	5W4GT 7/-	6BX6 5/-												PF183 17/-	SP41 7/-	UM4 5/6
1B3GT 7/6	5X8 10/-	6BX7 14/-												PL36 11/-	SP42 12/-	UM84 4/-
1B24A 80/-	5Y3GT 6/-	6BZ6 6/6												PL81 9/6	SP61 7/-	UU5 10/-
1C5G 6/-	5Z3 9/-	6C4 6/-												PL82 9/-	T41 17/-	UY1N 10/-
1G4GT 8/6	5Z4G 7/6	6CB6 5/6												PL83 8/-	TP22 11/-	UY11 11/-
1G6GT 7/6	5Z4GT 8/-	6CD6GA 23/-												PL84 7/-	TP25 6/-	UY21 11/-
1H5GT 7/6	6/30L2 15/-													PL95 15/-	TT21 48/-	UY41 8/-
1L4 3/6	6A8G 6/6	6CG7 9/-	6Q7 7/6	12AQ5 8/-	30C15 15/-	150C4 11/-	C1A 90/-	EAF42 10/-	EF80 5/-	EY84 10/-	ME91 8/-			PL302 15/-	TT22 50/-	UY82 10/-
1N5GT 8/6	6AB4 6/6	6CH6 11/-	6R7G 7/-	12AT6 5/-	30C17 16/-	305 12/6	C1K 80/-	EAF801 9/6	EF83 10/-	EY86 8/-	MH4 8/-			PL303	U17 10/-	UY85 6/-
1Q5GT 10/-	6AC7 4/6	6CL6 10/-	6S2 8/-	12AT7 6/6	30C18 15/-	310A 27/6	CBL1 16/-	EB34 3/-	EF85 7/-	EY87 8/6	MHL4 9/-			PL504 16/-	U18/20 13/6	VL6631 38/-
1R4 7/-	6AF4A 9/6	6CU6 13/-	6S4 11/-	12AU6 5/6	30F5 17/-	311A 37/6	CBL31 17/-	EB91 3/3	EF86 6/6	EY88 8/6	ML4 9/-			PL508 17/6	U19 50/-	VP23 6/6
1R5 7/-	6AG5 4/-	6CW4 12/6	6SA7 7/6	12AU7 6/-	30FL1 15/-	328A 40/-	CL4 12/-	EBC33 9/-	EF89 5/6	EZ35 5/6	ML6 8/-			PL509 30/-	U20 13/6	VP41 7/-
1S5 5/-	6AG7 7/6	6CY5 8/-	6SC7 13/-	12AV6 6/-	30FL12 18/6	329 20/-	CY31 7/-	EBC41 10/6	EF91 4/6	EZ40 7/6	M8PEN/T 10/-			PL802 14/-	U25 15/-	VP13 15/-
1T4 4/6	6AK5 6/-	6CY7 12/-	6SG7 6/6	12AV7 9/-	30FL13 9/-	329A 35/-	DAF41 10/-	EBC81 6/6	EF92 7/6	EZ41 9/-	MT17 90/-			PL803	U26 15/-	VR105/30 7/-
1T5GT 8/-	6AK5W 8/-	6D6 13/6	6SH7 5/-	12AX4GTB 9/-	715B 70/-	DAF91 5/6	EBC90 5/-	EF93 4/6	EZ80 5/6	MU12/14 10/-			PL804	U31 9/-	VR150/30 6/6
1U4 6/-	6AK6 11/6	6DK6 8/6	6SH7GT 6/6	12AX7 8/-	715C 80/-	DAF92 9/6	EBC91 6/-	EF94 5/-	EZ81 5/6	N78 21/-			PL805	U33 30/-	VU33 10/-
1U5 9/6	6AK7 6/6	6DQ6B 12/-	6SJ7 7/6	12AX7 13/6	807 9/6	DAF96 7/9	EBF80 8/-	EF95 5/-	EZ90 5/-	N8P1 70/-			PL807	U37 30/-	VU39A 10/-
1V2 9/-	6AL3 8/6	6D84 15/-	6SJ7GT 6/6	12AY7 13/6	807W 27/6	DC90 9/-	EBF83 8/6	EF96 4/-	FG17 90/-	N8P2 70/-			PL808	U50 6/-	VU111 10/-
1X2B 7/6	6AL5 3/3	6EA8 11/-	6SK7 6/6	12BA6 6/6	811A 30/-	DF91 4/6	EBF89 6/6	EFL200 14/-	FW4/500 17/-	PABC80 8/-			PL809	U52 6/-	VU120 15/-
2A3 7/-	6AM5 5/-	6EH7 6/6	6SK7GT 6/6	12BA7 6/6	813 75/-	DF92 3/6	EBL31 25/-	EH90 6/6	GC10B 37/-	PC86 11/6			PL81 16/-	U76 5/-	VU133 10/-
2C26A 10/-	6AM6 4/6	6EJ7 7/-	6SL7GT 5/6	12BE6 6/6	829B 60/-	DF96 7/9	EC53 10/-	EF183 6/8	GC10D 55/-	PC88 13/-			PL802 14/-	U78 5/-	W76 8/-
2C39A 140/-	6AN8 10/-	6F5 8/-	6SN7GT 6/-	12BH7 6/6	832A 57/6	DH76 6/8	EC86 12/-	EF184 7/-	GN4 30/-	PC900 9/6			PL81 11/-	U81 13/-	W107 8/-
2C40 65/-	6AQ5 6/6	6F6 14/-	6SN7GT 6/-	12BV7 10/-	833A 340/-	DH101 10/-	EC88 12/-	EF800 20/-	GR10M 30/-	PC84 7/-			PL82 11/-	UABC80 6/9	W729 12/-
2C51 8/6	6AQ6 10/-	6F6G 5/-	6SQ7 7/6	12BY7 10/-	837 15/-	DH101 10/-	EC90 6/-	EF811 15/-		PC85 8/-			PL83 9/-	UAF41 10/-	X65 10/-
2C53 75/-	6AR5 6/6	6F11 6/6	6SR7 7/6	12C8 8/-	866A 14/-	DK40 10/-	EC92 6/6	EF812 15/6		PC88 12/-			PL84 7/-	UBC41 9/6	X66 10/-
2CW4 12/-	6AR6 6/6	6F13 7/-	6SS7 6/6	12CU6 15/-	872A 57/6	DK91 7/-	EC93 9/6	EF814 13/6	G810D 55/-	PC89 10/6			PL802 14/-	UBF80 7/6	X76M 9/-
2D21 6/6	6AS5 7/-	6F14 12/-	6ST7 7/6	12E1 26/-	927 55/-	DK92 9/-	EC94 8/-	EK2 15/-	G810H 40/-	PCC189 11/-			PL81 11/-	UBL21 12/-	XC11 15/-
2E24 50/-	6AT6 5/-	6F15 11/-	6SU7GT 5/-	12E14 55/-	955 4/-	DK96 8/-	EC95 17/-	EK90 5/-	G8129 67/6	PCC805 17/-			PL81A	UC92 6/6	XC12 6/6
2E26 30/-	6AU6 5/-	6F17 9/-	6SU7GT 6/-	12J5GT 4/-	4378 25/-	DL66 25/-	EC97 17/-	EL5 11/-	G847X 55/-	PCC806 17/-			PL82 7/9	UCC85 8/-	XC12T 8/-
2X2 7/-	6AV5GTA 13/-	6F18 8/-	6SU7GT 6/-	12J7GT 8/-	5544 120/-	DL68 13/-	EC97 17/-	EL34 10/6	GU50 35/-	PCC808 42/-			PL83 8/-	UCF80 10/6	XC15 4/6
3A4 4/-	6AV6 6/-	6F22 6/6	6SU7GT 6/-	12J7GT 8/-	5545 150/-	DL69 35/-	EC97 17/-	EL36 9/6	GY501 16/-	PCH200 14/-			PL84 7/-	UCH21 11/-	XC15T 7/-
3B28 42/6	6AW8A 11/-	6F23 15/8	6SU7GT 6/-	12K5 10/-	5551A 320/-	DL91 5/6	EC98 12/-	EL38 27/6	GZ30 7/6	PCL81 10/-			PL802 14/-	UCH42 13/-	XC23 17/-
3C45 65/-	6AX4GTB 9/-	6F24 13/6	6SU7GT 6/-	12K7GT 7/-	5654 8/-	DL92 7/-	EC99	EL41 11/-	GZ31 6/-	PCL82 7/9			PL81 16/-	UCH42 13/-	XC25 7/-
3D6 3/3	6AX5GT 13/-	6F25 15/-	6SU7GT 6/-	12K8 10/-	5670 10/-	DL93 4/-	EC99	EL42 11/6	GZ32 9/6	PCL83 13/-			PL81 16/-	UCH42 13/-	XC25 7/-
3D21A 50/-	6B4G 16/6	6F28 14/-	6SU7GT 6/-	12Q7G 5/-	5751 12/-	DL94 8/-	EC99	EL81 5/-	GZ33 16/-	PCL84 8/9			PL82 7/9	UCH42 13/-	XC25 7/-
3E29 65/-	6B8G 3/-	6GH8 11/-	6SU7GT 6/-	12SG7 5/-	5796 280/-	DL95 8/-	EC99	EL83 7/6	HABC80 8/6	PCL85 9/6			PL83 8/-	UCH42 13/-	XC25 7/-
3Q4 8/-	6B8G 3/-	6GK6 12/-	6SU7GT 6/-	12SH7 5/-	5814A 12/-	DL96 7/6	EC99	EL84 5/-	HBC90 5/-	PCL86 9/6			PL84 7/-	UCH42 13/-	XC25 7/-
3Q5GT 8/-	6B8G 3/-	6J4 9/6	6SU7GT 6/-	12SJ7 5/-	5894 110/-	DM160 11/6	EC99	EL85 8/6	HBC91 6/-	PCL805 12/6			PL802 14/-	UCH42 13/-	XC25 7/-
3S4 8/-	6B8G 3/-	6J5GT 6/-	6SU7GT 6/-	12SK7 8/-	6080 27/6	DY70 12/-	EC99	EL86 8/6	HF93 6/6	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
3V4 8/-	6BA6 4/6	6J7 8/6	6SU7GT 6/-	12SK7GT 8/-	6146 30/-	DY86 6/6	EC99	EL90 6/-	HF94 5/6	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4-125A 180/-	6BE6 5/-	6K7 6/8	6SU7GT 6/-	12SN7GT 8/-	6146B 47/6	DY87 7/-	EC99	EL91 5/-	HK90 8/6	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4-250A 230/-	6BF5 16/-	6K8G 6/-	6SU7GT 6/-	12SQ7 8/-	6267 6/6	DY802 10/-	EC99	EL95 7/-	HL23 7/8	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4-400 300/-	6BF6 9/-	6K25 15/-	6SU7GT 6/-	12SR7 6/8	6360 25/-	E55L 55/-	EC99	EL360 23/-	HL23DD 7/8	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4B32 80/-	6BH6 8/6	6L6GT 9/-	6SU7GT 6/-	1487 16/-	6550 33/-	E80CC 21/-	EC99	EL803 17/-	HL42DD 9/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4CX250B 260/-	6BJ6 8/6	6L7 6/6	6SU7GT 6/-	20CV 62/6	6683 47/6	E80CF 29/-	EC99	EL821 11/-	HL92 7/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4HA5 9/6	6BK4 21/-	6L18 6/-	6SU7GT 6/-	20D1 9/-	6922 12/6	E80L 18/-	EC99	EL822 18/-	HL94 8/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
4THA 8/-	6BK7A 10/-	6LD20 6/6	6SU7GT 6/-	20L1 20/-	6939 42/-	E81L 22/-	EC99	EL84 11/-	HL133DD 17/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
5AR4 11/-	6BL7GTA 12/-	6N7GT 7/-	6SU7GT 6/-	20P1 10/-	7199 15/-	E83F 20/-	EC99	EL821 11/-	HL133DD 17/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
		6P1 12/-	6SU7GT 6/-	20P3 12/-	7586 25/-	E84L 9/6	EC99	EL822 18/-	KT33C 17/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
		6P28 12/6	6SU7GT 6/-	20P4 20/-	7591 20/-	E88C 24/-	EC99	EL84 11/-	KT36 20/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	20P5 20/-	7895 25/-	E88CC 12/6	EC99	EL84 11/-	KT44 8/6	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	25C5 9/-	8005 135/-	E90CC 9/-	EC99	EL84 11/-	KT45 30/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	25L6GT 7/6	9002 6/8	E91H 10/-	EC99	EL84 11/-	KT66 27/8	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	25Z4G 6/-	9003 10/-	E130L 100/-	EC99	EL84 11/-	KT71 8/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	25Z6GT 12/-	A1834 16/-	E180F 16/-	EC99	EL84 11/-	KT76 8/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	30A5 8/-	A2293 23/-	E188CC 16/8	EC99	EL84 11/-	KT88 33/-	PCL86 9/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	30AE3 8/-	AC/HL/DD 9/-	E280F 42/-	EC99	EL84 11/-	KTW63 6/-	PCL88 17/-			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-	30C1 6/6	108C1 6/6	EA50 4/-	EC99	EL84 11/-	LL4 9/-	PCL800 18/-			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-		150B2 12/-		EC99	EL84 11/-	LP2 8/-	PCL801 15/6			PL81 16/-	UCH42 13/-	XC25 7/-
			6SU7GT 6/-		150B3 11/-		EC99	EL84 11/-					PL81 16/-	UCH42 13/-	XC25 7/-

PLEASE NOTE THAT VALVES LISTED ABOVE ARE NOT NECESSARILY OF U.K. ORIGIN

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.

OUR NEW 1969/1970 CATALOGUE IS NOW READY. PLEASE SEND QUARTO S.A.E. FOR YOUR FREE COPY

WE WANT TO BUY:
SPECIAL PURPOSE VALVES. PLEASE OFFER US YOUR SURPLUS STOCK. MUST BE UNUSED.

TELEX 261306

APPOINTMENTS VACANT

DISPLAYED SITUATIONS VACANT AND WANTED: £7 per single col. inch.
LINE advertisements (run-on): 8/- 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 THURS., 12 p.m., 5th MARCH for the APRIL issue, subject to space being available.

SALES ENGINEERS

ETHER ENGINEERING

are expanding in the
TRANSDUCER MARKET
and require additional sales effort.
If you are successfully selling quality transducers or associated equipment to professional users, you may wish to consider this excellent opportunity to join a rapidly expanding member of the Pye Group.

also have an interesting new development line in
AUTOMATIC TEST EQUIPMENT
Sales Engineers at present qualified in this field are invited to join an expanding division of this company.

Modern marketing methods are employed and the company offers excellent working conditions, including:

- ★ Company Car
- ★ Pye Group pension and life assurance scheme
- ★ Superior dining facilities
- ★ Active Sports and Social Club

Applicants will receive immediate response and a quick decision.
Apply in writing, giving brief details of career to date, to:
Personnel Manager
Ether Engineering Ltd.
Park Avenue, Bushey, Herts.

Ether Engineering Ltd

A Member of the PYE Group of Companies

409

A Special Project R & D team is being set up by Control Systems Ltd. at Uxbridge to provide group facilities for subsidiary companies manufacturing and marketing internationally-known electronic equipment of advanced concept. New staff are required as follows:–

ELECTRONIC ENGINEERS

at graduate and qualified level with an interest in the application or design of M.O.S. integrated circuits in Mini Computer equipment with an emphasis on office mechanisation.

GRADUATES

in computer science or mathematics seeking a first appointment in industry who will carry out original work on the development and programming side of the new equipment.

Members of the Research and Development team enjoy first-class conditions of employment including the opportunity of four weeks holiday and a very good Life Assurance and Pension Scheme. The modern R & D building is in pleasant surroundings overlooking the Buckinghamshire countryside.
Apply, with relevant particulars of experience to:

Group Personnel Manager,
Control Systems Ltd.
The Island,
Uxbridge, Middx.

Lamson Industries Group

399

There is scope, variety and responsibility as a RADIO TECHNICIAN in Air Traffic Control

Join the National Air Traffic Control Service of the Board of Trade as a Radio Technician and you have the prospect of a steadily developing career in a demanding and ever-expanding field.

Entrance qualifications: you should be 19 or over, with at least one year's practical experience in telecommunications. Preference will be given to those having ONC or qualifications in Telecommunications.

Once appointed and given familiarisation training, you will be doing varied and vital work on some of the world's most advanced equipment including computers, radar and data extraction, automatic landing systems, communications and closed-circuit television. Work is based on Civil Airports, Air Traffic Control Centres, Radar Stations and specialist establishments. Vacancies exist in various parts of the United Kingdom.

Salary: £985 (at 19) to £1,295 (at 25 or over); scale maximum £1,500 (higher rates at Heathrow). Some posts attract shift-duty payments. Promotion prospects are excellent and ample opportunity and assistance is given to study for higher qualifications. The annual leave allowance is good and there is a non-contributory pension scheme for established staff.

Send this coupon for full details and application form:-
To: A. J. Edwards, C.Eng., M.I.E.E., M.I.E.R.E.,
Room 705, The Adelphi, John Adam Street, London WC2
marking your envelope 'Recruitment'.

Name .....

Address .....

WW/A4

Not applicable to residents outside the United Kingdom.

NATCS National Air Traffic Control Service

378

computer engineering

NCR requires additional ELECTRONIC, ELECTRO MECHANICAL ENGINEERS and TECHNICIANS to maintain medium to large scale digital computing systems in London and provincial towns.

Training courses will be arranged for successful applicants, 21 years of age and over, who have a good technical background to ONC/HNC level, City and Guilds or radio/radar experience in the Forces.

Starting salary will be in the range of £900/£1,250 per annum, plus bonus. Shift allowances are payable, after training, where applicable. Opportunities also exist for Trainees, not less than 19 years of age, with a good standard of education, an aptitude towards and an interest in, mechanics, electronics and computers.

Excellent holiday, pension and sick pay arrangements. Please write for Application Form to
Assistant Personnel Officer
NCR, 1,000 North Circular Road,
London, NW2
quoting publication and month of issue.

Plan your future with **NCR**

85

SERVICE ENGINEERS

Our Instruments Company is currently expanding its activities and range of products.

Senior and Intermediate vacancies exist at the Service Department situated in Reading Berks.

The Department is furnished with modern test and fault finding equipment and the work is varied and interesting. Equipments are modern analogue and digital devices incorporating the latest techniques in instrumentation.

Previous servicing experience is desirable but our main requirement calls for an enthusiastic sound approach to the servicing of our wide range of products.

Applications in writing please to:

RACAL THE ELECTRONICS GROUP

Mr. L. A. Jemmett.
Racal Instruments Ltd.,
Bennet Road,
Reading,
Berks.

411

EAST AFRICAN COMMUNITY

Meteorological Department

requires

Sectional Engineer Grade II (Telecomms.)

to serve on contract for one tour of 21–27 months in the first instance. Salary in scale EA. Shg. 24300–27780 (approx. £S. 1417–1620 p.a.) plus an Inducement Allowance normally tax free, of £S. 822–886 p.a. paid direct into officer's bank in U.K. Gratuity 25% of total emoluments. Generous paid leave. Education Allowances. Furnished accommodation at reasonable rental. Free passages. Contributory pension scheme available in certain circumstances.

Candidates, up to age 45, must possess O.N.C. or City and Guilds Final Certificate (Telecomms.) plus 7 years relevant experience in telecomms. engineering. Equivalent experience in one of the armed services is acceptable. Candidates must have a good theoretical and practical knowledge of FSK, ISB and SSB receivers and transmitters and of Mufax and facsimile transmitters and recorders. A good working knowledge of radar systems is essential.

The officer will be responsible to the Chief Sectional Engineer for the installation, operation and maintenance of the Department's radio telecommunications, radio sounding and radar equipment. He will be liable for service anywhere in East Africa but will probably be stationed at Entebbe, Dar es Salaam or Nairobi.

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1., for application form and further particulars stating name, age, brief details of qualifications and experience and quoting reference number M2K/690413/WF

379

RACECOURSE TECHNICAL SERVICES LIMITED

OPERATE A

TELEVISION UNIT FOR HORSERACING

and require a

TELEVISION ENGINEER

for operation and maintenance of the MCR

QUALIFICATIONS

★HNC, City & Guilds or equivalent.
★Experience in operation and maintenance of high grade television equipment.
★Willing to travel.

OPPORTUNITIES

★The Company is planning further expansion in the fields of television and electronics.
★Good salary and prospects.
★Expenses paid on location.

Applications stating age and experience should be sent to:

RACECOURSE TECHNICAL SERVICES LTD.,
88 Bushey Road, Raynes Park, London, S.W.20.

400

Opportunities with Redifon in Radio Communications

Experienced Test Engineers are invited to write to Redifon with regard to vacancies in our Test Department at Wandsworth.

The Company is engaged in the design and manufacture of a wide range of radio communications and allied equipment from military pack-set to broadcast transmitter, including communications receivers, M.F. beacons, teleprinter terminals, complete radio office installations for the Merchant Marine and mobile H.F. S.S.B. Stations. Our Test Engineers have sound technical knowledge coupled with good practical experience in the alignment and test of H.F. and V.H.F. Communications equipment. The work is varied and interesting and offers excellent opportunity to broaden experience in semiconductors, S.S.B. and Frequency synthesis.

Limited vacancies also exist for engineers experienced in Test gear maintenance.

Please write in the first instance to: The Personnel Officer

REDIFON LTD.,
Broomhill Road, Wandsworth, SW18.

REDIFON

A Member Company of the Redlffusion Organisation.

Suppliers of Radio Communications equipment to Home, Commonwealth, and foreign governments. Contractors to B.B.C., G.P.O., Crown Agents, Cable and Wireless, leading shipping companies of the world, etc.

403

INTERTEL
COLOUR TELEVISION

have vacancies for

VTR ENGINEERS

at their studio at

66 DEAN STREET
LONDON, W.1

Applicants should have a good working knowledge of colour video tape recording. Applications giving full details of previous experience should be forwarded to

Chief Engineer

INTERTEL COLOUR TELEVISION
WYCOMBE ROAD
WEMBLEY, MIDDLESEX

410

Work as a RADIO TECHNICIAN attached to Scotland Yard

You'd be based at one of the Metropolitan Police Wireless Stations. Your job would be to maintain the portable VHF 2-way radios, tape recorders, radio transmitters and other electronic equipment, which the Metropolitan Police must use to do their work efficiently.

We require a technical qualification such as the City & Guilds Intermediate (telecommunications) or equivalent.

Salary scale: £1,095 (age 21), rising by increases to £1,500 plus a London Weighting Allowance. Promotion to Telecommunication Technical Officer will bring you more.

For full details of this worthwhile and unusual job, write to: Metropolitan Police, Room 733 (RT), New Scotland Yard, Broadway, London, S.W.1.

319

V.H.F. TELEVISION RELAY & COMMUNAL AERIAL SYSTEMS

We are planning a considerable expansion of our activities and have the following vacancies:

I. A SENIOR ENGINEER

to have control of all aspects of systems design, planning, estimating, installation and commissioning.

II. ENGINEERS

capable of undertaking either:
(*a*) System planning and estimating.
(*b*) control of installation work.
or (*c*) test and commissioning duties.

Candidates for these appointments must have a good background of practical experience in this field of work, and an up-to-date knowledge of techniques and equipment.

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

343

ELECTRONIC ENGINEER

PRECISION TAPES LIMITED offer an excellent career to a man preferably between the ages of 25-40 years.

He would take full responsibility for the Electrical Servicing and maintenance of high speed tape duplicating systems and associated audio equipment operating under production conditions. Applicants must have experience in the Audio field and should have a thorough knowledge of Solid State Circuitry and hold H.N.C. Telecommunications or equivalent, but we would consider O.N.C. combined with a thorough practical experience of electronics.

Salary to be negotiated. Location Chadwell Heath, Dagenham.

Apply Mr. R. W. Holme,
PRECISION TAPES LTD.,
A.T.V. House,
17 Great Cumberland Place,
London, W.1

391

LEEVERS-RICH
EQUIPMENT LIMITED

319 TRINITY ROAD, S.W.18 **01-874-9054**

Manufacturers of Professional Tape Recorders and Allied Equipment, require

SENIOR ELECTRONICS ENGINEERS

for the DEVELOPMENT and TEST Departments. Staff position with top salaries

Apply in writing stating age and experience

Government of ZAMBIA

Police Department

requires

RADIO SPECIALIST

on contract for one tour of 36 months in the first instance. Salary according to experience in the Scale Kwacha 2460 to 3000 (Approx. £.Stg.1435–Stg.1750) plus an Inducement Allowance of £.Stg.684 a year which is payable direct to the Officer's bank in the U.K. Gratuity of 25% of total salary drawn. Both gratuity and Inducement Allowance are normally TAX FREE. Liberal leave on full salary or terminal payment in lieu. Free passage. Accommodation at moderate rental. Education Allowances. Outfit and plain clothes allowances. Contributory pension scheme available in certain circumstances.

Candidates, who will serve in the rank of Inspector of Police, must have completed a five year apprenticeship or hold a Service Trade Certificate or equivalent qualification and have had at least six years post-qualification experience in the Installation and maintenance of modern low and medium power H.F. equipment, S.S.B. and I.S.B. equipment, and of V.H.F. equipment including multiplex links. Knowledge of maintenance of teleprinters, diesel and petrol generators preferred.

The Officer will be required to maintain and install police radio equipment throughout Zambia, travelling by road and air, and to train Zambian Officers for City and Guilds examinations.

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1, for application form and further particulars stating name, age, brief details of qualifications and experience and quoting reference number M2Z/61274/WF.

404

Borough of Lowestoft Committee for Education

LOWESTOFT COLLEGE OF FURTHER EDUCATION

Engineering and Science Department

Principal: A. E. Boddy, B.Sc.(Econ.), F.R.G.S.

LECTURER

LECTURER GRADE I required for teaching radio, electronics and other subjects associated with the General Certificate for the Radio Officer (Merchant Navy) Course.

Salary in accordance with the Burnham Scale, at present £1,110 to £1,850, plus allowances for approved qualifications. Starting point within the scale determined by past teaching and/or appropriate industrial experience.

The post is vacant as from the 1st of May, 1970. Applicants preferably with teaching experience, suitable qualifications and industrial experience should apply to the Secretary, The Lowestoft College of Further Education, St. Peter's Street, Lowestoft, Suffolk, for further particulars and application form.

393

SKILLED MEN are required for the repair and overhaul of aircraft instruments and flight control units at BEA's Workshops at Heathrow Airport – London.

Applicants should preferably be apprentice trained in one of the following trades–

Electrical
Instruments (Fine mechanical)
Radio
Electronics

and can expect a certain amount of 'on-the-job' training.

Commencing rate £27.4.6. rising within 6 months to £28.16.0. and ultimately to £32.16.6. according to qualifications and responsibility. Avionics supplement of £2.10.0. pw may later be earned by qualified staff.

* Good promotion prospects
* Generous shift payments when applicable
* Opportunities for holiday air travel.

Write or phone for an application form to
Personnel Officer Engineering (Employment) (W W)
BEA, Engineering Base,
Heathrow Airport – London,
Hounslow, Middlesex.
SKYport 3131 Exts. 4302, 4185 or 4692

BEA

Electronics Maintenance Engineers

There are excellent opportunities in the Installation and Maintenance Division of U.K. Electronics and Industrial Operations of E.M.I. Ltd., at Hayes, Middlesex, for engineers to carry out maintenance work on a wide variety of electronic equipments including laboratory test gear and trans-ceivers.

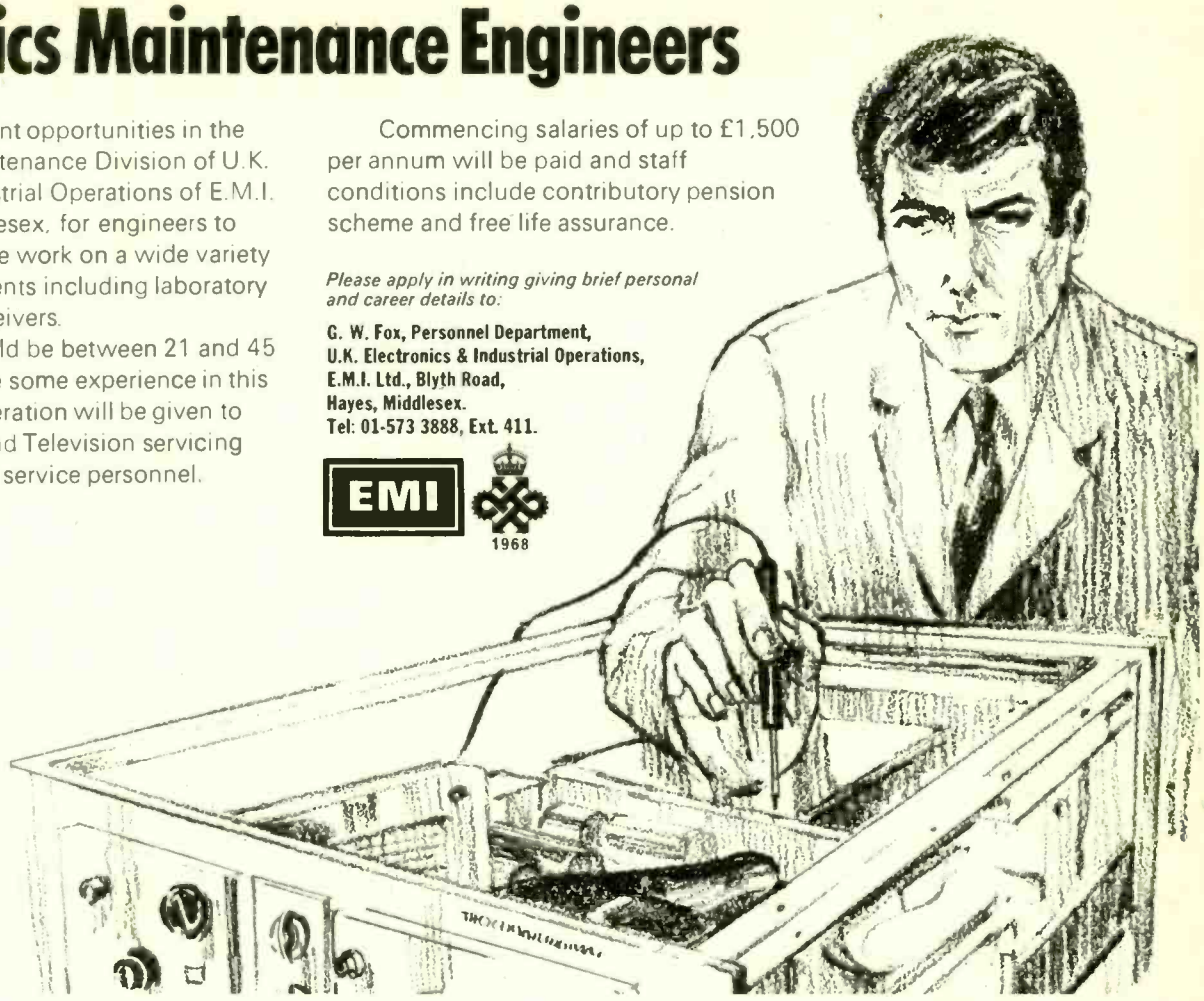
Candidates should be between 21 and 45 years of age and have some experience in this type of work. Consideration will be given to experienced Radio and Television servicing technicians and to ex service personnel.

Commencing salaries of up to £1,500 per annum will be paid and staff conditions include contributory pension scheme and free life assurance.

Please apply in writing giving brief personal and career details to:

G. W. Fox, Personnel Department,
U.K. Electronics & Industrial Operations,
E.M.I. Ltd., Blyth Road,
Hayes, Middlesex.
Tel: 01-573 3888, Ext. 411.

EMI 1968



309

GEC-Marconi Electronics

ELECTRONIC TECHNICIANS

Marconi can offer you

Attractive salary. Annual salary reviews
Good working conditions. 37-hour working week
Non-tied housing in a new town
in certain circumstances

At Basildon we have a number of vacancies for technical staff to work on the design and manufacture of specialised electronic test equipment and also on the repair and maintenance of general electronic test apparatus. Applicants should have a good basic knowledge of electronics and have some previous industrial or retail trade experience.

Marconi

THE QUEEN'S AWARD TO INDUSTRY 1966 1967 1968 1969

Please telephone or write for an application form to: Mr. R. McLachlan, Personnel Officer, The Personnel Dept, The Marconi Company Limited, Christopher Martin Road, Basildon, Essex. Phone: Basildon 22822.

A GEC–Marconi Electronics Company

2814

SENIOR TELEVISION TECHNICIAN

is required to be responsible for facilities in a small wired TV Systems Laboratory. He should be conversant with Colour Television Receivers and will be responsible for the maintenance of specialised test equipment. Other duties will include maintenance of records and equipment movement control.

Qualifications in R.T.E.B. and Colour Endorsement or H.N.C. desirable.

Good prospects of promotion for a keen young man with initiative. Salary negotiable up to £1,500 p.a. depending on qualifications. Training can be given. Subsidised canteen.

Write, giving details of past experience to:

Head of Operational Services Dept.
Rediffusion Engineering Ltd.
187 Coombe Lane West
Kingston-upon-Thames, Surrey
Tel: 01-942 6641

390

COUNTY MEDICAL PHYSICS DEPARTMENT

ST. GEORGE'S HOSPITAL, LINCOLN

ELECTRONICS TECHNICIAN

(Medical Physics Technician Grade III)

Salary scale: £1,180—£1,500 p.a.

required to assist in the development and construction of electronics instruments used in Medical Physics. Applicants should possess O.N.C. or equivalent electro-technical qualifications and should be able to construct and test equipment from circuit diagrams. Applications, including age, details of qualifications and experience with the names of two referees to be sent to **The Hospital Secretary, St. George's Hospital, Lincoln.**

356

Government of UGANDA

REQUIRES

BROADCASTING ENGINEERS

To serve on contract for one tour of 21-27 months in the first instance. Salary according to experience in scale Uganda Shg. 21,120-27,780 (£Stg. 1,232-1,620) a year, plus an Inducement Allowance, normally tax free, of £Stg. 778-886 a year, paid direct into a Uganda bank account nominated by the officer. Gratuity 25% of total emoluments drawn. Liberal paid leave. Accommodation provided at reasonable rental. Outfit and education allowances. Free passages. Contributory pension scheme available in certain circumstances.

Candidates must possess the City and Guilds Final Certificate in Telecommunications (with Radio) or an equivalent qualification and have wide practical experience of technical broadcasting equipment including high power M.F. transmitting and studio control equipment.

The officer will be required to undertake senior operational duties including the maintenance of broadcasting equipment in transmitting stations and studios; outside broadcasts and recordings in remote districts; and to give assistance with the training of junior engineering staff.

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1., for application form and further particulars stating name, age, brief details of qualifications and experience and quoting reference M2K/690995/WF.

405

METROSOUND GROUP OF COMPANIES

ELECTRO-MECHANICAL ENGINEER

A vacancy exists for a skilled Electro-mechanical Engineer who will be required to service and maintain a production unit of high speed tape duplicating equipments.

The applicants must be thoroughly conversant with the latest transistorised circuitry as applied to professional tape recorders and ideally should have had some experience with studio equipments.

The successful applicant who will be laboratory based will be paid a minimum salary of £1,600 p.a. which could be considerably increased in the case of an exceptionally experienced or qualified applicant.

Please write or telephone in the first instance to:

Mr. R. Bishop,
Audio Works, Cartersfield Road,
Waltham Abbey, Essex.
Waltham Cross 31933.

402

OMRON PRECISION CONTROLS

SUPPLIERS OF

PROCESS TIMERS
MICRO & LIMIT SWITCHES

are still expanding
and require experienced
FIELD SALES ENGINEERS
also
SALES OFFICE MANAGER
to co-ordinate operations
Apply: P. A. LEIGH.
Tel. 01-723 2231

349

RADIOLOGICAL PROTECTION SERVICE

(Department of Health and Social Security and Medical Research Council)

Clifton Avenue, Belmont, Sutton, Surrey

requires

Junior Technician and Technician

POST 1. **JUNIOR TECHNICIAN** required for duties in the Department of Electronics to assist in the construction of nucleonic instruments. Preference will be given to those candidates with aptitude and interest in electronic and mechanical practice. Salary according to experience at a point on the scale £467 (—922) plus London Weighting. M.R.C. conditions of employment.
Applications with the names and addresses of two referees to the Administrative Officer at the above address, quoting reference 70/3/4/17.

POST 2. **TECHNICIAN** required for duties in the Department of Electronics to maintain nucleonic instruments and systems. Previous experience of testing and 'fault-finding' on Electronic equipment is essential. Two 'A' level G.C.E's desirable but not essential.
Salary according to qualifications and experience at a point on the scale £982 (—1255) plus London Weighting. M.R.C. conditions of employment.
Applications with the names and addresses of two referees to the Administrative Officer at the above address, quoting reference 70/3/4/9.

Closing Date: 19.3.70

386

COMPUTER ENGINEERS

the big Burroughs challenge!

Burroughs large on-line systems dominate the U.K. market. A wide variety of concepts, a rapidly expanding market and a policy of promotion from within – all mean exciting opportunities for trained computer engineers to develop their skills in the large, on-line systems field or into the supervisory grades and beyond. Join the Burroughs boom – and grow with us.

We want experienced computer engineers to work on our B5500 and B6500 installations in the Greater London area With Burroughs, you can find the freedom to enlarge your talents, open fresh horizons, learn new skills – on the largest third generation systems in the world – these are the exciting prospects at Burroughs. In return we are offering you three weeks' paid holiday, free life assurance and a contributory pension scheme.

If you have an electronics qualification and experience with computer systems, then take a big step now into one of today's development industries – fill in the coupon and send off for one of our application forms. The address is:

The address is: **Geoff Lewis, Burroughs Machines Ltd. (Z), Heathrow House, Bath Road, Cranford, Hounslow, Middlesex.**

Computers | Visible Record Computers | Electronic Accounting Systems | Accounting & Adding Machines | Calculators | Cash Registers

Burroughs

NAME .....

ADDRESS .....

..... WW/A

Vacancies exist in our AYLESBURY and CRAWLEY factories for:

SERVICE ENGINEERS

Our Product. Flight Simulators

Requirements. A complete theoretical knowledge coupled with at least 2 years practical experience in one or more of the following:— Digital computing techniques, hardware, software & computer peripherals. We are prepared to train suitable applicants who have considerable experience in transistorised and integrated circuits. A knowledge of analogue computing techniques and principles of hydraulics systems would be advantageous. ONC or City & Guilds Electronics.

Travel. Must be prepared to travel anywhere in the U.K. and Overseas.

Salary. Negotiable but we are prepared to go as high as £1,800. for the right persons.

Applications to:

Personnel Manager, Redifon Air Trainers Limited, Bicester Road, Aylesbury, Bucks.

Personnel Manager, Redifon Limited, Flight Simulation Division, Gatwick Road, Crawley, Sussex.

413

BP

requires an

ASSISTANT TECHNICIAN

to undertake maintenance and development work in the Communications Division of their LONDON OFFICE. The maintenance element involves a sound knowledge of Teleprinters and associated telegraph equipment, and the development work requires a good working knowledge of Electronics and/or Audio systems.

Candidates, aged 25 to 30 years, should possess a minimum qualification of ONC and have at least 2 years' relevant practical experience. Preference will be given to applicants continuing their studies to HNC.

We offer three weeks' holiday, subsidised lunches, non-contributory pension and other benefits.

Please write giving brief details to **Mrs. M. G. Park, External Recruitment, The British Petroleum Company Limited, Britannic House, Moor Lane, London, E.C.2,** quoting reference R.11193/ZH.

407

ANTARCTIC EXPEDITION

require

Wireless Operator/Mechanics

With current morse speed of 20 w.p.m. PMG Certificate, teleprinter experience essential. Salary from £1,003 according to qualifications and experience with all living and messing free.

For further details apply to:

BRITISH ANTARCTIC SURVEY
30 Gillingham Street, London, S.W.1

406

CONTINUOUS EXPANSION

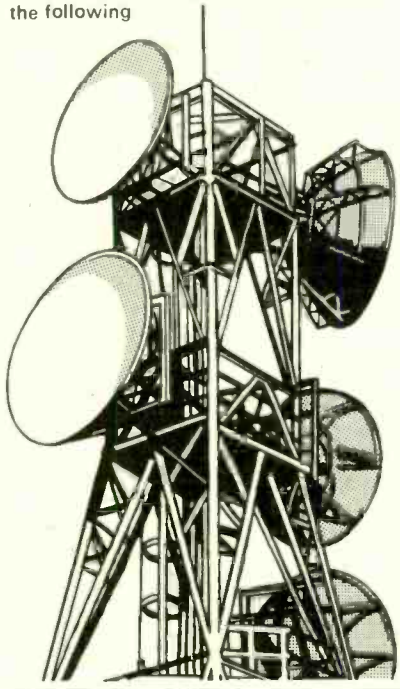
Standard Telephones & Cables, Microwave and Line Division based at Basildon are growing fast. In order to keep pace with this consistent growth rate we require the following

Installation Engineers Technicians & Testers

Ref. 25720

To test and commission Multiplex, Co-axial Line and Microwave Radio Systems.

Ideal candidates will be less than 45 years of age with practical experience on some of the above equipment. These challenging posts call for drive, initiative and common sense. It is necessary for applicants to be prepared to work anywhere in the U.K.



Test Technicians

Ref. 27221

The diversity of products manufactured at the Basildon Plant demands experienced testing staff for work on complex transmission systems.
Candidates should hold an ONC in electrical engineering and be able to offer considerable practical experience in the field of testing and fault clearing all types of land-unit, pcm and microwave equipment.

Applications should be addressed to
The Personnel Officer,
STC Chester Hall Lane,
Basildon, Essex.

STC

91

UNIVERSITY OF LIVERPOOL
Institute of Child Health
Alder Hey Children's Hospital

Applications are invited for the post of

ELECTRONICS TECHNICIAN

to assist with research. Applicants should be suitably qualified and have experience in general instrumentation and pulse techniques. The successful applicant will be expected to be able to assist in the design and development of medical electronic instruments. Initial salary, according to age, qualifications and experience. Application forms may be obtained from the Registrar, The University, P.O. Box 147, Liverpool L69 3BX. Quote ref. RV/5643/W.W. 384

JUNIOR ELECTRONICS TECHNICIAN

required for construction and repair of electronic instruments and maintenance of a Linear Accelerator. G.C.E. "O" level in Physics and Maths required; "A" levels or O.N.C. an advantage. Day release for further study is possible. Salary according to age and experience.

Apply with full details to The Director, Medical Research Council Cyclotron Unit, Hammersmith Hospital, London, W.12.

360

MALE TECHNICIAN

BRISTOL POLICE require a Technician to service and maintain facsimile and dictation equipment.

38 hour week. Salary £965-£1,130 according to qualifications. The post is superannuable. Applications to:

The Chief Constable
Bristol Police Headquarters, Bristol 1 389

CRAFTSMEN and SEMI-SKILLED MEN

are required for interesting work in the Signal Engineering Department of London Transport at FULHAM

The workshop in which these vacancies exist undertakes a considerable variety of work which includes the manufacture of prototype mechanical and electronic equipment for Signalling, Automatic Trains and Automatic Fare Collection projects together with the overhaul of electro-pneumatic equipment, ticket machines, clocks, telephones and allied apparatus and fault finding on electronic components.

- **GOOD RATES OF PAY AND PROSPECTS OF PROMOTION**
- **ADDITIONAL PAYMENT FOR OVERTIME**
- **EXCELLENT WORKING CONDITIONS**
- **FREE TRAVEL ON AND OFF DUTY**
- **PENSION AND SICK SCHEMES**

This is an opportunity for a secure, absorbing and worthwhile occupation. Please apply to a London Transport Recruitment Centre:—

Griffith House,
280 Old Marylebone Road,
London, N.W.1

Chiswick Works,
566 High Road,
Chiswick,
London, W.4 359

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. 84

Electronic Test Engineers

Pye Telecommunications of Cambridge has immediate vacancies for Production Test Engineers, The work entails checking to an exacting specification VHF/UHF and SSB radio telephone equipment before customer delivery; applicants must therefore have experience of fault finding and testing electronic equipment, preferably communications equipment. Formal qualifications, while desirable, are not as important as practical proficiency. Armed Service experience of such work would be perfectly acceptable.

Pye Telecom is the world's largest exporter of radio telephone equipment and is engaged in a major expansion programme designed to double present turnover during the next 5 years. There are therefore excellent opportunities for promotion within the Company. Pye also encourages its staff to take higher technical and professional qualifications. These are genuine career opportunities in an expansionist company so write, or telephone, for an application form without delay. Interviews can be arranged anywhere in the country at locations to suit the majority of applicants.

Mrs A. E. Darkin, Pye Telecommunications Ltd.,
Cambridge Works, Haig Road, Cambridge.
Telephone: Cambridge 51351.

Pye Telecommunications Ltd

387

MOBILE COMMUNICATION ENGINEERS

SOUTHERN GERMANY

Design engineers are required for interesting projects in an attractive area of Southern Germany. Engineers are required for a contract of two years' duration and should be qualified to a minimum standard of H.N.C. and some years' experience in either of the following fields:

(a) Mobile V.H.F. or U.H.F. solid state transmitter output stage design. Preferably at outputs of 20 W or more.

(b) Vehicle aerials and matching network design for wideband V.H.F.

The remuneration will be in the range of £3,000-£4,000 p.a., depending upon qualifications and experience. Write in confidence to:

INTERNATIONAL SCIENTIFIC CONSULTANTS LTD.
P.O. BOX 75, NORMANDY HOUSE, ST. HELIER, JERSEY, C.I. Quote Ref: EG.14

385

LARGS of Holborn for High Fidelity

the leading retailers of Radio and Hi-Fi equipment require top-class
RADIO AND HI-FI SERVICE ENGINEERS
First-class working conditions and top rates of pay (according to experience) for the right men.

Apply in confidence to:
A. BARROWS, LARGS OF HOLBORN,
76/77 HIGH HOLBORN, LONDON, W.C.1.
Phone: 01-242 2626 365

GUY'S HOSPITAL MEDICAL SCHOOL
Department of Physics

ELECTRONICS ENGINEER

or TECHNICIAN required to join Blood Flow Research Group for three-year project. Applicants should possess specialist experience/interest in construction/development of analogue solid state circuitry, and Grad.I.E.E.E., H.N.D., H.N.C., O.N.C., or equivalent qualifications. Salary according to qualifications and experience, with superannuation.

For further details of work telephone Dr. Gosling or Mr. King, **01-407 7600 Ext. 546.** Applications giving full particulars and quoting ref. PH.2, to
The Secretary, Guy's Hospital Medical School, London Bridge, S.E.1. 372

We are reorganising our service department and require three

TOP GRADE
SERVICE ENGINEERS/ TECHNICIANS

to work exclusively on Quad amplifiers and tuners returned for factory overhaul or repair.

Apply, in confidence, giving full details of training and experience to

Mr. J. H. Walker
ACOUSTICAL MANUFACTURING CO. LTD
St. Peter's Road, Huntingdon
375

LANCASHIRE CONSTABULARY
HUTTON
wanted
RADIO TECHNICIANS

Must have experience in Radio/Television servicing and have obtained CGLI/TREB in Television Final Servicing Certificate or equivalent.
Pay £985 to £1,500.
Starting point according to age and experience.

Apply to: **The Chief Constable, P.O. Box 77, Lancashire Constabulary, Hutton, Preston, PR4 5SB** 380

An immediate vacancy occurs at THE WIRELESS COLLEGE, COLWYN BAY, NORTH WALES

for a SENIOR INSTRUCTOR to take overall charge of the preparation of students for P.M.G./M.P.T. examinations, and to be directly responsible for telegraphy instruction. Applicants must hold a P.M.G. First Class Certificate. Recent marine operating and/or teaching experience is desirable but not essential. Write in the first instance to the Principal. 355

ENGINEERS

Have you considered a career in Technical Authorship? If you have sound experience in electronics and ability to write clear concise English we can offer positions as Technical Authors. The salary range is £1500-£2000 plus with excellent prospects and rewards. Box No. W.W.364, Wireless World.

RADIO OPERATORS

There will be a number of vacancies in the Composite Signals Organisation for experienced Radio Operators in 1970 and in subsequent years.

Specialist training courses lasting approximately nine months, according to the trainee's progress, are held at intervals. Applications are now invited for the course starting in September, 1970.

During training a salary will be paid on the following scale:

Age 21	£800 per annum
,, 22	£855 ,,
,, 23	£890 ,,
,, 24	£925 ,,
,, 25 and over	£965 ,,

Free accommodation will be provided at the Training School.

After successful completion of the course, operators will be paid on the Grade 1 scale:

Age 21	£965 per annum
,, 22	£1025 ,,
,, 23	£1085 ,,
,, 24	£1145 ,,
,, 25 (highest age point)	£1215 ,,

then by six annual increases to a maximum of £1650 per annum.

Excellent conditions and good prospects of promotion. Opportunities for service abroad.

Applicants must normally be under 35 years of age at start of training course and must have at least two years' operating experience. Preference given to those who also have GCE or PMG qualifications.

Interviews will be arranged throughout 1970.

Application forms and further particulars from:

Recruitment Officer, (R.O.3) Government Communications Headquarters, Oakley, Priors Road, CHELTENHAM, Glos., GL52 5AJ

Telephone No. Cheltenham 21491, Ext. 2270

92

SKILLED IN ELECTRONIC ENGINEERING?

Help keep aircraft on the straight and narrow

Air traffic has become so congested that complex electronic techniques are used as an aid in controlling aircraft both on airways and on airport approaches. As a Telecommunications Technical Officer III in the **National Air Traffic Control Service** of the Board of Trade, your job would be to install and maintain various air navigational and landing aids at civil airports, and communications and computer systems at radar stations and signal centres.

Because you handle such advanced equipment, you will receive thorough training. Study for higher qualifications is encouraged, and this could range from short courses with financial assistance to full-time study at a university or technical college.

Pay: (London rates—a little less elsewhere) £1,350 starting salary at 23, £1,625 at age 28 or over on entry, rising to £1,810. Within 3 years you could be upgraded, and on a scale rising to £2,050. A few years after that, you could be in the salary bracket going up to £2,375, and there are several higher grades still.

Qualifications: O.N.C. in Engineering, including a Pass in Electrical Engineering; or equivalent standard of technical education.

Send for full details and an application form (which must be returned completed by April 3rd, 1970) to Civil Service Commission, 23 Savile Row, London, W1X 2AA. Please quote S/207/13

397

THE UNIVERSITY OF MANCHESTER

TELEVISION SERVICE

Applications are invited for the post of **ASSISTANT STUDIO ENGINEER,** to assist with the maintenance and operation of television equipment used in the University studios and Mobile Unit.

Applicants should possess a Higher National Certificate or equivalent and have a good knowledge of basic electronics with particular emphasis on transistor circuitry. They should have experience in maintenance of electronic equipment, radar, television or similar field.

Initial salary range £1050-£1300 per annum.

Applications, giving full details of age, qualifications and previous experience and giving the names of two persons to whom reference may be made, should be sent as soon as possible to The Director of Television Services, The University, Manchester M13 9PL.

368

NORFOLK EDUCATION COMMITTEE

The County Technical College, King's Lynn

LECTURER GRADE I

in **RADIO and TELEVISION SERVICING** to teach electronics, radio and TV Servicing (including Colour) to C & G Final.

Applicants should have considerable relevant practical experience and hold a C & G Final Certificate.

Salary £1100–£1900 p.a. point of entry depending upon qualifications and experience.

Details and forms from the Registrar at the College.

County Hall,
Martineau Lane,
Norwich,
NOR 49A

F. LINCOLN RALPHS,
Chief Education Officer

388

TV MECHANICS FOR NEW ZEALAND

RADIO and TV MECHANICS—are you dissatisfied with your present working conditions, high taxation and lack of progress? Why not shift to the sunny South Pacific and join the friendly team at TISCO, New Zealand's largest Service Company! Being purely in Television Service, our mechanics are important people, not just numbers on a time sheet.

All 30 of our Branch Managers are mechanics. You can be with us in 3 months if you write now. Requirements: 5 years' experience and £20 towards the family's fare, remainder of which will be paid.

Mr. B. I. Wells, Tech. Supervisor, TISCO Ltd., Private Bag, Royal Oak, Auckland, NEW ZEALAND.

351

CAREERS IN RECORDING

PHILIPS PHONOGRAPHIC INDUSTRIES in Baarn, Holland, offer excellent career possibilities to young men between 22 and 30 years of age to join the Classical Recording Department as technicians.

Duties will include the installation and maintenance of equipment on major recording sessions in various parts of Europe.

Candidates must be prepared to reside in Holland and should have a thorough knowledge of at least one European language, ideally German or French.

Essential requirements are a good knowledge of music and the ability to follow a musical score; practical knowledge of basic electronics with experience in transistor circuitry and techniques; a general knowledge of recording and test equipment. ONC in telecommunications and audio experience would be an advantage.

Please apply in writing, giving details of age, education and experience, to:

The Personnel Officer,
Philips Records Limited,
Stanhope House,
Stanhope Place,
London, W.2.

Initial interviews will be held in London.

345

ELECTRONICS TECHNICIANS

As part of our rapid expansion in production requirements, we need a number of experienced men to trace and rectify faults in the complex equipment we use in the assembly and testing of semi-conductors. A sound knowledge of basic electronics is essential, and experience of working with advance equipment is highly desirable.

Good pay and conditions. Overtime work readily available.

Please write brief details or telephone for application form to:

ITT

Personnel Manager
STC Semiconductors Limited
Footscray, Sidcup, Kent
01·300·3333 Ext. 397

STC SEMICONDUCTORS

369

£2,200—£2,600 ELECTRONIC ENGINEERS

are required for Interesting contracts in the SOUTHERN HOME COUNTIES. Min. qualification H.N.C. and design experience in one of the following fields—wide band solid state feedback amplifiers, filters and networks or communication repeater amplifiers. Write to:

STRAND TECHNICAL CONTRACTORS LTD.
Norman House, 105-109 Strand, London, W.C.2; or Tel.: 01-836 6443

Quote Ref. B.37 346

Experienced Mftr./Working Jewellers have spare capacity to diversify with Electronics manufacturer. Five/ soft soldering-Rhodium Plating of small component parts.
Strictest confidence. Box No. WW392
392

NOTTINGHAMSHIRE BEESTON COLLEGE OF FURTHER EDUCATION

Radio, TV and Electronics Technicians, Part I Course No. C & G 434

A one-year, full-time and/or block release course will commence in September, 1970. The course will be open to students already engaged in the industry and to students leaving school this year who possess a good standard in mathematics and science. Minimum age of entry is 16 years.

Radio, TV and Electronics Mechanics, Part I & II Course No. C & G 433

A two-year block release course will be offered in September, 1970. Part I of 13 weeks and Part II of 22 weeks. Minimum age of entry is 15 years.

Radio and Television Servicing, Part I Course No. C & G 48

This one-year, full-time course will be offered next session for the last time after which it will be replaced by the Technicians and Mechanics courses. Students already in industry and those leaving school this year who possess a good standard in mathematics and science will be accepted on this course.

For further particulars and entry forms for the above courses write to: The Principal, Beeston College of Further Education, High Road, Beeston, Nottingham, NG9 4AH.

SITUATIONS VACANT

A FULL-TIME technical experienced salesman required for retail sales; write giving details of age, previous experience, salary required to—The Manager, Henry's Radio, Ltd., 303 Edgware Rd., London, W.2. [67

ARE YOU INTERESTED IN HI FI? If so, and you have some experience of selling in the Retail Radio Trade, an excellent opportunity awaits you at Telesonic Ltd., 243 Euston Road, London, N.W.1. Tel. 01-387 7467. [21

DEPARTMENT of Nuclear Physics, University of Oxford, has a vacancy in the experimental electronics group for a technician to work on the development, building and maintenance of modern nuclear electronic equipment. Salary within the range of £659-£1,316 depending on age, qualifications and experience. Five-day week working and good paid leave. Write to T. L. Green, Nuclear Physics Laboratory, Keble Road, Oxford, mentioning reference A123. [408

ELECTRONICS OFFICER required to run C.C.T.V. and Audio Section of the Department of Audio-Visual Communication, British Medical Association. He will be required to give information and advise on equipment to medical teachers. His responsibilities will include establishing contact with manufacturers, ordering equipment and materials, maintaining, modifying and operating equipment for demonstration and experimental purposes. Applicants should be able to present evidence of formal training and practical experience will be essential. The starting salary will be up to £1,550 p.a. according to qualifications and experience. Write briefly, in the first instance, stating age, education, qualifications and experience to the Director, Department of Audio Visual Communication, The British Medical Association, B.M.A. House, Tavistock Square, London, W.C.1. [347

RADIO TEST ENGINEERS. Production testing and fault finding on transistorised Audio Amplifiers & FM Receivers. 5-day week. Apply, Chief Engineer, Rogers Developments (Electronics) Ltd., 4-14 Barmeston Road (off Bromley Road), Catford, S.E.6. Tel: 01-698 7424/4340. [22

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

SERVICE ENGINEER for repairing Audio Equipment required by Dixons Photographic Ltd., to be employed at North Acton. If interested, please contact P. Rowley for more details, either by telephone (01-965 0411) or by letter to Camera House, 95 Victoria Road, London, N.W.10. [362

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 Mobile 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

TECHNICIAN

Applications are invited for the post of technician to maintain computer systems, to construct computer hardware, and to assist in the general running of a small electronics laboratory.
Suitable qualifications are experience in electronic equipment construction and maintenance of electro-mechanical devices and an interest in the subject generally.

Salary range £868–£1,486.
Pension plan.

Apply in first instance by letter stating briefly personal details and relevant experience to:

Mr. P. FENWICK, C.C.A.
R.S.M. Building, Imperial College,
Prince Consort Road, London, SW7
383

CRANFIELD INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND CONTROL ENGINEERING

Applications are invited for appointment as

TECHNICAL OFFICER

in the High Frequency and Radar laboratories which are concerned with postgraduate teaching and research.
The duties, which are interesting and varied include the supervision of the day-to-day activities in the labpratories and responsibility for the development of specialised experimental equipment. Candidates should have appropriate experience and possess an H.N.C. or Graduateship of a professional institution as a minimum qualification. Salary within scale rising to £1,623 p.a. (under review). 37-hour week of five days, staff superannuation and sick pay schemes, generous holidays. Subsidised transport over a wide area.

Application form from Staff Records Officer, Cranfield Institute of Technology, Cranfield, Bedford.
373

RADIO TECHNICIAN

with initiative, responsibility, and ability to work unsupervised, is required by company operating construction barges and rigs in the North Sea.
The applicant should be capable of carrying out all repairs to VHF, SSB, Marine I.F. R-T, Radar, Sonar, and C.C.T.V.
Offshore and away from base duties may be frequent.
Salary will be negotiable.
Applicants should write giving brief details of experience and stating qualifications to:

Mr. Paul Nagelsmit
Brown & Root (U.K.) Limited
Casing Yard, Suffolk Road,
Great Yarmouth, Norfolk
Tel: Great Yarmouth 55371 352

SITUATIONS WANTED

ELECTRONIC ENGINEER, 22 years experience D.C., L.F., Audio, etc. Products and test gear. Presently £2,000 p.a., London. seeks responsible position West of line Salisbury/Worcester. Alternatively seeks others to start small Design/Manufacture Business same area. Box No. W.W. 396 Wireless World.

Radio Operators

Your chance of a shore job with good pay from the start!

If you hold a 1st Class Certificate of Competence in Radiotelegraphy issued by the Postmaster General or the Minister of Posts and Telecommunications, or an equivalent certificate issued by a Commonwealth administration or the Irish Republic, the Post Office can offer you employment at a United Kingdom Coast Station, with a starting salary of £965—£1,215 (depending on age). Annual rises will take you to £1,650 and there are good prospects of promotion to more responsible and better paid posts.
If you are 21 or over, please write for more details to:

The Inspector of Wireless Telegraphy,
External Telecommunications Services,
Wireless Telegraph Section (WW),
Union House, St. Martins-le-Grand,
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 93

Test Technicians

Our test department is expanding. It is responsible for the testing of magnetic storage devices, high-speed printers, punched-card and paper-tape equipment.

For people with experience in electronics, opportunities exist immediately. Further vacancies will arise over the next few months. Training will be given to those who do not have previous computer experience.

Applicants must have worked on the testing, maintenance or repair of electronic equipment, and preference will be given to those qualified to ONC (Elect.) or C&G Final.

Locations: Kidsgrove and Winsford. Both are situated in rural surroundings bordering on the Cheshire Plain. Housing is available at attractive prices, and assistance with mortgage can be arranged.

Write giving details of age, qualifications, and experience, to:

Brian Buckley, Personnel Services Manager, International Computers Ltd., Kidsgrove, Stoke-on-Trent, quoting reference WW239M.

International Computers **ICL**

ELECTRONICS CIRCUIT DESIGN ENGINEER

for varied and interesting work on the application of I.C.'s and discrete component circuits to the control and regulation of electric power.

Minimum qualifications: O.N.C. (Electronics). Experience in closed loop system design would be valuable.

Housing and removal assistance available in some circumstances.

Write with full details to:

The Technical Director,
BRENTFORD ELECTRIC LIMITED,
Manor Royal, Crawley,
Sussex

358

LEEDS POLYTECHNIC
Calverley St., Leeds LS1 3HE

Full-time three-week courses:

The Principles of

COLOUR TELEVISION

4th-22nd May and 8th-26th June

For details, write to:
Department of Electrical Engineering

370

PERKIN-ELMER LIMITED OF BEACONSFIELD

is actively engaged in the development and manufacture of automatic analytical equipments using infra-red, ultra-violet, nuclear magnetic resonance and other techniques.

The Company is in the process of considerable expansion and requires:

ELECTRONIC TEST ENGINEERS

The job descriptions for these appointments call for a sound knowledge of modern electronic circuits and the ability to diagnose faults logically and systematically using standard test methods. O.N.C. (Elec); City and Guilds Technicians Certificate or equivalent is desirable, but applications will be considered from those who have good practical test experience.

Apply to:
P. L. Nielsen
Personnel Officer
PERKIN-ELMER LIMITED
Post Office Lane
Beaconsfield, Bucks.

ARTICLES FOR SALE

AMAZING VALUE

Plessey SL402A Preamp and 2W Amp	42/-
GE PA234 1W Audio Amplifier	17/6
RCA 40669 8A 400V Triac	24/-

Notes supplied FREE with each order.
New Full Specification Devices, by Return.
P & P 1/-. Cash With Order. Mail Order Only.
Unbeatable rates for medium quantities.
JEF ELECTRONICS (W.W.),
York House, 12 York Drive, Grappenhall, Warrington, Lancs. 394

CAPACITOR DISCHARGE IGNITION SYSTEM *(W.W. JANUARY 1970)*

Invertor transformer 30VA Ratio 15 : 1

CWO **32/-** + 5/- p. & p.

MAGTOR LTD., 68 Dale St., Manchester M1 2HS

361

ACY22, BC108, BFY52, OC45, OC71, OC202, ZTX300, 2N2926, 2N3708. All at 1/9 each or 16 for £1. Money back guarantee. P. & P. 1/-.—J. M. King. 17 Buckridge, Portpool Lane, London, E.C.1. [382

BRAND NEW ELECTROLYTICS 15/16V. 0·5, 1, 2, 5, 8, 10, 20, 30, 40, 50, 100 mfds. 8s. 5d. 200 mfds. 10d. ¼ watt 5% carbon film resistors E.12 series 10 ohms to 1 Megohm 1/5. Wirewound 5W 5% E.12 series 15 ohms to 15,000 ohms 10d.; postage 1/- per order.—The C.R. Supply Co., 127 Chesterfield Road, Sheffield, S.8. [381

BUILD IT in a DEWBOX quality plastics cabinet. 2 in. × 2½ in. × any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76

HOW to Use Ex-Govt. Lenses and prisms. Booklets. Nos. 1 & 2, at 2/6 ea. List Free for S.A.E. H. W. ENGLISH, 469 RAYLEIGH RD., HUTTON, BRENTWOOD, ESSEX. [87

MUSICAL MIRACLES. Send S.A.E. for details of Cymbals and Drum Modules, versatile independent bass pedal unit for organs, pianos or solo, musical novelties, waa-waa kits (49/-). Also bargain components list reed switches etc. D.E.W. Ltd., 254 Ringwood Road, Ferndown, Dorset. [95

NEW CATALOGUE No. 18, containing credit vouchers value 10/-, now available. Manufacturers' new and surplus electric and mechanical components, price 4/6, post free. Arthur Sallis Radio Control Ltd., 28 Gardner Street, Brighton, Sussex. [94

SHIP'S R/T and Alarm for sale. Siemen F.20. Best offer secures. Box W.W. 363, Wireless World.

SOLARTRON QD 910 storage Oscilliscope perfect £250. Frequency decade Schomandl 20 CS to 31-111 MCS new. Offers, Burgess, East Lake, London Road, Bognor Regis. [357

UHF, COLOUR and TV SERVICE SPARES. Leading British makers' surplus Colour Frame and Line time base units incl. EHT transformer, £5, carriage 10/-. Integrated UHF/VHF 6 position push button tuner, 4 transistors, knobs, circuit data. Easily adjusted for use as 6 position UHF tuner, £4/10/-, P/P 4/6. UHF 3 transistor tuner incl. circuit. £2/10/-, P/P 4/6. UHF/VHF transistorised IF panel. £3/10/-, P/P 4/6. MURPHY 600/700 series complete UHF conversion kits incl. tuner, drive assy. 625 IF amplifier, 7 valves, accessories, housed in special cabinet plinth assembly, £8/10/- or less tuner £2/18/6, P/P 10/. SOBELL/GEC 405/625 switchable IF amplifier and output chassis, 32/6, P/P 4/6. UHF tuners incl. valves, slow motion drive assy, knobs, aerial panel, £5/10/-, P/P 4/6. UHF list available on request. New or manufacturer tested VHF tuners, AT7650 Philips 19TG170, Sobell 1010, KB Featherlight 35/-. AT7639 Peto Scott, Decca, Ekco, Ferranti, Cossor 50/-, Cyldon C 20/-, AB miniature with UHF injection incl. valves 78/6, Ekco 283/330, Ferranti 1001/6 25/-. New fireball tuners, Ferguson, HMV, Marconi type 37/6, Plessey 4 position push button tuners with UHF injection, incl. valves, 58/6. Many others available. P/P all tuners 4/6. Large selection channel coils. Surplus Pye, Ultra, Murphy, 110° scan coils 30/-, Sobell 110° Frame O/P transformers 17/6, P/P 4/6. Perdio "Portorama" LOPT assy incl. DY86, suitable for transistorised TV, 40/-, P/P 4/6. LOPTs, Scan Coils, FOPTs available for most popular makes. PYE/LABGEAR transistorised booster units B1/B3 or UHF, battery operated 75/-, UHF mains operated 97/6, post free. COD despatch available. MANOR SUPPLIES, 64 GOLDERS MANOR DRIVE, LONDON, N.W.11. CALLERS 589B HIGH ROAD, N. FINCHLEY, N.12 (near GRANVILLE ROAD). Tel. 01-445 9118. [60

TEST EQUIPMENT — SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [64

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx5s, etc., AR88, CR100, BRT400. G209, S640, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [65

NEW GRAM AND SOUND EQUIPMENT

CONSULT first our 76-page illustrated equipment catalogue on Hi-Fi (6/6). 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

YOUR TAPES TO DISC—£6,000 Lathe. From 25/-. Studio/Location Unit. S.A.E. Leaflet. Deroy Studios, High Bank, Hawk St., Carnforth, Lancs. [70

VALVES

VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A. Boxmakers, 75a Godwin St., Bradford, 1. [10

ARTICLES WANTED

VOLUNTARY Rescue Services seek 2 VHF hand-portables, 1 mobile, 1 base station (minimum); GPO approved; limited budget. Write W. H. Jarvis, Rannoch School, via Rannoch Station, Perthshire. [371

DESIGN AND DEVELOPMENT ENGINEER

A progressive and interesting position is available at our factory in London, W.11, for an experienced circuit development engineer, with first class knowledge of Transistor Radio, both A.M. and F.M., duplex, transistor tape recorders.

Top salary according to experience and ability.

Please apply to: **Mr. J. Dickman, Managing Director,**

Fidelity Radio Ltd.

Olaf Street, London, W.11

Telephone: 727 0131

374

SENIOR ENGINEER

(Colour Television)

The Road Transport Industry Training Board operates at its Wembley Park headquarters one of the most modern closed circuit colour television studios in the country from which teaching and training programmes are produced on both film and video-tape.

An opportunity exists for an experienced engineer to join our small, enthusiastic team. He will be responsible to the Chief Engineer primarily for the operation and maintenance of the video-tape recording and telecine systems.

Applicants must be experienced in the latest systems of broadcast quality colour television. Knowledge of PAL Encoding systems and TR50 videotape equipment would be a distinct advantage. It is unlikely anyone under 24 years old will have sufficiently varied experience.

A salary will be negotiated in the region of £2250 depending on experience. Conditions of service include three weeks holiday, life assurance and a contributory pension scheme.

Please send relevant personal history, stating how the above requirements are met and quoting reference ZH.150, to:

J. R. Barber,
Personnel Manager,
RTITB, Capitol House,
Empire Way, Wembley,
Middlesex.

395

ELECTRONICS EXPORT SALES ENGINEER

Based on PARIS

RAPIDLY EXPANDING FRENCH electronics firm specialising in TV and F.M. translators and transmitters seeks mature export sales engineer

CANDIDATES MUST

- speak and write absolutely perfect English
- like travelling. The work entails about 4 months a year away from Paris (throughout the world)
- be at least 28 years old
- have at least 3 years technical/commercial experience in our field
- be technically and intellectually sound
- be commercially dynamic

Candidates are preferred who speak a little French and Spanish

THIS IS A RESPONSIBLE POSITION

Exactly the right man will be offered a salary of at least 30 000 Frs. (£2 500) per year

Curriculum vitae in English, in writing, with photograph (which will be returned)

L.G.T., 4, rue de Garches 92 St-CLOUD • France • as soon as possible

376

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. 82

Norwich City College

Department of Electrical Engineering

H.N.D. Course in Electrical and Electronic Engineering

The Department of Electrical Engineering of the Norwich City College offers students who have studied Physics and Mathematics at Advanced level in the GCE and passed in one subject (or have obtained a good ONC or OND in Engineering) a modern sandwich course for the Higher National Diploma in Electrical and Electronic Engineering. Subjects studied include Computation, Statistics, Economics and Law, Electronics, Control, Telecommunications, Power and Machines. Well balanced and interesting industrial training with pay will be arranged as required. The course is approved for major grant awards by Local Authorities.
Accommodation will be arranged by the College if desired.

Enquiries about the course starting in September 1970 should be made to:

E. Jones, B.Sc., Ph.D., C.Eng., M.I.E.E.,
Head of Department of Electrical Engineering,
Norwich City College,
Ipswich Road, Norwich, Norfolk, NOR 67 D.

347

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [63

WANTED, televisions, tape recorders, radiograms, new valves, transistors, etc.—Stan Willetts, 37 High St., West Bromwich, Staffs. Tel. Wes. 0186. [72

WANTED. PYE Link TX 450L. Eddystone EA12. EC10. Heathkit HW17. Beam Rotators. Prompt Cash. ALLSETS & Co. Ltd., 15 Burscough Street, Ormskirk. Tel.: 73005. [273

VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Walton's Wireless Stores, 55 Worcester St., Wolverhampton. [62

CAPACITY AVAILABLE

AIRTRONICS, Ltd., for coil winding, assembly and wiring of electronic equipment; transistorised sub-unit sheet metal work.—3a Walerand Rd., London, S.E.13. Tel. 01-852 1706. [61

ELECTRONIC and Electrical Manufacture and Assembly. Prototypes and short production runs. East Midlands Instrument Co. Ltd., Summergangs Lane, Gainsborough, Lincs. Tel. 3260. [88

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.—PHILPOTT'S METALWORKS, Ltd., Chapman St., Loughborough. [17

TECHNICAL TRAINING

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. home-study courses in radio, TV, servicing and maintenance. R.T.E.B., City & Guilds, etc., highly informative 120-page Guide—free.—Chambers College (Dept. 837K), College House, 29-31 Wrights Lane, Kensington, London, W.8. [16

CITY & GUILDS (Electrical, etc.), on 'Satisfaction or Refund of Fee" terms. Thousands of passes. For details of modern courses in all branches of electrical engineering, electronics, radio, T.V., automation, etc.; send for 132-page handbook—free.—B.I.E.T. (Dept. 152K), Aldermaston Court, Aldermaston, Berks. [13

RADIO officers see the world. Sea-going and shore appointments. Trainee vacancies during 1970. Grants available. Day and boarding students. Stamp for prospectus. Wireless College, Colwyn Bay. [80

TECHNICAL TRAINING IN Radio, TV and Electronics through world-famous ICS. For details of proven home-study courses write: ICS, Dept. 443, Intertext House, London, S.W.8. [24

TV and radio A.M.I.E.R.E., City & Guilds, R.T.E.B.; certs., etc., on satisfaction or refund of fee terms; thousands of passes; for full details of exams and home training courses (including practical equipment) in all branches of radio, TV, electronics, etc., write for 132-page handbook—free; please state subject.—British Institute of Engineering Technology (Dept. 150K), Aldermaston Court, Aldermaston, Berks. [15

TUITION

ENGINEERS.—A Technical Certificate or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C.Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B., and G.C.E. Exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts, Building, etc.—For full details write for FREE 132-page guide: British Institute of Engineering Technology (Dept. 151K), Aldermaston Court, Aldermaston, Berks. [14

KINGSTON-UPON-HULL Education Committee. College of Technology. Principal: E. Jones, M.Sc., F.R.I.C.
FULL-TIME courses for P.M.G. certificates and the Radar Maintenance certificate.—Information from College of Technology, Queen's Gardens, Kingston-upon-Hull. [18

MERCHANT NAVY: Residential Radio Officer Training.—R.M.S. Wray Castle, Ambleside, Westmorland. [311

BOOKS, INSTRUCTIONS, ETC.

FOR SALE—Wireless Journals, 1911-1940. Lambert, 60 Salhouse Road, Rackheath, Norwich. [366

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a Moffat Road, Thornton Heath, Surrey, CR4-8PZ. [66

BUSINESS OPPORTUNITIES

GROUP OF YOUNG qualified electronic engineers with development laboratory in London wish to undertake development projects of low to medium complexity. Box W.W. 348, Wireless World.

FOR HIRE

FOR HIRE CCTV equipment, including cameras, monitors, video tape recorders and tape—any period.—Details from Zoom Television, Amersham 5001. [75

development engineer

For the programming, development and modification of automatic and airborne test equipment. Applicants should have knowledge and experience of electrical and electronic measurement, servomechanism tests, Manometric measurements and Gyroscopic equipment tests. In addition, familiarity with computer fundamentals and programming is required, and at least HNC or equivalent in a relevant subject.

Apply, giving brief details of education and experience to:

Personnel Officer Engineering (General) (*)
BEA Engineering Base,
Heathrow Airport—London,
Hounslow, Middlesex

414

A NEW HI FI pulse rate F.M. TUNER M·70

- 14 Si TRANSISTORS, 4 Si DIODES
- TUNING METER
- DISTORTION—LESS THAN 0.5%
- SUITABLE FOR STEREO
- SIGNAL/NOISE—60db
- NOMINAL TUNING 88-108Mc/s
- NO COILS! NO ALIGNMENT!
- AUDIO O/P—300mV
- FREQUENCY RESPONSE 25c/s-15kc/s
- 3 STAGES OF LIMITING
- ULTRA HIGH SENSITIVITY
- POWER REQUIREMENTS 12V AT 25mA

11" by 5" printed circuit board for above tuner with fitted tuning gang, together with complete shopping list and assembly details for all components required:

75/- (approx. cost of remaining components—£6)

'A HIGH FIDELITY TUNER FOR ABOUT £10!

Printed circuit accommodates all components, you just insert each one—if you can read and use a soldering iron—45 mins.

The shopping list consists of two prepared orders which are sufficient for you to obtain all the components required.

If you are building a Hi Fi set up, an excellent tuner is a must; a tuner that will impress you as well as your friends. p. & p. 5/-

Mail Orders to: **DEPT. WW, MULTEL**
30 BAKER STREET · LONDON · W.1

WW—126 FOR FURTHER DETAILS

Electronics and Instrumentation

Robert L. Ramey.

The purpose of this book is to provide a sound groundwork for understanding the basis of existing instruments and their applications. It will prove a useful introduction to instrumentation for students of electronics and a single course in electronics and instrumentation for students in other branches of science and engineering.

55s net by post 57s 321 pp. 207 illustrations

obtainable from your bookseller or:

THE BUTTERWORTH GROUP
Butterworths-Iliffes-Newnes
88 KINGSWAY LONDON W.C.2 01-405 6900

RADFORD

NEW POWER AMPLIFIERS

MONO POWER AMPLIFIER PA50
STEREO POWER AMPLIFIER SPA50

The PA 50 is a transistor power amplifier having a power output in excess of 50 watts. The SPA 50 is a dual channel power amplifier having identical characteristics. The amplifier was designed basically for sound reproduction for professional use, but its exceptional characteristics in respect of distortion, transient response and power bandwidth make it also suitable for commercial and industrial uses.

The presentation is a low format of a depth suitable for shelf mounting. The amplifier is supplied in a metal housing suitable for fitting into a cabinet if required. The front facia is of extruded aluminium section with end pieces to form a complete frame. It is fitted with an anodised aluminium panel, screen printed.

The amplifier uses a true complementary symmetry output circuit with matched NPN and PNP transistors to obtain a virtually zero 'crossover' distortion. Improved circuitry has been developed to provide high gain in the output stages and drive circuits with wide bandwidth permitting a large amount of feedback to ensure an extremely low overall distortion. The success of the circuitry and the devices used is exhibited by the power bandwidth characteristic of 0·5 MHz at the —3 dB point.

The amplifier is unconditionally and absolutely stable with any form of output load of any impedance characteristic, from short-circuit to open-circuit. The amplifier itself is fully protected by current and voltage limiting and in addition is protected against the failure of a device in the power amplifier itself by a high speed current protection circuit in the power supply.

A new low distortion level of 0·01% has been reached for the amplifier at the —3 dB reference to the rated output, with the distortion proportionally decreasing with output power. Approximately 60 watts (continuous tone rating) is available at clipping level at 0·025% distortion both channels driven simultaneously.

Considerable attention has been given to reliability and ease of service. All components are to Mil specifications where possible. The amplifier is constructed in modules and all active circuits are on plug in type circuit boards. The contacts in the sockets and circuit boards are hard electro gold plated and the circuit boards themselves are immersion gold plated. Circuit board sockets are fitted to a printed circuit mother board thus eliminating wiring with its variations in performance and stability.

SPECIFICATION

Mains Input	110 volts. 120 V. 130 V. 220 V. 230 V. 240 V. 50-60 Hz.
Output Matching Impedance	4-16 ohms (100 V line extra).
Output Power	50 Volt-amperes nominal. (Watts into an 8 ohm resistive load).
Distortion	0·025% at clipping onset. 0·01% at —3 dB ref: clip level.
Input Facilities	High impedance 22K ohms. Low impedance, optional 200/600 ohms balanced/unbalanced.
Input Sensitivity	High impedance. 1 Volt r.m.s. Low impedance. 0·5 Volt r.m.s.
Functions	*Switched on front panel* Mains on/off. Louspeaker 1. Loudspeaker 2. Hi/Low Impedance input.

Price: PA 50—£55 SPA 50—£85

A complementary matching stereo pre-amplifier control unit SC 24 is also available price **£75.** Further details available upon request.

Radford Audio Limited
Bristol BS3 2HZ, England

WW—128 FOR FURTHER DETAILS

P. F. RALFE

10 Chapel St London N.W.1

Phone 01-723-8753

LEDEX ROTARY SOLENOID SWITCHES suitable for all types of remote circuit selection and a variety of switching operations—brand new stocks—no waiting—off the shelf deliveries of the following types.

(1) Miniature type—1 pole 12 positions 3 banks wafer dia. 1¾in., 3 position foot mounting. Operating voltage. 24 Volts D.C. 50/-

(2) Miniature type—1 pole 7 position 5 banks 1¾in. dia. wafers for flange mounting. Operating voltage. 12 Volts D.C. 37/6

(3) Standard type—2 pole 6 way 13 bank. 48 Volts D.C. Operating voltage 55/-

(4) Standard type with 1¾in. wafers, 2 pole 12 position 6 banks plus 2 pole 12 position 2 bank in ceramic insulation.. 50/-

(5) Standard type—1 pole 2 positions with long shaft to enable user to build up wafers to suit requirements. Voltage 48 Volts D.C. 40/-

(6) Standard type wafers—1 pole 12 position 3 banks for 24 Volts flange mounting 45/-

TUBE BASES EIMAC SK 200A for 4×250 transmitting values. New. Boxed. With fixing clips. Price 42/6 ea.

AMPHENOL AERIAL C/O RELAYS. High quality type terminated to N Type connectors 75 ohms 48V DC coil. Brand new 50/- each.

GEC QUARTZ CRYSTALS. Type QA/328 600 KHz of recent manufacture. Brand new. Only 12/6 each.

MINIATURE SEALED RELAYS STC TYPES

4184GE. 2 change over. Medium duty. 48 v. 2500Ω.
4184GD. 2 change over. Medium duty. 24 v. 700Ω.
4184GB. 2 change over. Medium duty. 6 v. 45Ω. All at 8/6 each. P. & P. 6d.

MAGNETIC DEVICES LTD. Mini relay 12 v. 590Ω. 2 pole change overs plus 2 makes and 2 breaks. Medium duty contacts. New. Boxed. Above relays 8/6 each. Post/packing 6d.

LARGE QUANTITY OF 600 TYPE RELAYS removed from equipment. Coil resistance 50Ω. 2 break contacts. 30/- per doz. Special price to clear the lot.

HIGH SPEED RELAYS. "Suitable for transistor circuits."
Plessey. Type mini sealed. 1 C/O contacts. 12 v. 3100Ω. Brand new. 15/- ea.
Siemens High Speed. Type H96E. Twin 1700Ω coils. 48 v. 15/-.
Siemens High Speed. Type H96D. Twin 500Ω coils. 12 v. 15/-.

PAXOLIN PC BOARD contains 63 Lucas DD006 diodes. Rates at 400 P.I.V. 500 mA. New and unused. With long leads. Board size 8×4 ins. 30/- ea.

LUCAS CAR RELAYS. 12 v. Heavy duty make. Suitable for spotlights, horns, overdrives, etc. Brand new. Only 7/6. Special price for quantities.

NICKEL-CADMIUM BATTERIES
D.E.A.C. manufacture RS 3·5 rating 3·5 Ah 1·24 v. Size as British U2, fully rechargeable. Offered BRAND NEW 19/6 each. P. & P. 1/6.

"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. Post/packing 10/-.

R.F. ATTENUATORS TYPE A38
These attenuators are contained in a screened cast case and are suitable for the audio to VHF 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.

VARIABLE R.F. ATTENUATORS.
By famous manufacturer 0-12 dB. In one OHM steps, 50 ohm impedance terminated to BNC connectors, also 0-120 dB in ten ohm steps, 50 ohm and 75 ohm types.

LANGBOURNE DYNAMICS TYPE 4B
Low Voltage/Highly Stabilised POWER SUPPLY UNIT
Variable between 3-30 v. D.C. at 1 A. Fully transistorised and current limiting offered. BRAND NEW at only £13.10 inclusive of P. & P.

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. P.P. 6d.

DIRECT CURRENT AMPLIFIER
Contains "Brown Convertor", for continuous balance system and associated circuit. Complete less valves (5) Brand new ..... 50/- P.P. 4/6

ALWAYS IN STOCK AT REASONABLE PRICES
Communications Receivers. Audio Oscillators. AC and DC Callibration Equipment. Schomandle Frequency Meters. Counter Timers to 220 MHz. Oscilloscopes/Pulse generators. RF and AF generators. Digital Volt Meters AC and DC. DC Potentiometers/Thermo Couple Pots. Storage Oscilloscopes and many other items of test equipment. We may be able to help so phone 01-723-8753.

SPECIAL OFFER

"INSULATION TESTERS" TYPE No. 11 METROHM by famous British manufacturer. All solid state. No handles to crank. Runs off 9 volt transistor battery. Simply press button for function. Range 0·1 to 25M ohms for insulation testing. Also 0·1 to 100 ohms for resistance and continuity checking. Clear, concise scale. Small size modern instrument, complete with carrying strap and protecting cover. Offered in good used condition with battery ready to work. For 250 volt pressure only. List Price £19.10.0. Our price £5.19.6 plus 4/6 post/packing.

"One Micovac Valve Voltmeter for one-eighth of original price." Will measure 0-480 Volt A.C. at frequencies up to 200 Mc/s., 0-480 Volt D.C. with centre zero facilities 0-10 Megohms resistance in 5 ranges. This extremely accurate meter was made to Services specification and comes complete with R.F. Probe, full instructions in guaranteed working order. Battery powered (not supplied). Price is only £9.19.6, plus 10/6 P.P. Excellent condition. Completely portable.

MARCONI AUDIO TESTER TYPE TF894
This directly calibrated AF oscillator from 50c/s to 12kc/s has a maximum output of 300mW. into 600 ohm and is fitted with an output level meter and 600 ohm ladder attenuator of 0-50dB. An alternative 5,000 ohm outlet is provided and the level in each case is continuously variable. AF measurements: the voltmeter may be used for AF inputs (external) over the ranges of 0 to 80 v. in 4 ranges, providing a very useful facility. Supplied in excellent condition and working order for only £18.10. Power supply 240 v. A.C. (internal).

DIRECTIONAL COUPLERS FOR REFLECTOR POWER MEASUREMENT
One of the major uses of a directional coupler is to obtain a sample of the R.F. Power in a transmission line and apply it to an indicator. We can supply couplers with a power handling capacity of up to 300 Watts, the response is flat over the 66-88 Mc/s, 156-184 Mc/s and 200-450 Mc/s bands. Two pick-up probes are mounted on the coupler, one giving incidence the other reflective power, the voltage developed is rectified and may be fed to a calibrated meter, C/W 50 ohm plugs. Price 60/-. P. and P. 3/6.

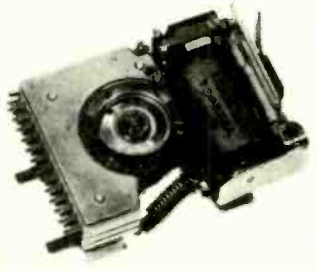
MINIATURE SIGNAL GENERATORS—A.T.E. MANUFACTURE
*** Contains RF Attenuator Gold Plated Components**
Specially designed for operators of VHF mobile equipment, these units are of very small size and are completely portable, the interior circuit and associated parts are gold plated and build to a very high standard. There are two models with attenuated output, CW and Modulation. Type MIP Range 215-270 Mc/s; Type MIG Range 45-92 Mc/s; both models are powered by U2 dry cell, directly calibrated and built into grey hammer tone alloy case, brand new. Our price is only £9.19.6, plus 5/6 post/packing for both models.

HIGH VOLTAGE EHT INSULATION TESTERS. TELEMAX TYPE 115.
Variable EHT output from 1 to 15 Kv. Leakage current 0 to 100 microamps. For A.C. operation. 110 to 250 volts. Cost over £70. Our price, in good used condition, £35.

ADVANCE VOLT STAT CV500/31
Input 162-276 v. A.C., 50—1 phase output 115 v. constant at 410 watt. Offered BRAND NEW at only £8. P. & P. 15/-.

ADVANCE D.C. SERIES
Output 24 v. D.C. at 5 amps. Input 200-245 v. A.C. ± 15%. Fully smoothed and protected. BRAND NEW units at only £10 each

A.E.I. MINIATURE UNISELECTOR SWITCHES
No waiting, straight off the shelf and into your equipment the Catalogue Nos. are 2202A, 4/33A63/1; coil resistance is 250 ohms. Complete with base, and the price is £4.19.6. Limited quantity only available.



KLAXON HOOTER ALARMS
240 v. A.C. These alarms produce an ear splitting noise which can be up to 250 yards. Good used condition. Only 75/-. P.P. 4/6.

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.

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. P. and P. 2/6.

MARCONI STANDARD SIGNAL GENERATOR T.F.867
Frequency range 15 kHz.-30 mHz. output variable from 4 micro volts to 4 volts at 75 ohms. Built in crystal calibrator. Calibration accuracy 1%. Supplied like NEW GUARANTEED.

PLATING AND CHARGING P.S.U.
Variable voltage 0-30 D.C. Current rating 20A. Continuous. Silicon full wave rectifiers amp/volt indication. Plus 0-240 v. A.C. outlets. £42.

HIGH QUALITY SIGNAL GENERATORS

- Marconi TF867 Standard generator frequency range 15 kHz. to 30 MHz.
- Marconi TF 144H/4 range 10 kHz to 72 MHz.
- Marconi TF144g range 85 kHz to 25 MHz.
- Marconi TF762C range 300 MHz to 600 MHz.
- General Radio range 8 MHz to 330 MHz.
- Hewlett Packard 616A 1·8 GHz to 4 GHz.
- Rhode & Schwarz BN41022 300 MHz to 1 GHz.
- Rhode & Schwarz BN41026 1 GHz to 1·9 GHz.
- Rhode & Schwarz BN41042 1·7 GHz to 5 GHz.

USA Pattern Modulated grid dip Meter built to rigid military specifications frequency range 2·5 MHz to 400 MHz. The Accurate calibration of this meter makes it ideal for use as signal generator and wave meter C/W. Small transit case all coils and leads for 115 v. A.C. operation. Price £18. P. & P. 10/6.

SPECIAL MONEY SAVING DISCOUNTS

on the Best Hi-Fidelity Equipment on the Market Today

	Rec. Retail Price	Discount Price
AMPLIFIERS		
ARENA F210 2×10 watts Stereo Amplifier teak case	£34 13 0	£29 10 0
ARMSTRONG 521 teak case	£52 0 0	£44 0 0
PHILIPS RH580 stereo amplifier magnetic input	£26 0 0	£21 5 0
DULCI 207 amplifier	£25 0 0	£17 0 0
DULCI 207M as above but accepts magnetic cartridge	£30 0 0	£21 15 0
GOODMANS Maxamp teak or walnut	£54 0 0	£42 15 0
LEAK Stereo 30 plus chassis model	£53 0 0	£43 10 0
LEAK Stereo 30 plus teak cased	£59 10 0	£48 12 6
LEAK Stereo 70 chassis model	£63 0 0	£50 15 0
LEAK Stereo 70 plus teak cased	£69 10 0	£55 15 0
NIKKO TRM 40B	£46 10 0	£39 10 0
NIKKO TRM 120	£95 0 0	£84 10 0
ROGERS RAVENS-BOURNE teak cased	£64 0 0	£54 10 0
ROGERS RAVENS-BROOK chassis model	£44 0 0	£35 0 0
ROGERS RAVENS-BROOK in teak case	£46 10 0	£39 10 0
SANSUI AU 222	£62 17 7	£56 10 0
SANSUI AU 555	£80 9 7	£69 10 0
TRUVOX TSA200 teak cased	£54 12 0	£45 5 0
METROSOUND ST20 teak cased 10 × 10 watts output	£32 0 0	£27 10 0
QUAD 33 Control Unit and 303 Power Amplifier	£98 0 0	£82 10 0
TELETON 203E	£28 7 6	£22 10 0
FM TUNERS		
ARENA F211 with Decoder	£39 18 0	£34 15 0
DULCI FMT7 Mono tuner	£22 1 0	£18 10 0
DULCI FMT78 Stereo tuner	£29 8 0	£23 10 0
GOODMANS Stereomax teak stereo tuner	£82 10 5	£70 10 0
LEAK Stereofetic chassis model	£56 11 0	£46 10 0
LEAK Stereofetic teak case	£64 14 0	£52 17 0
QUAD Stereo Tuner	£51 0 0	£45 15 0
TRUVOX FM200 less Decoder	£37 12 11	£32 10 0
ARMSTRONG 523 AM/FM teak case	£52 9 0	£44 17 6
ARMSTRONG 524 FM teak case	£40 4 6	£34 17 6
TUNER AMPLIFIERS		
ARENA T1500 teak only	£64 1 0	£57 10 0 (add 7 gns. for decoder)
ARMSTRONG 525	£87 16 9	£74 15 0
ARMSTRONG 526	£98 15 6	£85 10 0
GOODMANS 3000	£79 14 9	£67 10 0 (with decoder)
B & O Beomaster 1400 with decoder	£110 0 0	£97 10 0
NIKKO FAM 12F	£68 8 3	£59 10 0
NIKKO ST 701	£136 3 11	£120 0 0
SANSUI 350	£129 1 10	£114 10 0
SANSUI 2000	£162 3 0	£147 10 0
SANYO DC60 2×30 watts rms	£99 0 0	£89 10 0 (with decoder)
TELETON F2000 2×5 watts rms	£51 19 0	£43 10 0 (with decoder)
TELETON CR10T Tuner Amplifier AM/FM with decoder	£39 10 0	£34 10 0
TELETON MX990 Tuner Amplifier AM/FM with decoder, two speakers, 8" bass and 2" tweeter speakers in matching cabinets	£64 12 0	£49 10 0
SPEAKERS (Prices quoted for single speaker unless otherwise specified)		
ARENA HT7	£19 19 0	£17 0 0
ARENA HT10 teak or rosewood	£19 19 0	£17 10 0
CELESTION Ditton 10	£21 13 1	£17 15 0
CELESTION Ditton 15	£31 3 7	£26 5 0
GOODMANS Maxim	£20 15 6	£16 15 0
GOODMANS Marimba	£24 0 5	£19 15 0
GOODMANS Mezzo II	£30 18 0	£25 10 0
GOODMANS Magnum K	£40 2 0	£29 15 0
LEAK Sandwich	£43 10 0	£37 10 0
LEAK Mini Sandwich	£29 15 0	£25 5 0
LOWTHER Accousta PM6	£45 10 0	£40 10 0
LOWTHER Accousta PM7	£55 10 0	£50 10 0
KEF Cresta	£22 3 7	£18 10 0
KEF Celeste	£29 0 0	£25 0 0
KEF Concord	£43 10 0	£37 10 0
KEF Concerto	£53 10 0	£45 0 0
QUAD Electrostatic	£66 0 0	£59 10 0
WHARFEDALE Denton per pair	£33 12 0	£29 10 0
WHARFEDALE Super Linton per pair	£42 0 0	£37 10 0
WHARFEDALE Dovedale III	£39 10 0	£32 19 6
WHARFEDALE UNIT 3 Speaker Kit	£10 17 6	£9 5 0
PLAYING DECKS		
GARRARD 401	£31 14 2	£27 0 0
GARRARD AP75	£23 16 7	£17 15 0
GARRARD SP25 Mark II	£15 11 11	£11 12 6
GARRARD SRP22	£6 12 10	£5 10 0
GARRARD SL95B	£45 9 1	£37 10 0
GARRARD SL75	£35 12 5	£30 10 0
GARRARD SL65B	£19 6 5	£15 15 0
GARRARD SL55	£13 17 9	£11 12 6
GARRARD 60 Mark II	£17 5 10	£14 19 6
GARRARD 3500	£12 4 10	£10 19 6
GARRARD 2025 T/C	£11 3 11	£10 10 0
GARRARD 1025	£10 6 2	£9 10 0
GOLDRING GL69	£25 1 6	£20 19 6
GOLDRING GL69P	£33 11 9	£28 10 0
GOLDRING GL75	£35 15 5	£28 15 0
GOLDRING GL75P	£46 18 8	£37 10 8
THORENS TD150	£29 8 1	£26 10 0
THORENS TD150A Mk II	£41 14 9	£35 0 0
THORENS TD150AB MkII	£45 10 7	£39 10 0
THORENS TD125	£63 4 9	£54 5 0
Plinths, tops and accessories of above available at 10% discount on retail price.		
STEREO CARTRIDGES		
AUDIO TECHNICA AT66	£6 6 0	£5 10 0
SHURE M3DM	£7 8 3	£6 2 6
SHURE 31E	£12 19 5	£11 10 0
SHURE 32E	£12 0 11	£10 15 0
SHURE 55E	£16 13 6	£13 19 0
SHURE 44E	£14 16 6	£12 19 6
SHURE M75E	£25 18 10	£23 5 0
SHURE V13 Mk II	£40 15 3	£35 0 0
GOLDRING C890	£5 4 0	£4 2 6
GOLDRING 800	£13 0 0	£8 10 0
GOLDRING 800E	£18 17 1	£15 10 0
STEREO TAPE DECKS AND RECORDERS		
AKAI Model 4000D 3-head stereo tape deck	£130 0 0	£104 10 0
AKAI X150E Stereo tape deck, crossfield head	£164 6 0	£139 10 0
AIWA TP 1011 professional stereo 3 head tape deck	£87 10 0	£74 10 0
SANYO MR910 4 track stereo tape recorder	£100 16 0	£89 10 0
SANYO MR929 4 track stereo tape recorder, 2 detachable speakers	£79 0 0	£67 10 0
SANYO MR801 stereo tape deck	£187 19 0	£169 10 0
REVOX model 1104 4-track tape deck	£100 0 0	£89 10 0
AKAI 1710W 4-track stereo recorder		
MONAURAL MAINS TAPE RECORDERS		
GRUNDIG TK120 continental twin-track tape recorder	£39 5 0	£29 10 0
GRUNDIG TK144 4-track tape recorder	£47 13 1	£41 10 0
GRUNDIG TK149 Automatic 4-track tape recorder	£55 18 10	£49 10 0
PHILIPS 4307 4-track tape recorder	£48 11 0	£41 10 0
PHILIPS 4308 2-speed 4-track tape recorder	£60 0 10	£51 10 0
COMPLETE HI-FI SYSTEMS		
RADON 404 SYSTEM Garrard SP25, separate 2×8 watt amplifier, 2 bookshelf type speakers teak or blond oak	£57 4 0	£49 10 0
TOSHIBA SOPHIA Transcription turntable, magnetic cartridge, integrated tuner amplifier, with stereo decoder, fitted hinged perspex top, 2 separate speakers, walnut finish	£82 19 0	£75 0 0
SANYO DC534E Transcription turntable, magnetic cartridge, integrated tuner/amplifier, 2×12 watts rms, decoder, fitted hinged perspex top	£132 10 0	£119 10 0
Matching SANYO SX/X speakers per pair	£37 16 0	£32 10 0
TRANSCRIPTION ARMS		
SME 3009 with shell	£31 6 3	£25 0 0
SME 3012 with shell	£33 5 3	£27 0 0
GOLDRING L75	£12 10 10	£10 0 0
GOLDRING L69 arm	£9 5 9	£8 5 0

All goods are in manufacturer's sealed cartons and are insured against loss or damage in transit.
Guaranteed "by return" service. *Add 7/6 to all orders for p. & p. Send cash/cheque with order. Personal Callers Welcome—Business Hours.*

SMITH'S RADIO SERVICE (Wolverhampton) LTD.
Dept. W.W.1, 26 Victoria Street, Wolverhampton, Staffs. Tel: Wolv. 29246

POWER ENGINEERING USING THYRISTORS

VOLUME 1

Techniques of Thyristor Power Control

30/- Mullard Postage 1/-

PRINCIPLES OF PULSE CODE MODULATION by K. W. Cattermole. 95/-. Postage 2/-.

SIGNAL PROCESSING, MODULATION AND NOISE by J. A. Betts. 42/-. Postage 1/6.

CLOSED CIRCUIT TV FOR ENGINEERS & TECHNICIANS by Leonard C. Showalter. 50/-. Postage 1/6.

THE HI-FI AND TAPE RECORDER HANDBOOK by Gordon J. King. 40/-. Postage 2/6.

UNDERSTANDING AND USING UNIJUNCTION TRANSISTORS by S. Hoberman. 24/-. Postage 1/-.

20 SOLID STATE PROJECTS FOR THE HOME by R. M. Marston. 18/-. Postage 1/-.

MINIFLUX MANUAL by Miniflux Electronics Ltd. 30/-. Postage 1/6.

THE SEMICONDUCTOR DATA BOOK by Motorola. 60/-. Postage 4/6.

TRANSISTOR SWITCHING AND SEQUENTIAL CIRCUITS by John J. Sparkes. 25/-. Postage 1/-.

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST
of British and American Technical Books

19-21 PRAED STREET, LONDON, W.2

Phone PADdington 4185
Closed Sat. 1 p.m.

WW—132 FOR FURTHER DETAILS

Radar Scanner & Ind Units

Comprise Elliptical scanner with twin horn feed and tuning unit 8.2 to 12.4 K Mc/s, Rotation mount with bearing indicator, slip ring unit, azimuth control and levelling adjustments. Mounting frame with feet. Indicator unit with cables. These are for use on 12 v. D.C. the Ind uses transistors and sub. min. valves. Size of scanner 29"×14"×15" deep, overall size of unit on stand 5' high 3' 6"×2' 6". The exact purpose of these units is not known, appear to be a 2 channel Rx with visual and aural indication. These would lend themselves to conversion to small radar set, supplied in good condition, made in France.

Price £45 plus £3 carr.

Radio Telephone Units

Boot mounting type for remote control 80 to 100 Mc/s single channel, double conversion Rx with crystal filter, use 16 valves and 14 transistors as 2 Invertors size 11"×6"×18" for use on 12v.+Ea, made by Hudson. Supplied in good internal condition slightly soiled outer cases, less xtals.

Price £15 plus 10/- carr.
S.A.E. for lists.

A. H. SUPPLIES
57 Main Road, Sheffield, S9 5HL

"SPECIAL OFFER"

Ex LCC Ultra radios requiring attention to clear from £4-0-0, each, callers only. 10 watts output, provision for microphone. Suit small factory, hall, public address. Standard play Professional Scotch Boy 1/4" Polyester and Acetate recording tape. (Low noise). Used once only. Approx., 2,500 ft. 19/6. List Price £4-0-0.

HARRINGAY PHOTOGRAPHIC LTD.
435 Green Lanes, London, N.4 • 01-340 5241

High grade of stability of electric parameters
Resistance and durability
Long operational life

Polish

electronic tubes for radio receiver sets
electronic tubes for TV receiver sets
and
electronic components

are offered by

UNIVERSAL

Foreign Trade Enterprise
Warszawa, Al. Jerozolimskie 44, Poland
P.O. Box Warszawa 1 No. 370.
Telex No. 81437

To persons interested we forward detailed information, catalogues and tenders.

Thanks to a bulk purchase we can offer

BRAND NEW P.V.C. POLYESTER AND MYLAR RECORDING TAPES

Manufactured by the world-famous reputable British tape firm, our tapes are boxed in polythene and have fitted leaders, etc. Their quality is as good as any other on the market, in no way are the tapes faulty and are not to be confused with imported, used or sub-standard tapes. 24-hour despatch service.
Should goods not meet with full approval, purchase price and postage will be refunded.

S.P.	3in.	150ft.	2/-	5in.	600ft.	6/-
	5¾in.	900ft.	8/-	7in.	1,200ft.	9/-
L.P.	3in.	225ft.	2/6	5in.	500ft.	8/6
	5¾in.	1,200ft.	10/-	7in.	1,800ft.	13/-
D.P.	3in.	350ft.	4/6	5in.	1,200ft.	12/-
	5¾in.	1,800ft.	16/-	7in.	2,400ft.	20/-

Postage on all orders 1/6

COMPACT TAPE CASETTES AT HALF PRICE

60, 90, and 120 minutes playing time, in original plastic library boxes.
MC 60 9/- each. MC 90 12/6 each. MC 120 18/3 each.

STARMAN TAPES
28 LINKSCROFT AVENUE, ASHFORD, MIDDX. Ashford 53020

WW—136 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

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

DIOTRAN SALES

P.O. BOX 5
WARE, HERTS
TEL. WARE 3442

S.C.R's 16AMP (unplated)

	1-24	25-99	100 up
100 PIV	9/6	7/6	6/-
400 PIV	14/-	12/-	10/-

All tested perfect functional devices guaranteed.

We will also buy your surplus stock—Send us your lists.

OVER 2 MILLION SILICON ALLOY & GERM. TRANSISTORS AVAILABLE FOR IMMEDIATE DELIVERY.

MANUFACTURERS END OF PRODUCTION SURPLUS.

TRANSISTORS Type and Construction		Qty. Price 100	Qty. Price 500	Qty. Price 1,000	Qty. Price 10,000
A 1 Germ A.F. NPN TO-1	=AC127, NKT773, AC157, ASY86	£3.10	£15	£25	£200
A 2 Germ. A.F. PNP TO-5	=ACY17-21, NK237-245	£1	£3	£5	£40
A 3 Germ. A.F. PNP TO-1	=AC128, NKT271, 2G381	£1	£3	£5	£40
A 4 Germ. R.F. PNP TO-1	=OC44-45, NKT72/125, ASY54	£1.10	£4.10	£7.10	£60
A 5 Germ. R.F. PNP TO-5	=2N1303, NKT164-7, 2G301-3	£1.10	£4.10	£7.10	£60
A 6 Germ. V.H.F. PNP TO-1	=AF116-7, KNT667, 2G417	£3.10	£15	£25	£200
A 7 Assorted Germ. A.F.-R.F. PNP mixed cans, general purpose		15s.	£2.10	£4	£32
A 8 Germ. A.F. SO-2 PNP	=2G371-89, ACY27-31, OC71-75	£2	£7.10	£12.10	£100
A 9 Sil. Alloy PNP TO-5	=2S301-5, BCY17-29, BCY30-34	£2	£7.10	£12.10	£100
A10 Sil. Alloy PNP SO-2	=2S321-325, OC200-205	£2	£7.10	£12.10	£100

A1 to A7 Guaranteed 80% Good usable Transistors ideal for low cost production work and experimental use.
A8 to A10 are all perfect devices, factory tested, no open or short circuit Transistors in these lots.

SEMICONDUCTORS FOR W.W. CAP.-DIS. IGNITION SYSTEM.

	Each
2N3525	15/-
2N3055	12/-
2N3702	3/-
2N3704	3/-
IN4001	1/6
IN4005	4/-

New and fully guaranteed.

PLASTIC PNP SILICON TRANSISTORS. Manufacturer's seconds from 2N3702-3 family. Ideal cheap trans. for manufacturing etc. £8 500, £13.10 1,000 pieces.

PLASTIC NPN SILICON TRANSISTORS. Manufacturers' seconds from 2N3707-3711 family. Ideal cheap trans. for manufacturing etc. £7.10 500, £12.10 1,000 pieces.

TO-18 METAL CAN SILICON PLANAR TRANS. Very high quality 99% good. Type 2N706, BSY27. £8 per 500 pieces, £13 per 1,000 pieces.

TOP HAT SILICON RECTIFIERS. All good. No short or open circuit devices. Voltage range 25-400PIV, 750mA. £3 per 100, £12.10 per 500.

1/- each TESTED TRANSISTORS 1/- each
ONE PRICE ONLY PNP, NPN, SILICON PLANAR 1/- EACH

BC108	2N696	2N1132	2N2220	2S733
BC109	2N697	2N1613	2N3707	2N3391
BFY50	2N706	2N1711	2N3711	TIS44
BFY51	2N708	2N2904	2S102	2N2906
BFX84	2N929	2N2905	2S103	2N2907
BFX86	2N930	2N2924	2S104	2N2696
BFX88	2N1131	2N2926	2S732	

From Manufacturers' Over-runs—Unmarked

TO-5 METAL CAN SILICON PLANAR TRANSISTORS. VERY HIGH QUALITY 99% good type. 2N697, BFY51, 2N1893, £8 per 500 pieces. £13/0/0 for 1,000 pieces.

HIGH QUALITY SILICON PLANAR DIODES. SUB-MINIATURE DO-7 Glass Type, suitable replacements for OA200, OA202, BAY38, IS130, IS940, 200,000 to clear at £4 per 1,000 pieces. GUARANTEED 80% GOOD.

GERM. PNP AND NPN TRANSISTORS TESTED, UNMARKED SIM. TO1—1/6 EACH

AC125	ACY22	ACY36	NKT677	OC81
AC126	ACY27	NKT141	NKT713	OC82
AC127	ACY28	NKT142	NKT773	2G301
AC128	ACY29	NKT212	OC44	2G302
AC130	ACY30	NKT213	OC45	2G303
ACY19	ACY31	NKT214	OC71	2G308
ACY20	ACY34	NKT215	OC72	2G371
ACY21	ACY35	NKT271	OC75	2G374

FULLY TESTED DEVICES AND QUALITY GUARANTEED—SURPLUS TO REQUIREMENTS

OA202 Silicon Diode. Fully Coded.
150 PIV 250mA Qty. Price £30 per 1,000 pieces.
BY100 SIL. RECT'S 800 PIV 550 mA.
1-49 2/6 each; 50-99 2/3 each; 100-999 2/- each; 1,000 up 1/10 each. Fully Coded. 1st Qty.

TEXAS 2G371 A/B Eqvt. OC71 Germ. Gen. Purpose Trans.

	Each
1-99	1/6
100-499	1/3
500-999	1/-
1000 up	9d.

All Brand New and Coded.

TRANSISTOR EQVT. BOOK
2,500 cross references of transistors—British, European, American and Japanese. A must for every transistor user. Exclusively distributed by DIOTRAN SALES. 15/- EACH.

Vast mixed lot of subminiature glass diodes. Comprising of Silicon, Germ, Point Contact and Gold Bonded types plus some Zeners. 500,000 available at Lowest of Low Price.
1,000 pieces £3.0.0. 5,000 pieces £13.10.0. 10,000 pieces £23.

Post and Packing costs are continually rising. Please add 1/- towards same. **CASH WITH ORDER PLEASE.** QUANTITY QUOTATIONS FOR ANY DEVICE LISTED BY RETURN.

OVERSEAS QUOTATIONS BY RETURN SHIPMENTS TO ANYWHERE IN THE WORLD AT COST

WE PURCHASE

COMPUTERS, TAPE READERS AND ANY SCIENTIFIC TEST EQUIPMENT. PLUGS AND SOCKETS, MOTORS, TRANSISTORS, RESISTORS, CAPACITORS, POTENTIOMETERS, RELAYS TRANSFORMERS, ETC.

ELECTRONIC BROKERS LTD.
49 Pancras Road, London, N.W.1. 01-837 7781

TAPE Monthly 2/6

ENTHUSIASTS
for tape recording subscribe to the only Magazine devoted exclusively to the subject.
25/- (U.S.A.) $3.75 yrly. incl. postage.

● *FREE SPECIMEN COPY ON REQUEST*
7 ALVERSTONE AVENUE, EAST BARNET, HERTS.

WANTED RELAYS

1. GEC Sealed Type M1574, 12v, 180 ohms; **2.** Ericsson or Plessey Tubular types: a. 48v, 1650 ohms, Ref. 12-0306; b. 48v, 1650 ohms, Ref. 12-0307; c. 24v, 440 ohms, Ref. 11-9145. **3.** Plessey or Ericsson Plug-in type 24v, 670 ohms with transparent cover, exactly same size as GEC sealed type. **4.** STC Type 4189GD 28v, 700 ohms.

PHONE ANY TIME: 021-454 8305

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 117-132

Printed in Great Britain by Southwark Offset, 25 Lavington Street, London, S.E.1, and Published by the Proprietors, I.P.C. ELECTRICAL-ELECTRONIC PRESS, LTD., Dorset House, Stamford St., London, S.E.1, telephone 01-928 3333. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.: Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency, Ltd.: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street, New York 14. CONDITIONS OF SALE AND SUPPLY: This periodical is sold subject to the following conditions, namely that it shall not, without the written consent of the publishers first given, be lent, re-sold, hired out or otherwise disposed of by way of Trade at a price in excess of the recommended maximum price shown on the cover; and that it shall not be lent, re-sold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

CLEARWAY to lower production costs with ADCOLA Precision Tools

For increased efficiency find out more about our extensive range of ADCOLA Soldering Equipment—and we provide:

★ THREE DAY REPAIR SERVICE ★ INTERCHANGEABLE BITS—STOCK ITEMS ★ SPECIAL TEMPERATURES AVAILABLE AT NO EXTRA COST.

ADCOLA TOOLS have been designed in co-operation with industry and developed to serve a wide range of applications. There is an ADCOLA Tool to meet your specific requirement. Find out more about our extensive range of efficient, robust soldering equipment.

No. 107. GENERAL ASSEMBLY TYPE

Fill in the coupon to get your copy of our latest brochure:

ADCOLA PRODUCTS LTD
Adcola House · Gauden Road · London · SW4
Tel. 01-622 0291/3 Grams: Soljoint, London SW4

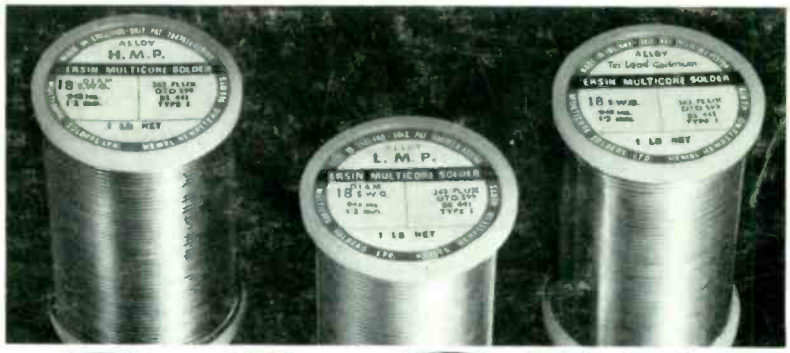
ADCOLA PRODUCTS LIMITED

Please rush me a copy of your latest brochure:

NAME .....
COMPANY .....
ADDRESS .....
..... WW

WW—002 FOR FURTHER DETAILS

HIGH & LOW



MELTING POINT SOLDERS FOR SOLDERING

- Gold plated surfaces
- Flexible printed circuits
- Silver plated surfaces
- High working temperature components

H.M.P.

HIGH MELTING POINT

For service at high temperature, or service at very low temperatures. Outstanding creep strength. Melting range 296°C – 301°C (565°F – 574°F).

Applications

A useful application of H.M.P. is the soldering of joints close to each other in such a way that the connections made first are not re-melted while later joints are made, with for example, a standard 60/40 alloy, melting point 188°C. Essential for use where high operating temperatures are experienced, for instance, electrical motors, car radiators, high temperature lamps. H.M.P. is also ideal for equipment, which is being operated in low temperatures, as it reduces the chance of the joint becoming brittle.

Specification

Multicore H.M.P. alloy complies with BS.219 Grade 5S. Supplied in a form of Ersin Multicore 5 core solder wire on 1lb. or 7lb. reels, incorporating Ersin 362 rosin based flux. This non-corrosive flux-cored solder wire complies with BS.441 and is available from 10 to 26 s.w.g., and in Multicore Solder Preforms. Ask for Technical Bulletin No. 1369.

L.M.P.

LOW MELTING POINT

A low melting point solder for soldering silver plated and gold plated surfaces. Melting point 179°C (354°F).

Applications

L.M.P. reduces the absorption of silver or gold into the solder alloy whilst soldering, and therefore, preserving the silver or gold plated surfaces. Also reduces the chance of a brittle joint being made.

NOTE

a) The solution of gold into tin rises rapidly with temperature and so the use of L.M.P. Low Melting Point Solder is preferable.
b) The solution rate of gold into tin is also reduced because L.M.P. is a ternary alloy comprising tin, lead and silver.

Specifications

L.M.P. is normally supplied in the form of Ersin Multicore 5 core solder wire, incorporating Ersin 362 rosin based flux, which complies with Min. Tech. specification D.T.D. 599A. It is available from 10 to 34 s.w.g. in 1lb. or 7lb. reels and Multicore Solder Preforms. Ask for Technical Bulletin 1469.

T.L.C.

EXTRA LOW MELTING POINT

Extra low melting point solder. Melting point 145°C (293°F).

Applications

T.L.C. alloy can be used whenever a soldered joint should be made with the minimum heat input. This would include heat sensitive transistors, flexible printed circuits and gold plated surfaces. The melting point of T.L.C. alloy is 38°C lower than any tin/lead alloy. Because of its low temperature application it is considered completely non-toxic in use unlike the high temperature cadmium-bearing brazing alloys.

Specification

T.L.C. alloy is normally supplied in the form of Ersin Multicore 5 core solder wire, incorporating Ersin 362 rosin based flux, which complies with Min. Tech. Specification D.T.D.599A. T.L.C. alloy can also be supplied in the form of Multicore precision made solid solder wire, Extrusol extruded solid solder bars for solderbaths and Multicore Solder Preforms. Available from 10 to 34 s.w.g. on 1lb. or 7lb. reels. Ask for Technical Bulletin No. 1569.

ERSIN Multicore 5 CORE SOLDER

See us on Stand 37 at the International Electronic Components Exhibition Paris 3-8 April.

MULTICORE SOLDERS LTD.
HEMEL HEMPSTEAD, HERTS.

PHONE:
HEMEL HEMPSTEAD 3636
TELEX: 82363

THE QUEEN'S AWARD TO INDUSTRY 1966

WW—003 FOR FURTHER DETAILS