Wireless World

October 1969 Three Shillings

Review of sound & TV equipment

Low-cost 15-watt amplifier

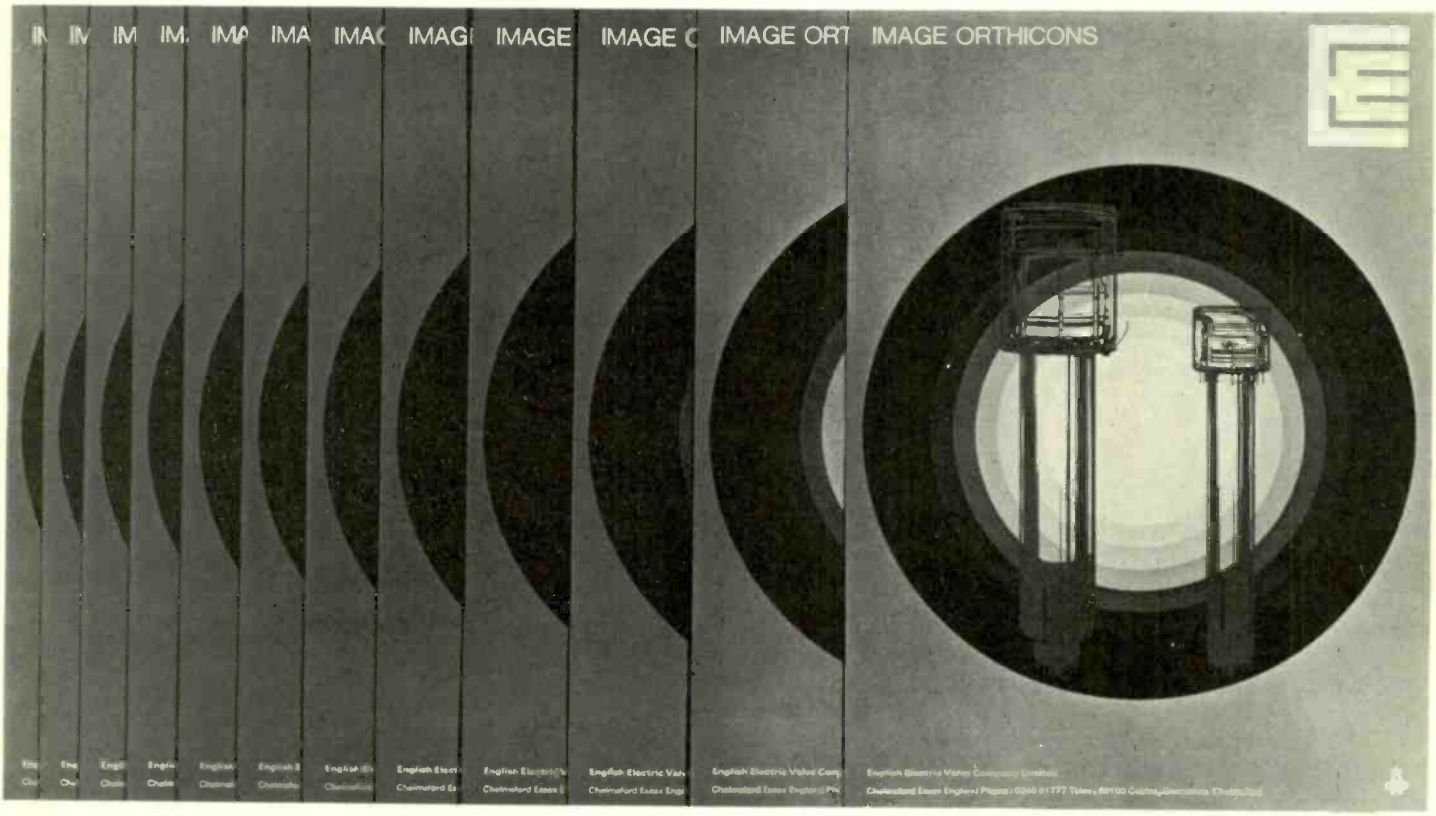
IT'S KEYSWITCH-WINNING RELAYS ON EVERY CIRCUIT

Relays in all shapes and sizes to cover the whole industrial electrical/electronic field—that's the measure of the Keyswitch product range which includes the whole set of Omron miniatures. All Keyswitch Relays are winners because they each combine competitive price and high quality. When you go for Keyswitch quality and economy you'll get speedy service too—Keyswitch will produce a prototype relay in 24 hours, deliver a large order of standards in under a week and any specialist order within a month. So whatever type of relays you need, when you want quality, good prices and prompt delivery, contact Keyswitch Relays Limited, Cricklewood Lane, London NW2; telephone 01-452 3344; telex 262754.

KEYSWITCH RELAYS—WHERE THE ACTION IS

Image Orthicons– a new brochure from EEV

This new brochure gives a summary of the EEV range of Image Orthicons, applications and brief data. Full information, including characteristic curves and operational conditions together with outline diagrams, is available on request. But for an introduction to the range, send for a free copy of our new brochure.



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

Please send me a copy of your Image Orthicon brochure.

NAME ____________ POSITION ____________

COMPANY ____________

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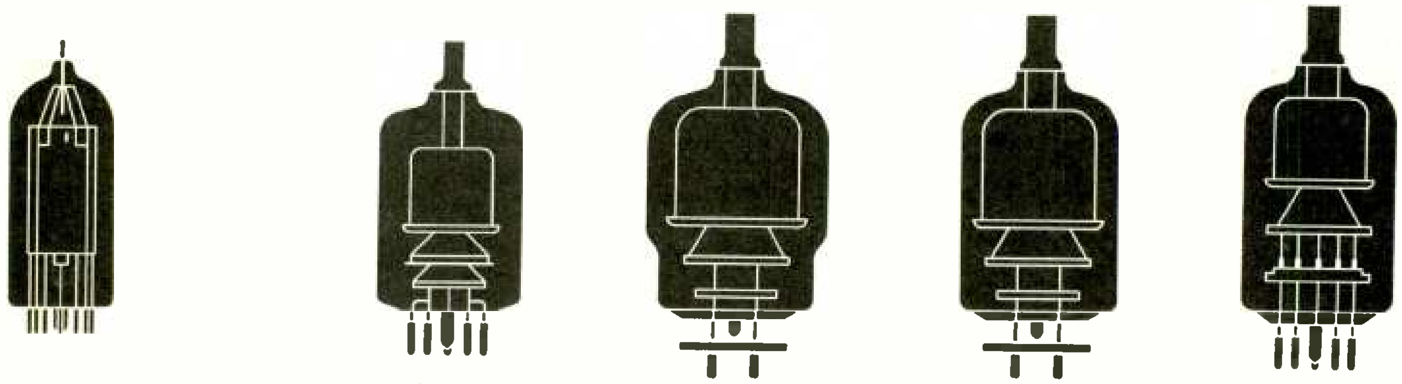
TELEPHONE NUMBER ____________ EXTENSION ____________

WW—006 FOR FURTHER DETAILS

WW33

New pulse tetrode for low power radars added to EEV's range

The new C1179—a high vacuum beam tetrode designed primarily for the output stage of power amplifier pulse modulators in 5kW-10kW radars.



C1179 C1148 C1149/1 C1150/1 C1166

Type	Service type	Anode dissipation max. (W)	Pulse output power (kW)	Anode voltage max. D.C. (kV)	Pulse anode current max. (A)	Heater ratings (V)	Heater ratings (A)	Base
C1148	—	40	130	14.0	12	6.3	5.0	B5F
C1149/1	CV6131	60	330	20.0	18	26.0	2.15	B4A
C1150/1	CV427	60	205	17.5	15	26.0	2.15	B4A
C1166	—	60	205	17.5	15	6.3	9.0	B5F
C1179	—	18	65	8.0	9.0	6.3	2.8	B7A

Send for full data on the EEV range of pulse amplifier tetrodes

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

Please send me full details on your range of pulse tetrodes.
I am particularly interested in using a pulse tetrode with the following parameters:

Pulse output power | Anode dissipation | Anode voltage | Pulse anode current

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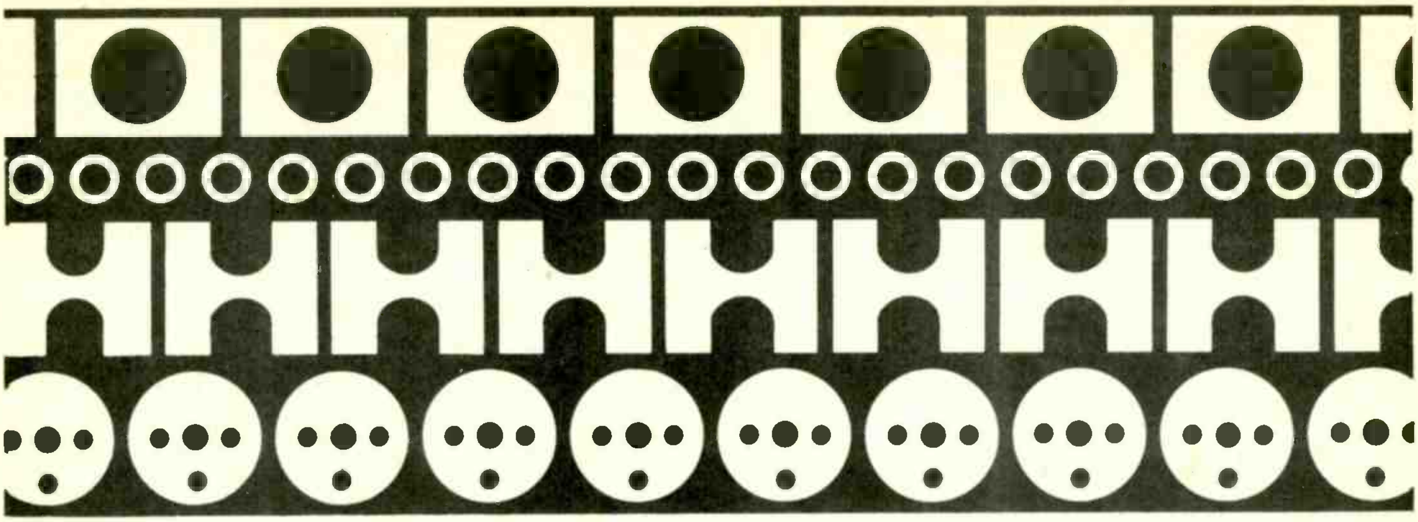
WW34
AP 362

WW—008 FOR FURTHER DETAILS



controlled soldering starts with an Enthoven preform

New free booklet describes the complete range of Enthoven Solder products, preforms among them. Ask now for your copy of 'Soldering with Enthoven'.

The right amount of solder, in the right place, every time. The right alloy to suit the surfaces to be joined. The right flux for effective wetting. The right heat-source. Enthoven know about this kind of thing, will give advice, supply preforms—cored or solid. Controlled soldering means economical soldering. Soldering with Enthoven preforms saves solder, time and wastage. Cuts costs. Produces a stronger, cleaner job. Enthoven supply washers, rings, shims and strips in a wide variety of alloys, cored and solid, and design to meet special requirements.

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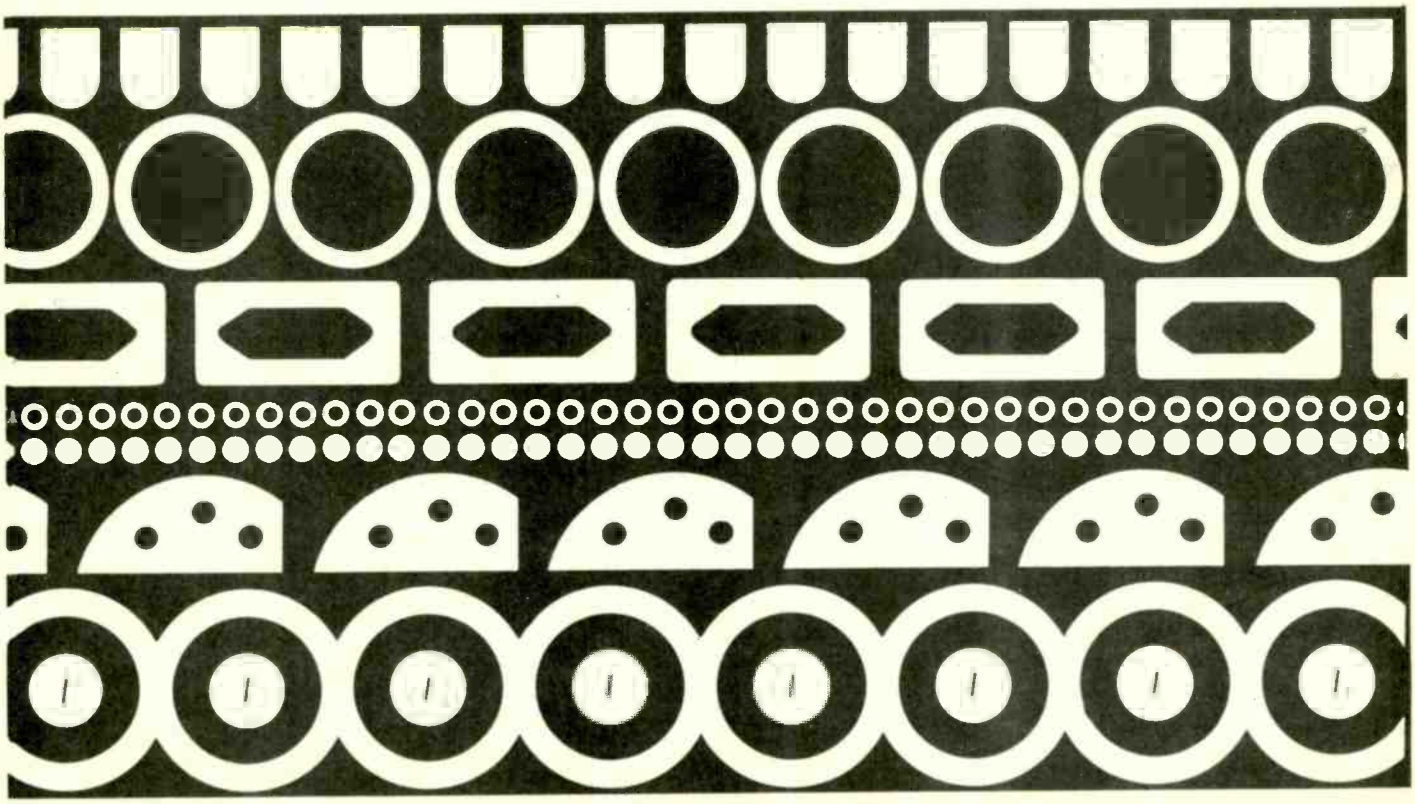

WW—009 FOR FURTHER DETAILS

WAYNE KERR
Universal RF Bridge

DIRECT READOUT of immittance at frequencies from 100kHz to 10MHz, with real and quadrature terms shown simultaneously, in equivalent series or parallel form as appropriate.

APERIODIC measurements of C, R *and* L, with facility for measuring C as equivalent negative L, and L as—C, if preferred. Also reads negative R and G.

STABLE CALIBRATION assured by use of unique magnetic potentiometers, minimising trimming operations and giving an electrical discrimination of 0.1% f. s. d.

SOURCE/DETECTOR SR268 is ideal companion instrument, with single-knob tuning from 100kHz to 100MHz (46.5kHz to 46.5MHz on SR268L). Push-button attenuators for output level and input sensitivity.

RANGES
1 femtofarad — 1 millifarad
100 milliohms — 100 megohms
10 picohenrys — 10 henrys
10 nanomhos — 10 kilomhos

FREQUENCY RANGE
100kHz — 10MHz

ACCURACY
Generally 1%

B602
£345

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NEW MALDEN SURREY ENGLAND

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WW—010 FOR FURTHER DETAILS

Silently, Garrard turn the tables to help you win new customers

Silence. That's the theme of this year's publicity for Garrard.

But there's nothing silent about our backing for you. This year, a bigger-than-ever campaign is telling the customer loud and clear . . . about Garrard quality, and about the range which is more impressive than ever.

From the Garrard No. 1 clockwork motor to Britain's first 3-speed auto changer . . . from the world-renowned 301 transcription unit to the first automatic transcription turntable in the UK . . . Garrard has pioneered for half a century. This year's new range maintains the traditions of one of the world's greatest names.

The promotional campaign consists of full colour advertisements in the 'Readers' Digest', 'Homes & Gardens', 'Ideal Home' as well as the colour supplements of the 'Telegraph', 'Sunday Times' and 'Observer'.

Full pages are also being taken in Hi-Fidelity specialist magazines.

All this is going to create a lot of interest in Garrard equipment—interest that you can turn into sales. Make sure you have adequate stocks to meet the demand. And have you seen the latest Garrard sales literature and showcards? If not, write to The Publicity Department, Garrard Engineering Limited, Newcastle Street, Swindon, Wiltshire, England. Telephone: Swindon 5381.

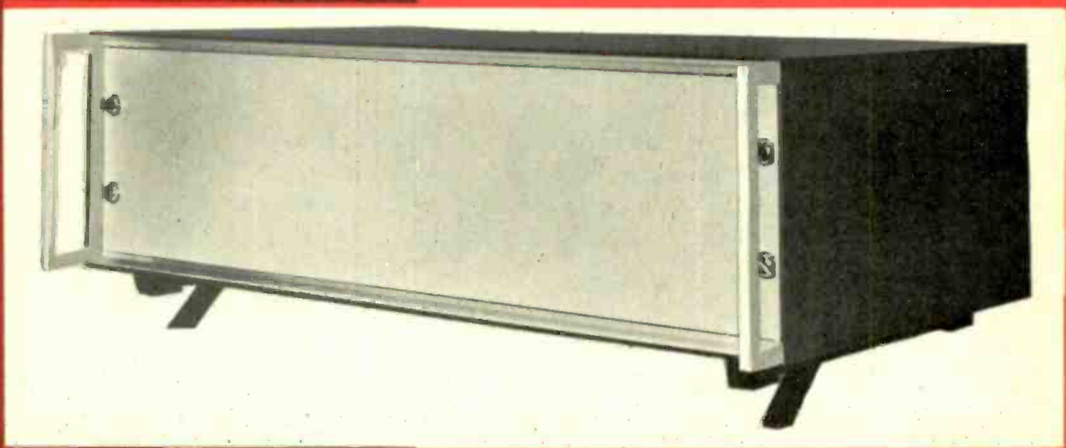
Garrard—sharing success with you

Fifty years of World Leadership

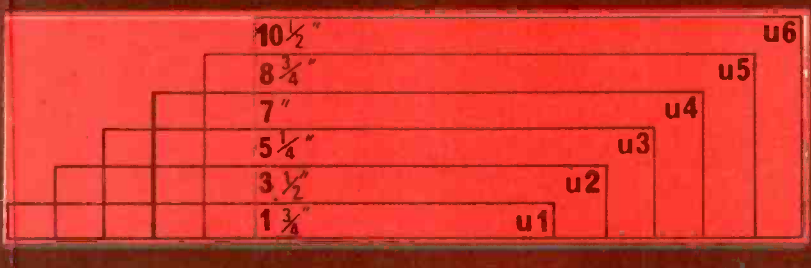
Garrard a PLESSEY quality product

a case for electronics

We're expanding our case range with the Series 'D' range of INSTRUMENT CASES - six sizes in height but all with 19″ wide apertures and 12″ in internal depth behind front panel. These cases start with a panel height of 1¾″ and range in increments of 1¾″ up to 10½″. All cases



are fitted with two retractable front legs to allow the cases to be tilted, and can be supplied with or without front handles. Finished in charcoal grey organasol and supplied complete with front panel fixing screws. Available immediately from stock.



case sizes

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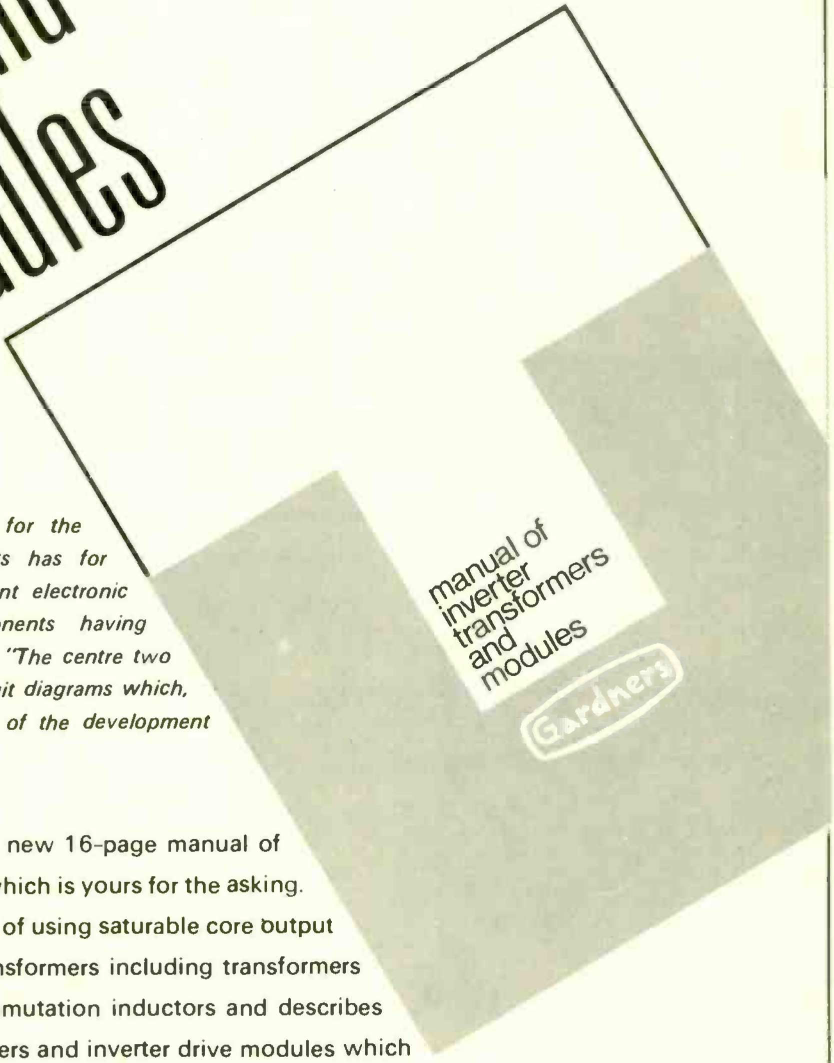
inverter transformers and modules



"The freedom to choose suitable line voltages for the operation of different types of electronic circuits has for many years, enabled engineers to produce efficient electronic equipment comprising many individual components having different optimum power supply requirements . . ." "The centre two pages of this brochure depict a series of basic circuit diagrams which, if taken in sequence, provide an historical survey of the development of modern inverter and converter systems".

This is an extract from the introduction to our new 16-page manual of inverter transformers and modules – a copy of which is yours for the asking. The contents include descriptions and methods of using saturable core output and driver transformers, linear core output transformers including transformers for the capacitively timed inverter circuit, commutation inductors and describes a number of representative converter transformers and inverter drive modules which have been added to our stock range of transformers and inductors.

Please write to us and we will post to you your own personal copy of this new manual.

a *vade mecum* on inverters!

Gardners

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

There's much more to a PHILIPS microphone

than meets the ear

It's the sound quality that really counts although impeccable appearance is certainly an asset. In fact, *every* aspect of microphone manufacture is covered by the makers of ten million of them—Philips. What's more, Philips make an unrivalled range of compatible equipment—amplifiers, loudspeakers, tape-recorders, record players and much more—for complete sound systems. All backed up by the finest service organisation in the country. Please ask for full information.

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Telex 262319

TVT34

WW—013 FOR FURTHER DETAILS

ORYX are trumps!

Full details of these and other instruments from the Sole U.K. and Export distributors.

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WW—014 FOR FURTHER DETAILS

E110-UK

Expand your Universe of Electronic Instrumentation with Hewlett-Packard

... for better solutions to your measuring problems

1 Microwave power meter
2 135 MHz counter with 12 plug-ins
3 Hybrid hot carrier diodes
4 Two oscillators from among 17
5 High-performance scope system

1 Zero-setting is no problem with this microwave power meter

Set zero in a fraction of a second, by simply touching a switch. And that's only one of the features built into the hp 432A power meter to give you accurate measurements faster and more conveniently.

The range of the thermistor-type meter extends from 1 μW to 10 mW. Accuracy of ±1% of full scale on all ranges is maintained at temperatures from 0° to 55°C.

*Frequency coverage from 10 MHz to 40 GHz, with field-proven temperature-compensated thermistor mounts. Individual **calibration factor** and **effective efficiency** data is shown on each mount. To calibrate the meter, just turn a front panel switch to the factor shown on the mount.*

Due to its unique dc bridge circuit, the 432A can also be used with a differential voltmeter when measurements of ±0.2% ±0.5 μW precision are required.

The price is £227. Add £46 for built-in rechargeable battery for up to 24 hours of portable operation.

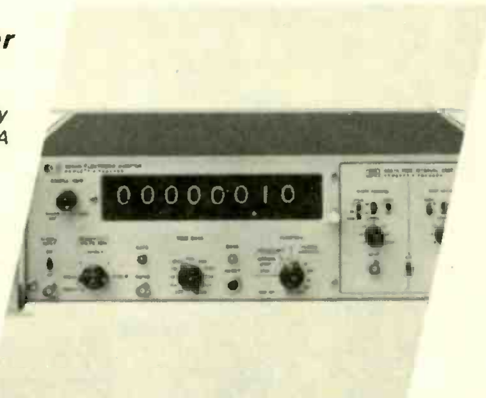
WW—200 for further details.

2 How about measuring the time it takes light to travel 10 feet?

Measuring the 10 ns light takes to travel 10 ft. is strictly in the line of duty for the hp 5248L counter with the new 5267A time interval plug-in (resolution: 10 ns). How's this for measurements involving explosives, shock waves, laser pulses and other high-speed applications?

Then there is the hp 5256A plug-in for frequency measurement up to 18 GHz. And this is what really sets the 5248L apart: plug-ins. Twelve of them. The industry's widest choice.

Even without plug-ins, the 5248L displays a healthy capability. It measures frequencies up to 135 MHz, frequency ratios, waveform periods, and multiples of periods and ratios. It also scales frequencies and totalizes.



The 100 MHz time base of the 5248L has an aging rate of less than 3 x 10^{-9}/day.

A second version (5248M) is equipped with an ultra-stable 100 MHz time base whose aging rate is less than 5 x 10^{-10}/day.

Your hp office has the complete story.

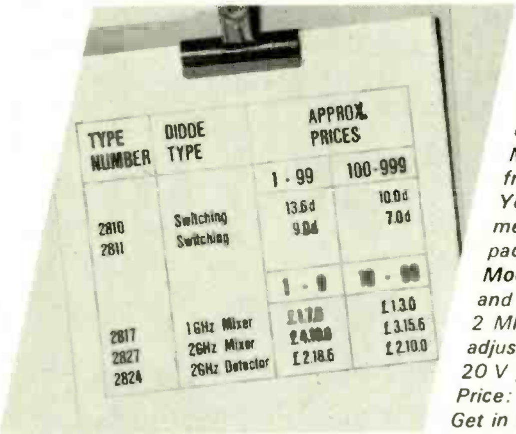
hp 5248L, £1325
hp 5248M, £1507
hp 5267A, £211
hp 5256A, £1027

WW—201 for further details.

WW205 for further details

E110-UK

3 It's price-cutting time for hybrid hot carrier diodes



A new hp manufacturing process did it: down went the prices of hybrid hot carrier diodes.

The 2800 series are epitaxial, planar passivated devices. Their unique design combines a conventional PN junction and a Schottky barrier. The benefits are fourfold.

1. The high breakdown and high temperature (200°C) operating and storage characteristics of silicon.

2. The low turn-on voltage of germanium.

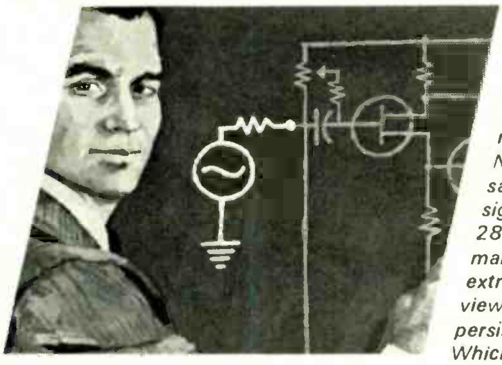
3. The 100 picosecond speed of a Schottky barrier majority carrier device.

4. The inherent resistance to shocks and vibrations of a planar diode.

The latest additions to the series are two switching diodes featuring forward currents of 35 ma and 20 ma at 1 V (capacitance: 1.2 pfmax); there are also 1 GHz and 2 GHz mixers with 60 erg burnout and 6 dB noise figures; and a 2 GHz detector with -56 dBm tangential sensitivity. All are available as single units, pairs and quads. Ask for the data sheets on the 2800 series diodes.

WW—202 for further details.

4 Do you work with ac circuits? You'll then want to explore our soft spot for oscillators.



The very first instrument from hp was a Wien Bridge RC oscillator. That was back in 1939. We've had a soft spot for oscillators ever since... to the point where hp oscillators are today, world known for their excellence.

Now there are 17 different oscillators, including two new ones we'd like you meet. Both feature 0.5% (0.05 dB) flatness, FET's in the bridge for improved stability, <0.1% (−60 dB) distortion, and balanced output.

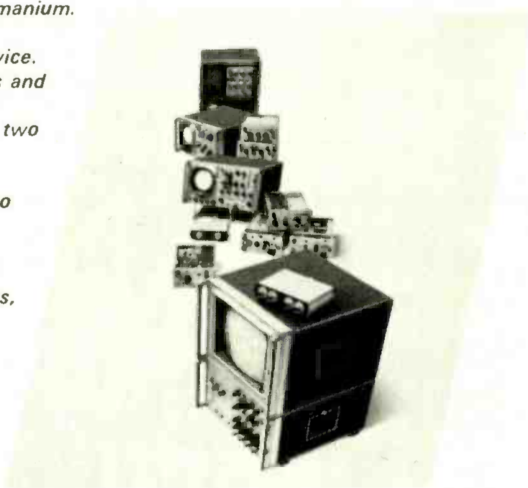
Model 204C has a 5 Hz – 1.2 MHz frequency range and an output of 5 Vrms. You can operate it with line power, mercury battery or rechargeable battery pack. Price: £116.

Model 209A generates simultaneous sine and square wave outputs from 4 Hz to 2 MHz. Output amplitudes independently adjustable to 10 Vrms (sine wave) and 20 V peak-to-peak (square wave). Price: £144.

Get in touch with us for the full story about our complete selection of oscillators.

WW—203 for further details.

5 29 reasons for the excellence of the hp 140 scope system



With such features as 12.4 GHz sampling, 50 µV/cm sensitivity with no drift, and variable persistence and storage, the excellence of the hp 140/141A scope system is obvious.

The 20 available plug-ins are in themselves 20 reasons why this 20 MHz system is right at the top. Plug-ins cover the entire range of scope capabilities, from spectrum analysis to microwave swept frequency measurements and time domain reflectometry (TDR).

Now add three wide-band, remote samplers which will let you see CW signals to 12.4 GHz and pulses with 28 psec rise times. Next come the six mainframes. They include the 143A with extra-large (8" x 10") CRT for group viewing, and the 141A for variable persistence and storage.

Which makes it 29 reasons. Why not select the ones that have a direct bearing on your work. The 140/141A brochure will help you do just that.

HEWLETT hp PACKARD

Hewlett-Packard Ltd.
224 Bath Road, Slough, Bucks, Great Britain
Tel. 33341

European headquarters:
Hewlett-Packard S.A., rue du Bois-du-Lan 7
1217 Meyrin-Geneva, tel. (022) 41 54 00

WW—204 for further details.

Please supply full catalogue of signal recovery instrumentation and application reports.

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W3

You'd be surprised at the scope of our test facilities. Our test department has its own vibration sweep testing techniques. Quality Assurance is of such importance at Brookdeal that as much time goes into testing and proving as into actual manufacturing.

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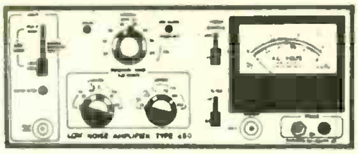
Myron Place, London, S.E.13.
Telephone: 01-852 7433.



PRODUCT FEATURE: Type 450 Low-Noise Amplifier gives 100dB gain with 300kHz bandwidth and better than 0.5dB noise figure. £185 (U.K.).

Brookdeal

the preferred equipment for signal recovery

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

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EDUCATIONAL BACKGROUND

ELECTRONICS EXPERIENCE

WW123

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last year was for a single radio valve, value 7/6d., urgently needed for shipboard replacement and rushed by us through the Rotherhithe tunnel to the London Docks so that they could sail with the tide. . . .

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last year was for 28,546 valves worth nearly £10,000, all specially selected within special parameters for an electronics manufacturer whose name is a by-word in Industry. . . .

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

rely on PYE

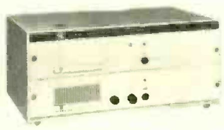
the vital contact

Pye 'Pocketfone' Personal Radiotelephone

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

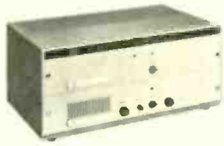
Pye 'Bantam' Portable VHF Radiotelephone

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



Pye VHF Radiotelephone Fixed Station

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



Pye UHF Radiotelephone Fixed Station

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

Pye 'Westminster' Remote Mounted Radiotelephone

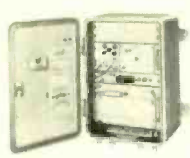
Completely solid state · 5-8W R.F. output · 1-10 channels with solid state switching · Illuminated channel indicator · Suitable for all climates · Meets all relevant specifications.

Pye 'Westminster' Front Mounted Radiotelephone

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

Pye Single-Sideband Radiotelephone

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



Pye 'Pioneer' Radiotelephone

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

Pye 5-Circuit UHF Radiotelephone

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

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THE QUEEN'S AWARD TO INDUSTRY 1966

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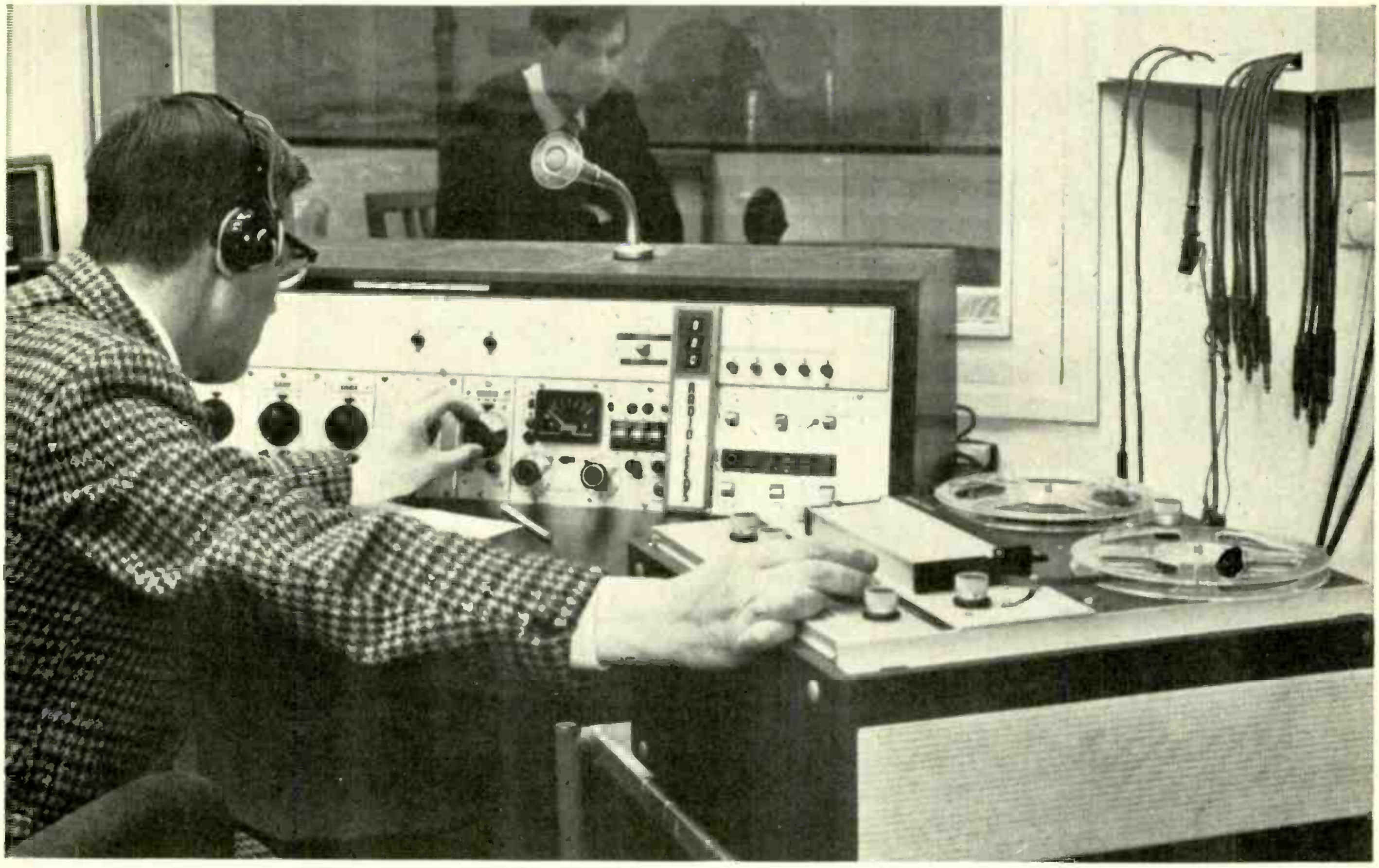

Radio Leeds: Where a tape recorder must be good and reliable you'll find a Ferrograph.

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 £150 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 ______________________

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WW

WW—022 FOR FURTHER DETAILS

DC multimeters

These instruments have dc ranges covering the measurement of voltage from 0.3μV to 1kV, current from 1pA to 1mA or 1A, and resistance from 0.3Ω to 1k MΩ. Left zero and centre zero scales are provided and a recorder output exists on all ranges.

Features are high input impedance on voltage ranges, low test voltage on linear resistance ranges, and large overload rating. The instruments are solid state powered by a self-contained battery. Low power consumption results in negligible warm-up drift.

Type TM 9 Series

Voltage Ranges
3μV, 10μV, 30μV . . . . 1kV. Accuracy $\pm$ 1% $\pm$ 1% f.s.d. $\pm$ 0.1μV. Noise $<$0.5μV p-p on the 3μV range for source resist. up to 30kΩ. Drift $<$0.7μV/°C and $<$0.7μV/day after warm-up of 2 mins. Input resist. $>$1MΩ/μV up to 10mV, $>$10kMΩ from 30mV to 1V, 100MΩ above 1V. Rise time on 3μV, 10μV, 30μV, 100μV to 1kV is 10s, 3s, 1s, $<$1s.

Current Ranges
3pA, 10pA, 30pA . . . . 1mA (1A for Type TM9BP). Accuracy $\pm$ 2% $\pm$ 1% f.s.d. $\pm$ 0.3pA. Noise $<$ 0.7pA p-p on the 3pA range. Drift $<$ 1pA/°C and $<$ 1pA/day after warm-up of 2 mins. Input resistance 1MΩ up to 1nA, 100kΩ from 3 nA to 1μA, 100Ω from 3μA to 1mA, 0.12Ω from 3mA to 1A on type TM9BP. Rise time on 3pA, 10pA, 30pA, 100pA to 1mA is 15s, 5s, 1.5s, $<$ 1s.

Resistance Ranges
3Ω, 10Ω, 30Ω . . . . 1kMΩ. Accuracy $\pm$ 1% $\pm$ 1% f.s.d. up to 100MΩ rising to $\pm$ 10% at 1kMΩ. Test voltage is 3mV at f.s.d. on Ω ranges. Test currents are 1μA and 1nA on kΩ and MΩ ranges.

Recorder output
0 to +1V at f.s.d. into not less than 1kΩ on left zero ranges. −0.5V to +0.5V into not less than 5kΩ on centre zero ranges.

Max. Overload
2kV peak on V ranges. 350V peak on mV, μV, and pA ranges. 50mA peak on μA ranges. 2mA peak on nA ranges.

Power Supply
One type PP9 battery, life 1000 hours; or AC mains when a Levell Power Unit is fitted.

Sizes & Weights
TM9A: 5″ x 7¼″ x 4½″ 4½lbs. Meter scale length 3¼″.
TM9B: 7″ x 10¼″ x 5½″ 8lbs. Meter scale length 5″, fitted with mirror.
TM9BP: As TM9B + current ranges up to 1A.

Prices
TYPE TM9A **£75** TYPE TM9B **£89** TYPE TM9BP **£93**
Optional Extras Leather Case TM9A £4.10. Leather Case TM9B and TM9BP £5. Mains power supply unit £7.10.

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LEVELL ELECTRONICS LTD.
PARK ROAD, HIGH BARNET, HERTS., ENGLAND Telephone: 01-449 5028

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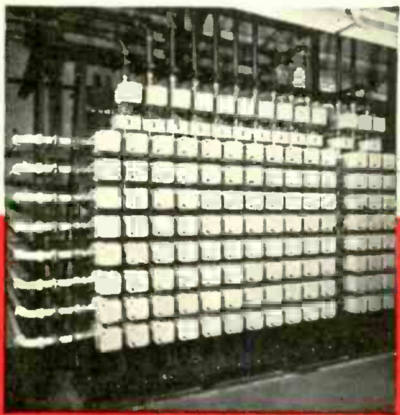
Here's how

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

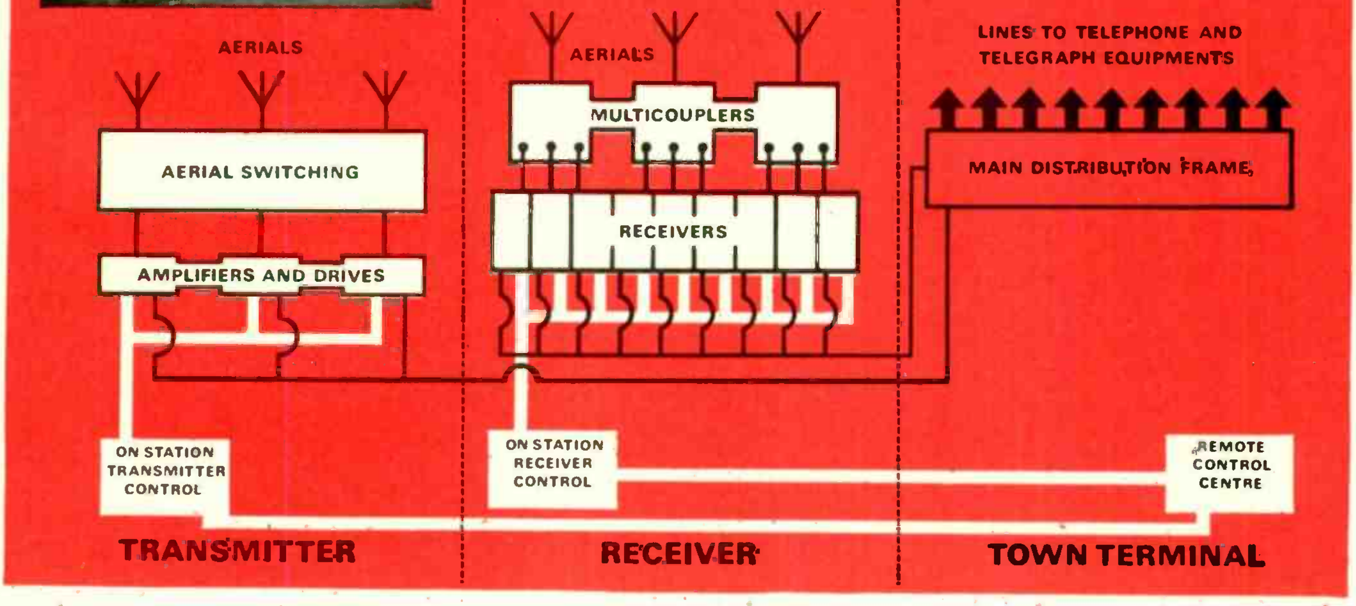
STANFAST Systems provide high speed frequency changing, automatic performance monitoring and rapid fault location affording optimum traffic handling capability and maximum revenue.

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

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



CROSSBAR AERIAL EXCHANGE TYPE 'A' 1016-A
Comprises a series of motorised coaxial changeover switches, a mounting rack and control/monitor panels to effect independent connexion between groups of transmitters and aerials. Enables the size and cost of an exchange to be kept low, while providing a transmitter to aerial switching facility of wide application potential.



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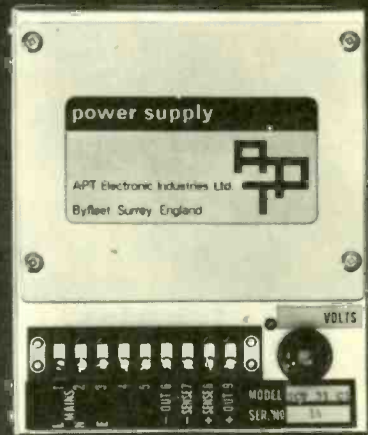
A·P·T POWER PACKS



The **SERIES 30** is a range of modular, mains operated d.c. power units with output voltages from 0-500V at maximum current ratings. These all silicon units are a result of careful design, are small in size, robust in construction and give a high performance. Three standard lengths are available covering the complete output range.

For further details write for fully descriptive leaflet and free slide rule selector.

PERFORMANCE

Stabilisation ratio:	>10,000:1. Typical 20,000:1.
Temperature coefficient:	≯0.005% per °C.
Output resistance:	≯0.5m Ω + 0.05m Ω per volt of output.
Output impedance:	<0.1 Ω to 200 KHz.
	<0.5 Ω to 500 KHz.
Ripple and noise:	≯250 μV or 0.0005% p-p, whichever is greater.

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Chertsey Road, Byfleet, Surrey. Tel: Byfleet 41131-2-3-4 Grams: APTRAN, BYFLEET

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THE *Adamin* DE-SOLDERING TOOL

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

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

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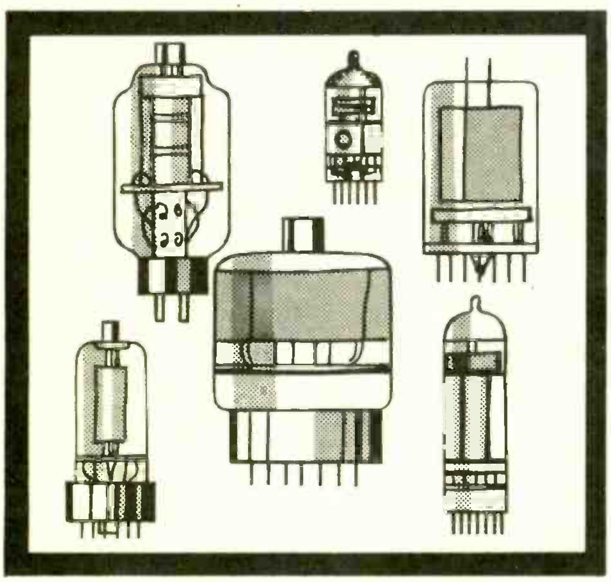
Last year we directly supplied

6 industrial giants, 89 large manufacturers, 392 smaller manufacturers, all three Armed Services, most government departments including 10 Ministries, 23 public corporations, 43 educational authorities and Universities and countless radio and television retailers in 1,162 cities, towns and villages in 38 counties.



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

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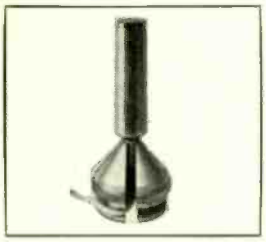
Microphones and Pick-ups by Bang & Olufsen

MICROPHONES



Beomic 1000 Omni-directional moving coil microphone. Response 50 – 17,000 Hz ± 2.5 dB. Sensitivity 0.1 mV/μbar. Hum sensitivity – 139 dB. Output: 200 ohms at 1 KHz. via 9ft lead, 5 pin DIN plug. Supplied with frequency response chart, lavalier cord, anti microphonic base, and packed in a futuristic container. Price *£9.9.0d.

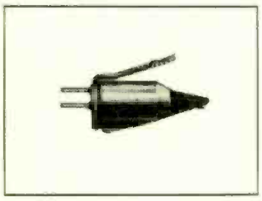
B.M.5. Studio quality Stereo ribbon microphone. Figure of 8 response: Sections may be swivilled up to 90° relative to each other for the desired stereo effect. Fitted with music/ speech switch. Response 30 – 13,000 Hz ±2.5 dB . Sensitivity 85 dB below 1 volt/μbar. Hum sensitivity – 146 dB. Output 200 ohms at 1 KHz. via 9 ft lead, 5 pin DIN plug. Supplied in rosewood presentation box with table stand. Price *£30.9.0d.

B.M.6. Mono ribbon microphone (lower half of the B.M.5). Specification as B.M.5. Supplied in presentation case with table stand, price *£21.2.0d. It may be converted to a B.M.5 by an addition of the B.M.7. (available separately price *£9.19.6d.)

Microphone Accessories Stereo/Mono extension leads: prices *15 ft £1.17.6d. 30 ft £2.9.6d. 45 ft £2.19.6d. 60 ft £3 15s. 75 ft £4 5s/Floor Stand £7.15s. Boom Arm £4.19.6d. Line matching transformer to 50 K ohm impedance; £2.9.6d.

PICK-UP CARTRIDGES

A range of quality magnetic cartridges using the B & O patented micro-cross system giving low harmonic distortion and a smooth frequency response. They follow the International tracking angle of 15° and, with standard ½" mounting centres, will fit virtually all quality pick-up arms.



S.P.6. Response 20 – 20,000 Hz ± 2.5 dB. Compliance 15 x 10^{-6} cm/dyne. Pressure 1.5 – 2.0 g. Stylus: 15 μ diamond. Output: 7 mV. 47K ohms. Price *£7.19.6d.
Replacement styli available: 15μ, 75μ, and 5 x 17μ elliptical.

S.P.8. As S.P.6, but supplied with 5 x 17μ elliptical stylus in Rosewood box, price *£12.19.6d.

S.P.10. Response 15 – 25,000 Hz ± 3dB. Compliance 25 x 10^{-6} cm/dyne. Pressure 1.0 – 1.5g. Stylus: 15μ naked diamond. Output: 5mV. 47K ohms. Price *£9.19.6d. Replacement styli available: 15μ and 5 x 17μ elliptical.

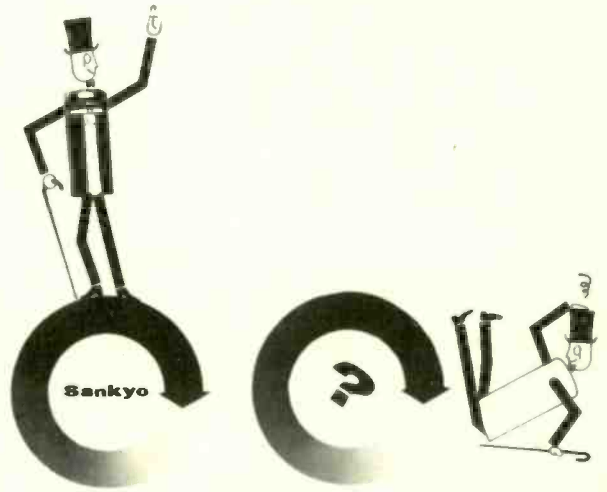
S.P.12. As S.P.10, but supplied with 5 x 17μ elliptical stylus. Price *£14.19.6d.

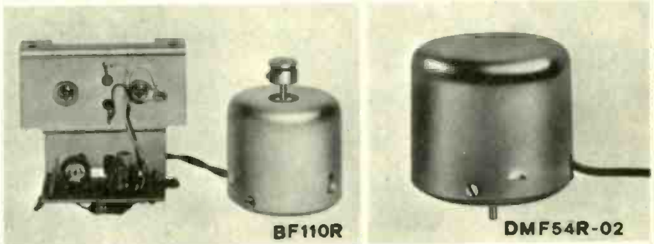
* Prices indicated are recommended retail prices.

B & O quality accessories are obtainable from B & O dealers:
Send for further details to the Accessory Department,
Bang & Olufsen U.K. Limited,
Eastbrook Road, Gloucester.
Telephone: 0452 21591.

WW—028 FOR FURTHER DETAILS

The Big Little Integrals That Can Make Or Break Your Product.





SY173L	Single speed (2000 rpm). For record players.
DMF54R-02	Single speed (2400 rpm). For tape racorders.
RK201R	Single speed (2400 rpm). For car players.
BF110R	Single speed (2000 rpm). With electrical governor motor. For tape recorders.
BF200R	Single speed (2200 rpm). For car recorders & players.
ZF200R	Variable speed (such as 1100, 2200 and 2800 rpm). With brushless & transistor motors. For de luxe record players & electronic calculators.
VM250B	Single speed (3600 rpm). For auto tuners.

Specification for Sankyo micro motors

TYPE	Dimensions ø (m/m)	Dimensions Length (m/m)	Rated Voltage (V)	Range of Voltage (V)	Rated Torque (gr-cm)	Rated Speed (rpm)	Load Current (mA)	Starting Torque (gr-cm)	Life (Hr)	Direction of Revolution
SY173L	40	32.4	6	4.5 ~ 6	3	2000	80	35	600	Left
DMF54R-02	38	34.8	6	4.5 ~ 6	9	2400	140	30	600	Right
RK201R	47.9	48	13.2	10 ~ 16	30	2400	210	100	1000	Right
BF110R	38	30	4.5	3.5 ~ 5.7	8	2000	160	30	1500	Right
BF200R	38	34.1	13.2	(5.5 ~) 9 ~ 16	15	2200	180	30	1500	Right
ZF200	46	50	9	6 ~ 9	20	2200	300	45	3000	Left, Right
UP550R	20	44.5	4.5	4 ~ 6 4.5 ~ 6	14	3700 5000	160	60	30	Right
VM250B	25	36.5	7	6.5 ~ 7.5	0.4	3600	45	25	500	Left, Right

Sankyo

Sankyo (Europe) Export und Import G.m.b.H.: 4 Düsseldorf, Bahnstraße 45-47, W. Germany. Tel: 325652/3 Telex: 8587097
Cables: SANKYORGEL DÜSSELDORF
Sankyo Seiki Mfg. Co., Ltd.: 17-2, Shinbashi 1-chome, Minato-ku, Tokyo 105, Japan. Tel: Tokyo 591-8371
Cables: SANYORGEL TOKYO
American Sankyo Corp.: Rm. 801-3, 95 Madison Ave., New York, N.Y. 10016, U.S.A. Tel: LE-2-8020

See Our data in VSMF VISUAL SEARCH MICROFILM FILE

WW—029 FOR FURTHER DETAILS

WANTED

COMPACT
AD-27

COMPACT
AD-17

HEATHKIT REQUIRE DISCERNING CUSTOMERS FOR THEIR NEW SUPERB STEREO COMPACTS, MODELS AD-27 AND AD-17.

REWARD A LIFETIME OF LISTENING PLEASURE

WILL ANYONE SEEKING INFORMATION ON THESE MODELS PLEASE CONTACT STAND NO. 63, INTERNATIONAL AUDIO & PHOTO-CINE FAIR AT OLYMPIA, OR SEND DIRECT TO

DAYSTROM LTD.,

BRISTOL ROAD, GLOUCESTER, ENGLAND. TEL. GLOS 29451

THERE ARE MANY OTHER CHARACTERS IN THE HEATHKIT RANGE TO BE ON THE LOOKOUT FOR: SUCH AS, STEREO TUNER/AMPLIFIERS, STEREO FM TUNERS, AMPLIFIERS, SPEAKER SYSTEMS, DOMESTIC ENTERTAINMENT PRODUCTS, TEST INSTRUMENTS ETC.

HEATHKIT

DAYSTROM LTD., Gloucester GL2-6EE England
Tel. Glos. 29451 Telex 43216

☐ Please send me details of Models AD-27 & AD-17
☐ Please send me my FREE Heathkit Catalogue
(Tick where appropriate).
DAYSTROM LIMITED, Gloucester GL2-6EE
NAME
ADDRESS
WW-10

WW—030 FOR FURTHER DETAILS

"Astronic"

series 1700

HIGH QUALITY AMPLIFIERS
10 WATTS—70 WATTS
ALL TRANSISTOR

10 WATT
TYPE 1700 100V OUTPUT
TYPE 1746 8OHM

75 WATT TYPE 1708

Details on request from:—

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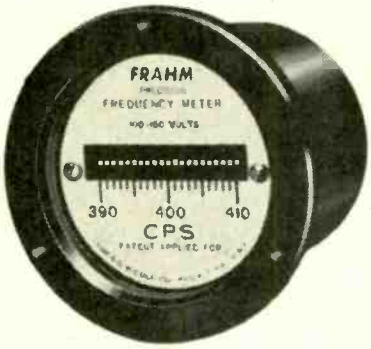
TELEPHONE: 01-907 4474/5/6.

WW—031 FOR FURTHER DETAILS

FRAHM vibrating reed FREQUENCY METERS



are widely used as standards in many industries because:—

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

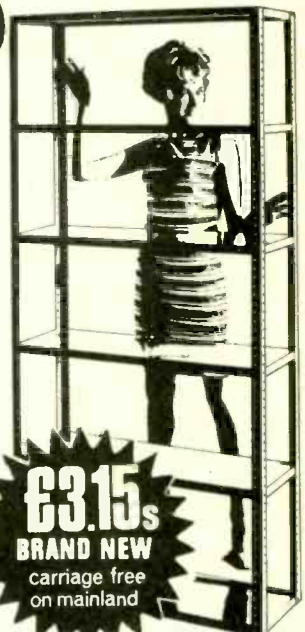
FRAHM Vibrating Reed Frequency Meters are available in miniature switchboard and portable forms, in ranges from 10 to 1700 cps. Descriptive literature on these meters, and on FRAHM Resonant Reed Tachometers, freely available from the sole U.K. distributors:—

ANDERS METER SERVICE

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

WW—032 FOR FURTHER DETAILS

STRONGHOLD steel shelving that adjusts every inch of its height!



Immensely strong— completely adjustable, every inch. Delivered free, mainland, with spanner provided for erection in minutes. Buy it by the bay!
(cash with order)
73" high x 34" wide x 12" deep unit with six shelves in heavy-gauge steel, stove enamelled grey or green! £3.15s.—Brand new! See the rest of the N. C. Brown range!

£3.15s BRAND NEW carriage free on mainland

N.C. BROWN LTD.
pacesetters in storage equipment

Send your FREE BROCHURE ☐ or Send ☐ (how many) bays of steel shelving @ £3.15s. in green ☐☐ grey (tick which)

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Address ....

Dept. WW Eagle Steelworks, Heywood, Lancs.
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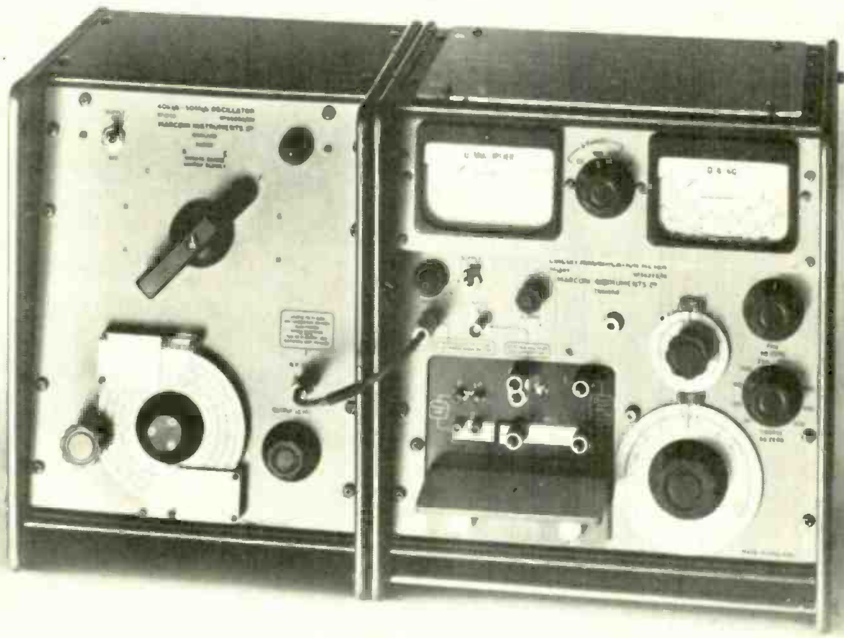
Tel: 01-405 7931

WW—033 FOR FURTHER DETAILS

Marconi puts Q-Measurement on the Gold Standard



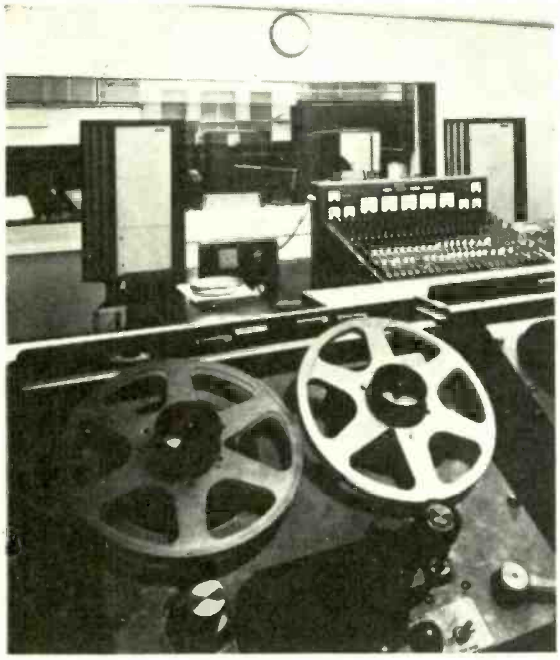
The new Marconi TF 1245A gives *gilt-edged* confidence in Q-measurement! By *gold-plating* the complete test-circuit and tuning capacitor, Marconi have cut inherent loss, increased long-term stability – factors which have always reduced the certainty of Q-measurement, especially at high frequencies.
TF 1245A covers the frequency-range, 1 kHz – 300 MHz, providing direct measurement of Q-factors from 5 to 1,000. Capacitance range is 7.5 to 500 pF. Delta-Q and Q multiplier facilities. Two specially designed oscillator units, TF 1246 and TF 1247, cover the ranges, 40 kHz – 50 MHz and 20 MHz – 300 MHz, respectively. You may select either or both, according to your individual needs.

mi

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

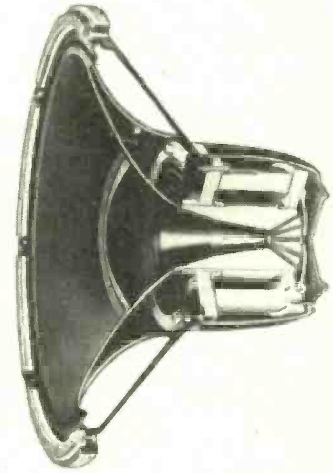
WW—034 FOR FURTHER DETAILS

The majority of Recording and T.V. studios use TANNOY monitors



Tannoy Monitor Gold Dual Concentric Loudspeakers, accepted as the "Quality Standard" most specified for professional use by Recording, Broadcasting and TV companies as well as the World's largest manufacturers of professional Audio Equipment.

THE *Monitor* GOLD *



THE NEW MONITOR GOLD now incorporates a Treble Roll Off Control and Treble Energy Control enabling precise adjustments to be made for room acoustics and programme material.

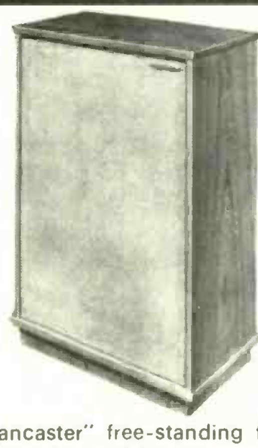
Frequency Response	30–20,000 cps
Power Handling Capacity	15″ 50 watts 12″ 30 watts III LZ 15 watts
Impedance	8Ω Nominal 5Ω Minimum

The same units provide professional standards in the home

"Lancaster" corner-mounting fitted with 12″ Dual Concentric. Height 2′ 9″. Width 2′ 1″. Front to rear corner 1′ 4¾″.

The range of Lancaster Enclosures – enthusiastically received by the technical press – are proving equally popular not only in the United Kingdom but throughout the World. High grade cabinet work and restrained modern styling enable them to blend well with the majority of furnishing schemes.

"III LZ" Mk. II, Aperiodic enclosure with III LZ unit.
Height 1′ 3″
Width 1′ 11″
Depth 9¾″



"Lancaster" free-standing fitted with 12″ or 15″ Dual Concentric.
Height 2′ 9½″
Width 1′ 9½″
Depth 1′ 0½″

All cabinets fitted with Monitor Gold Loudspeakers

TANNOY®

TANNOY PRODUCTS LIMITED
Norwood Road, West Norwood, London, S.E.27
Tel: 01-670 1131

HIGH FIDELITY MOVING COIL STEREO HEADPHONES (TYPE LS43) Now available from DAYSTROM LTD. GLOUCESTER

WW—036 FOR FURTHER DETAILS

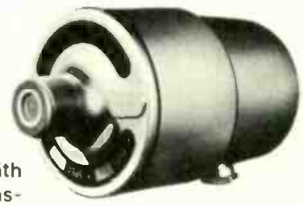
Celestion PA

Loudspeakers for all Public Address Systems

Re-entrant Horns

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

Driver Units



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

Re-entrant Loudspeakers

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

Loudspeaker in Glass Fibre

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

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

WW—037 FOR FURTHER DETAILS

LYNDA JENKINS

Count down. Cue light on. Tape running.
Dry throat. Switch-back stomach.
Rubber knees. Can't remember the
intro . . . Oh yes, after three.

What else can go wrong?
Not my Reslo mike, thank goodness.
Man, do I cling to *that*.

Here we go . . . loud and clear,
with any luck I'll get off before
they start throwing things.
Like golden discs.

DON'T FAIL TO VISIT OUR PRIVATE TRADE SHOW AT THE HAND & FLOWER HOTEL, HAMMERSMITH ROAD, LONDON. W.14
(Opposite Olympia)

16th – 18th Oct.

Reslo DERRITRON GROUP **RESLO MIKES, ROMFORD, ESSEX.**

WW—038 FOR FURTHER DETAILS

Vortexion

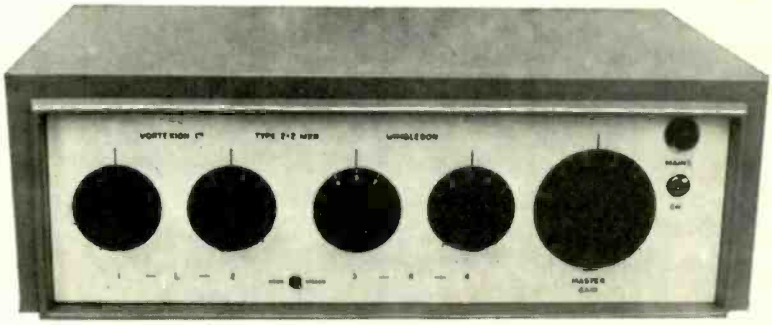
STEREO MIXERS

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

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

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

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



Also available Monaural Electronic Mixers:—

4 Way Monaural Mixers	3 Way Monaural Mixers with P.P.M.
6 Way Monaural Mixers	4 Way Monaural Mixers with P.P.M.
8 Way Monaural Mixers	6 Way Monaural Mixers with P.P.M.
10 Way Monaural Mixers	8 Way Monaural Mixers with P.P.M.

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4 WAY MIXER USING F.E.T.'s. This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 3-30/60 Ω balanced line microphones, and a high impedance line or gram. input followed by bass and treble controls. Since the unit is completely free from the input rectification distortion of ordinary transistors, this unit gives that clean high quality that has tended to be lost with most solid state amplifiers.
100uV on 30/60 ohm mic. input. 100mV to 100 volts on gram/auxiliary input 100 KΩ.

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.

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

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 m W 600 ohms. Output 100-120v or 200-240v. Additional matching transformers for other impedances are available.

30/50 WATT AMPLIFIER. With 4 mixed inputs, and bass and treble tone controls. Can deliver 50 watts of speech and music or over 30 watts on continuous sine wave. Main amplifier has a response of 30 c/s-20Kc/s ± 1db. 0.15% distortion. Outputs 4, 7.5, 15 ohms and 100 volt line. Models are available with two, three or four mixed inputs for low impedance balanced line microphones, pick-up or guitar.

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

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

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SEW PANEL METERS

- LOW COST
- QUICK DELIVERY
- OVER 200 RANGES IN STOCK
- OTHER RANGES TO ORDER

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.

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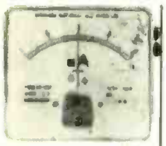

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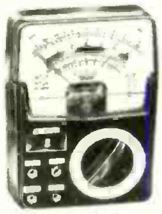

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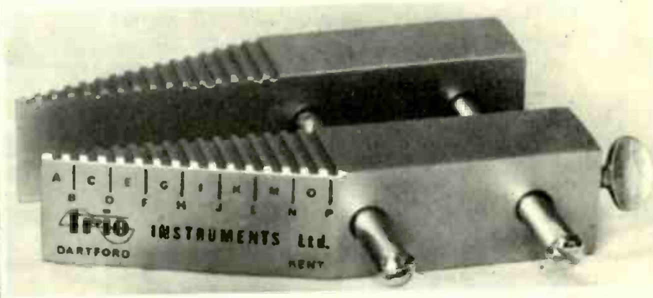

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Some notes on Bridge Measurement by WAYNE KERR

Number 3
Bridge Standards

This series of notes is intended to cover the principal aspects of design and application of the Transformer Ratio Arm Bridge. An important feature of this type of bridge is its ability to cover a wide range of impedances with a small number of resistive and reactive standards by using multiple tapping points on transformer windings. Furthermore it is possible, by an appropriate arrangement of these tappings, to achieve pure standards using conventional resistive and reactive components. Figure 1 illustrates transformer tappings which allow the ratio between the standard and the unknown to be varied by a factor of 10^6 to 1. This is achieved by varying the 1, 10, 100 and 1000 tapping points for the unknown impedance on both transformers.

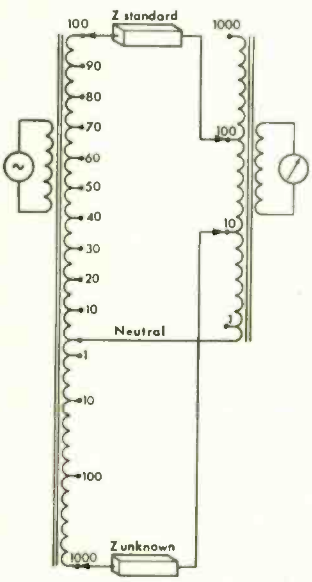

Fig. 1

The standard impedance can also be connected to any 10 turn tap between Neutral and 100 turns on the left hand transformer. This provides a decade ratio facility in addition to the range multiplication already described.

In a practical bridge network, the standard impedance may consist of a series of resistors and capacitors, each component being selected to be one tenth the value of its predecessor in the series. The unique advantage of using decade taps in this way is that each standard reactance and resistance can be independently switched to any tap on the transformer from Neutral to 100 turns as described and therefore the effective value of each standard can be independently multiplied to give a complete decade range of values.

If solid dielectric capacitors are used as fixed value standards, small resistive losses associated with the power factor of the dielectric will cause errors in measurement to occur. However, the simple arrangement shown in Figure 2 can be made to balance these losses and effectively purify the standards.

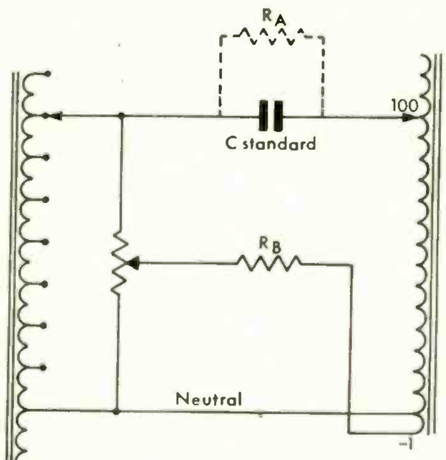

Fig. 2

R_A is the resistive term associated with the power factor of the standard capacitor. A fixed resistor R_B is connected to balance the current produced in the right hand transformer by R_A and an exact balance can be made by means of the potentiometer connected across the left hand transformer winding forming a potential divider.

If the standard capacitor is connected to the 100 turn tap of this transformer, R_B can be substantially less than one hundredth of R_A and therefore becomes a practical value in the order of megohms.

The measurement of network characteristics can be performed using a transformer ratio arm bridge. Figure 3 illustrates the use of the bridge for measuring the transfer admittance of a network terminated with a resistor R_T. This resistor acts as the terminating resistor as, at balance, equal currents flowing in the right hand transformer effectively return R_T to Neutral. The various components of the standard arm of the bridge can be varied and made effectively negative by switching to windings of reverse sense on the right hand transformer as illustrated by the dotted line in Figure 3, and from this it follows that measurements can be performed in all four quadrants of the complex plane using one set of resistive and one set of capacitive standards.

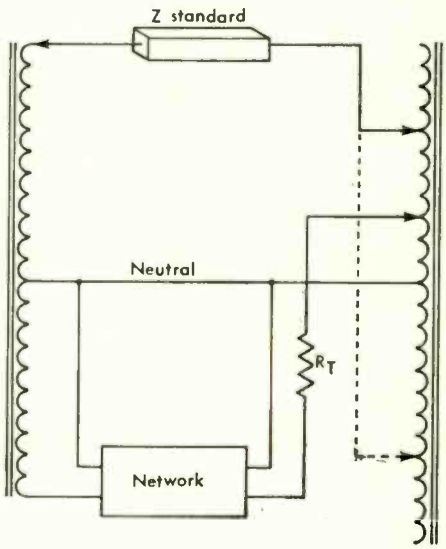

Fig. 3

If the features of the transformer ratio arm bridge so far described are compared to those of other types of A.C. bridge it is apparent that the main advantages are high accuracy combined with versatility.

The principles which have been discussed may be applied to simple, low cost bridges and to more advanced designs up to the standard required for the precise comparison of standards to an accuracy of a part in a million.

The next issue of these notes will develop the use of the bridge neutral facility in order to achieve the design for a precise and stable standard of capacitance.

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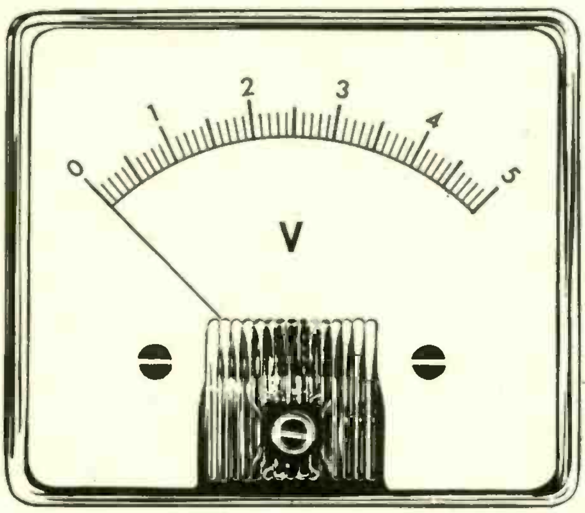

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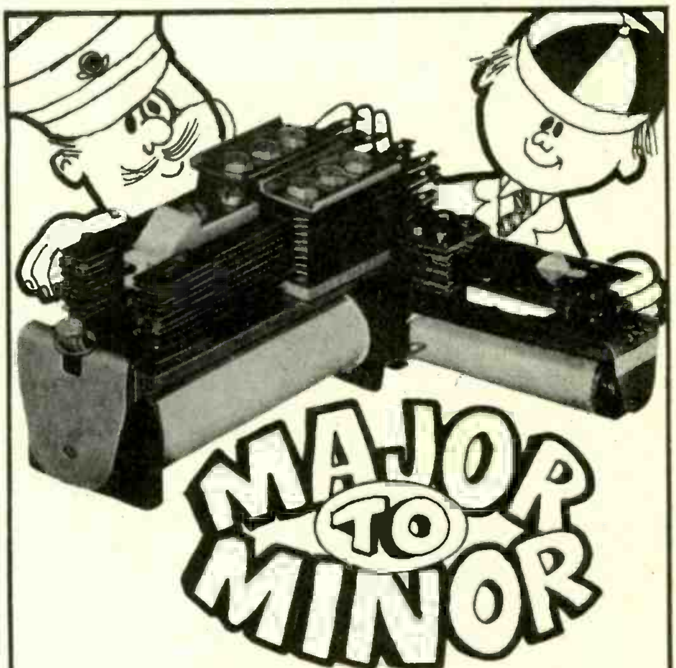

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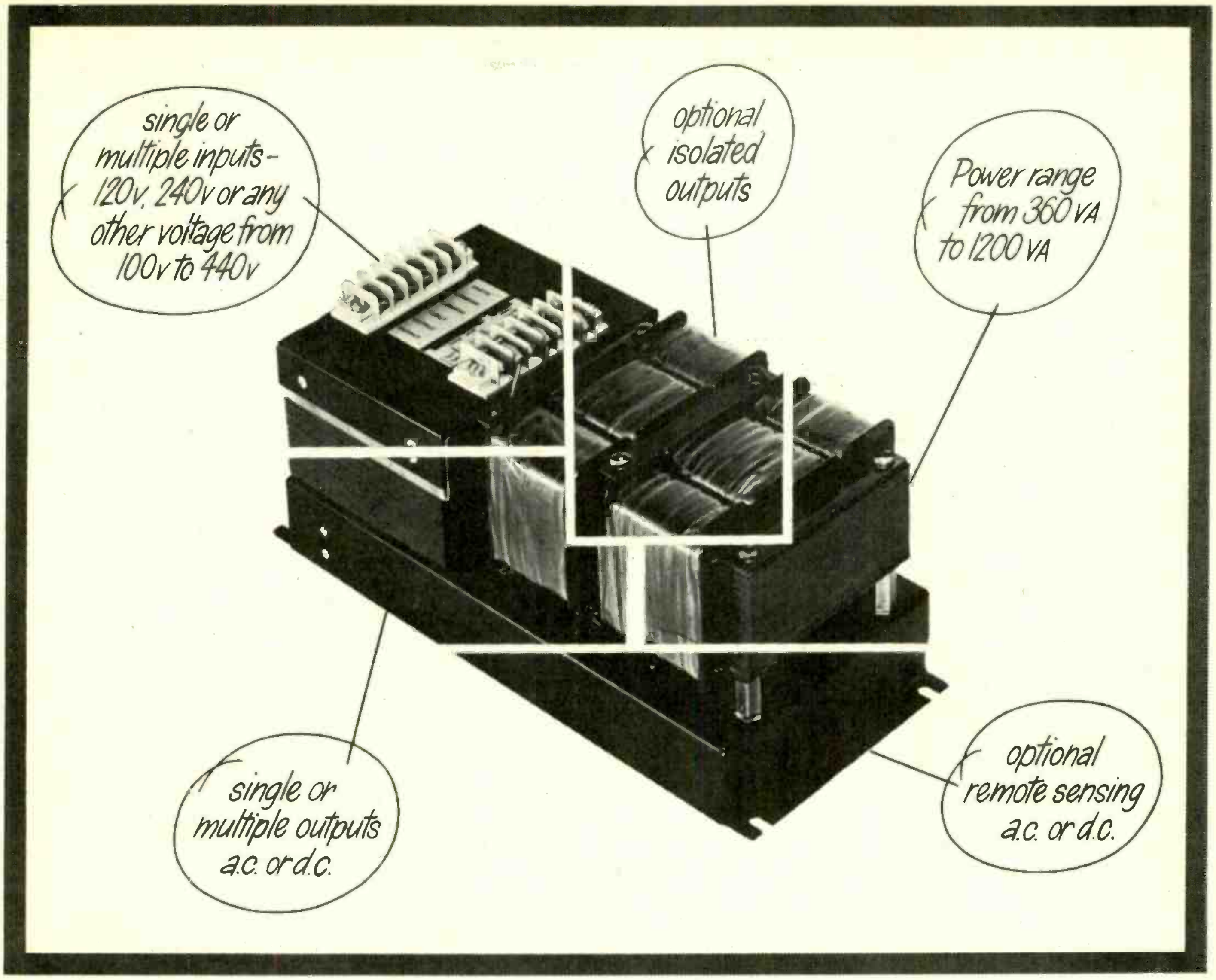
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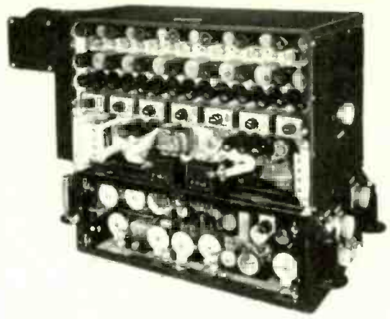

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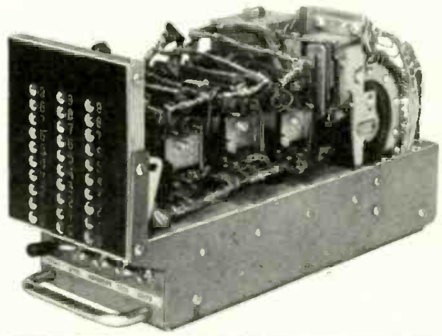

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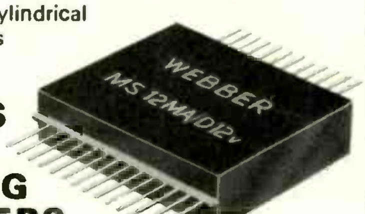

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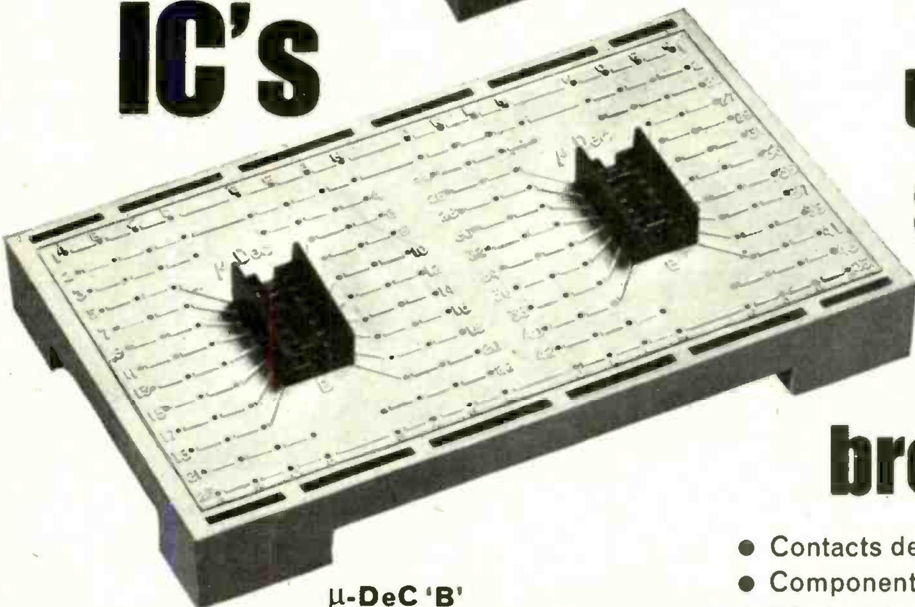

use DeC solderless modular breadboards

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The board to use if breadboarding with one package type.
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- Contacts designed for maximum life.
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81E

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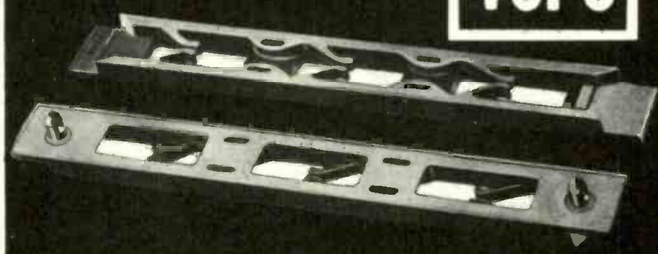

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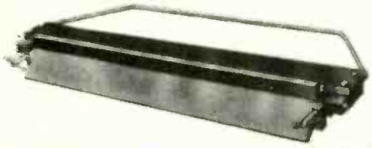

Forms channels and angles down to 45 degrees which can be flattened to give safe edge. Depth of fold according to height of bench.

48" × 18 gauge capacity	£40	0	0
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24" × 18 gauge capacity	£8	0	0
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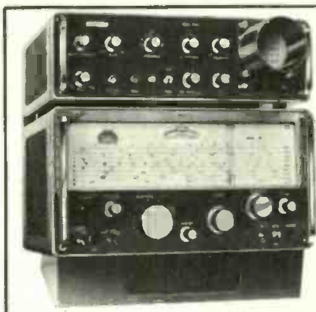

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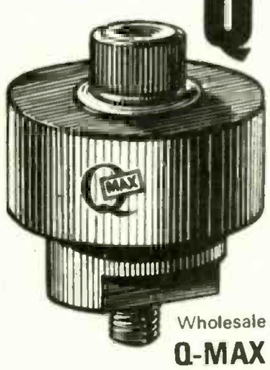

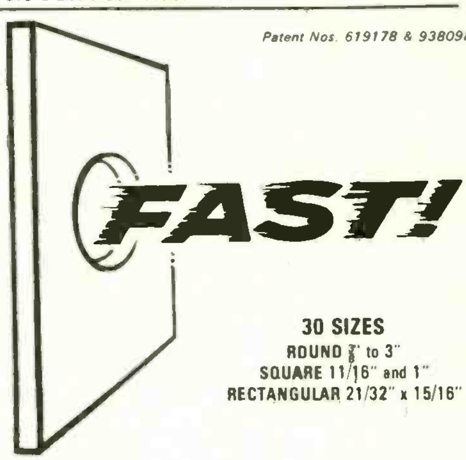

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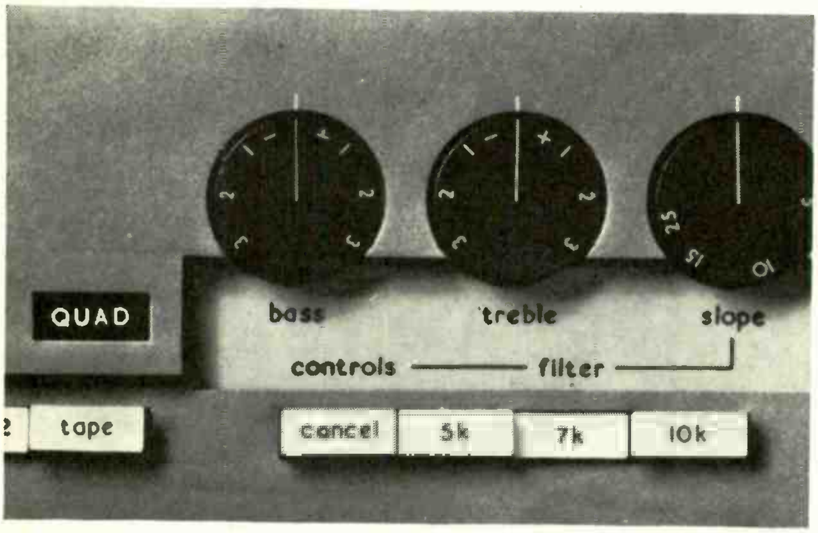

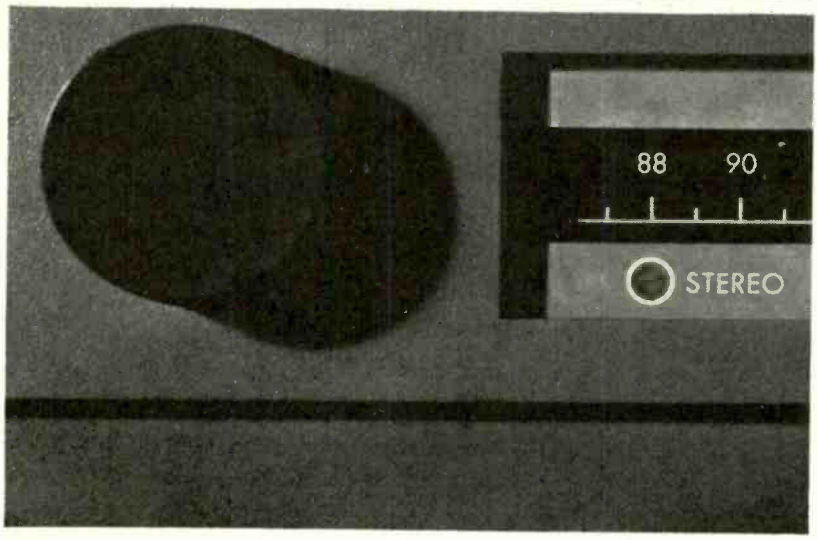

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For use in boats, cars, coaches, trains, country house plants, caravans, etc.
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Typical type B12/250T	Maximum output 650W	£34.13.0
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Input/output efficiency is over 80 per cent with most models.
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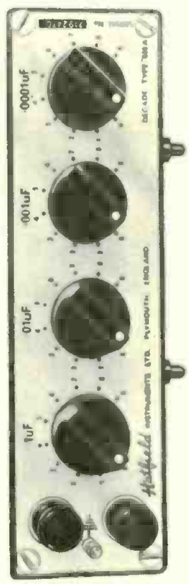

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Small enough to put in your pocket (but too useful to keep there) the new Hatfield Capacitor Decade Box Type 688A has been developed for use by design engineers for circuit tolerancing and similar applications. The unit is exceptionally compact, measuring only 5½in. × 1⅞in. × 2½in. and provides a rapid means of capacitor selection over the range 100 pF to 1 μF. Accuracy is better than 5% at any setting.

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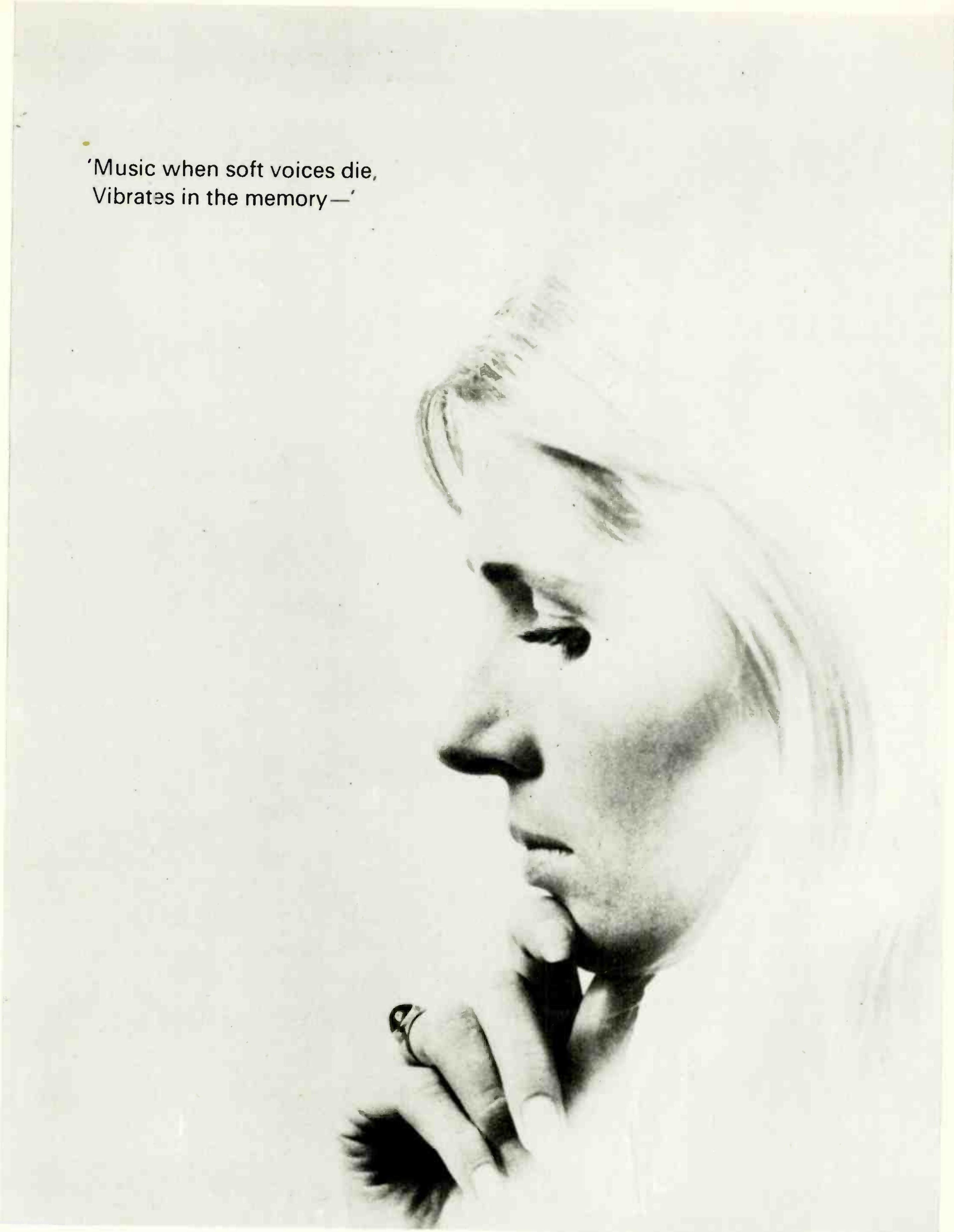

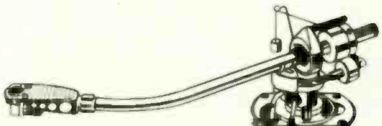

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The technique: thin ceramic films and platinum electrodes fused into a solid layered structure.

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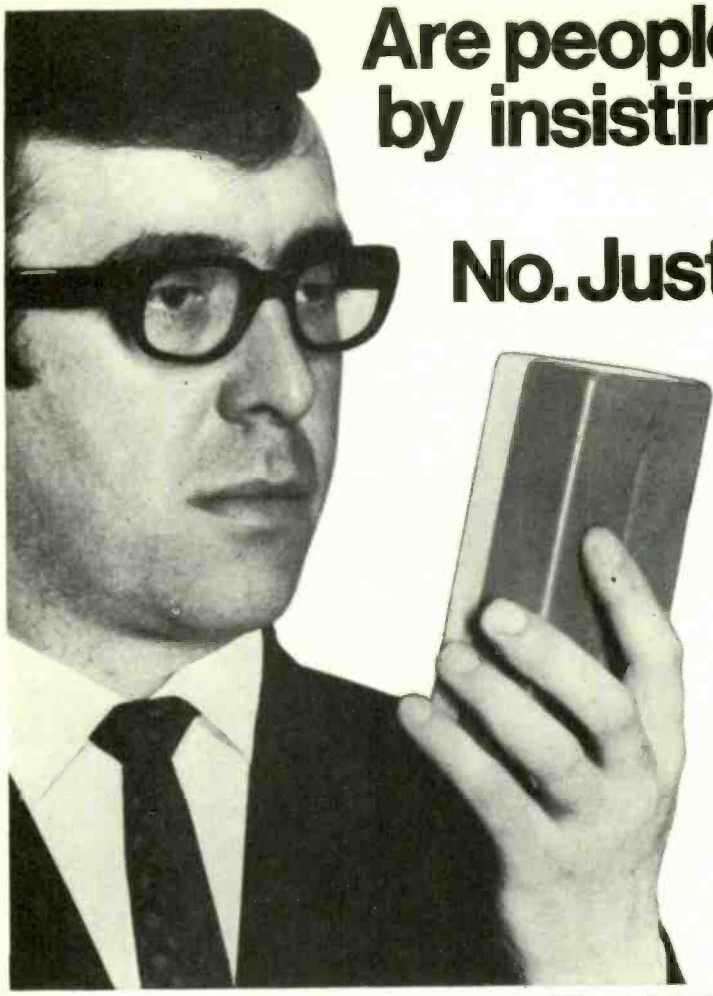
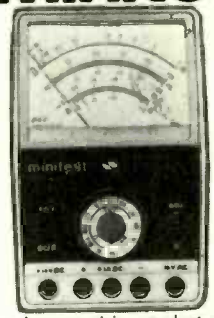


Are people being stubborn by insisting on the Minitest?



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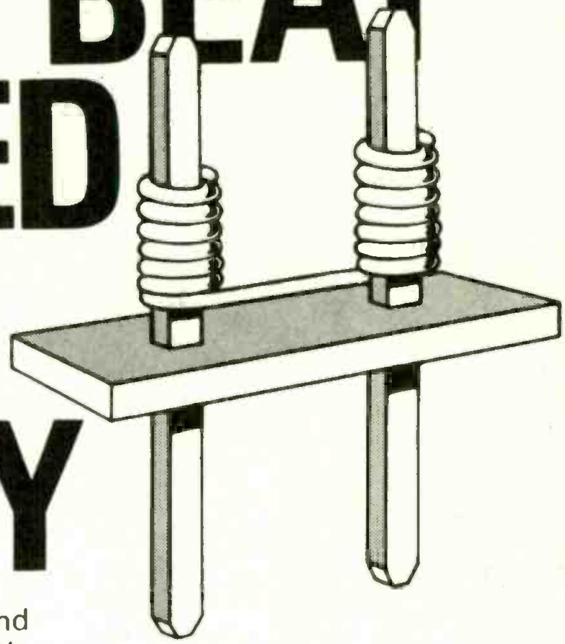

Failure rates in service better than 0·0000007% per thousand hours. In twelve years Ferranti have made millions of joints *without a single failure.*

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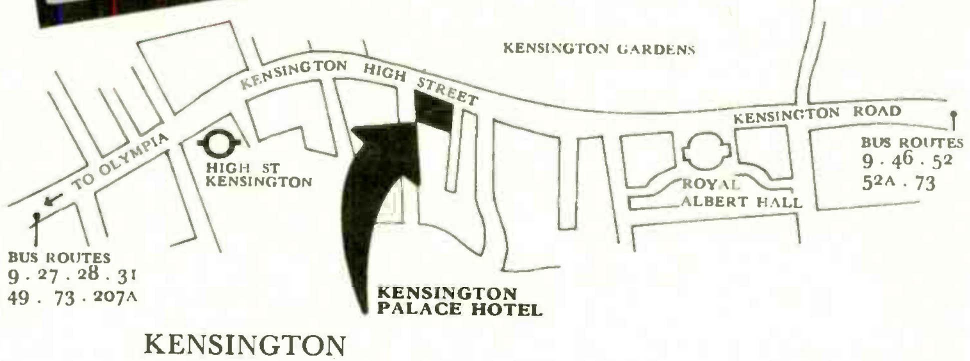

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by Gordon J. King, AssocIERE, MRTS

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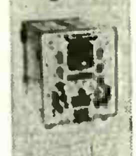

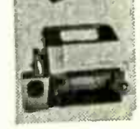

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WW—093 FOR FURTHER DETAILS

Tektronix plug-in spectrum analyzers cover the spectrum from 50 Hz* to 10.5 GHz

Centre frequency-displays from 10 Hz.

50 Hz to 1 MHz
NEW TYPE 1L5

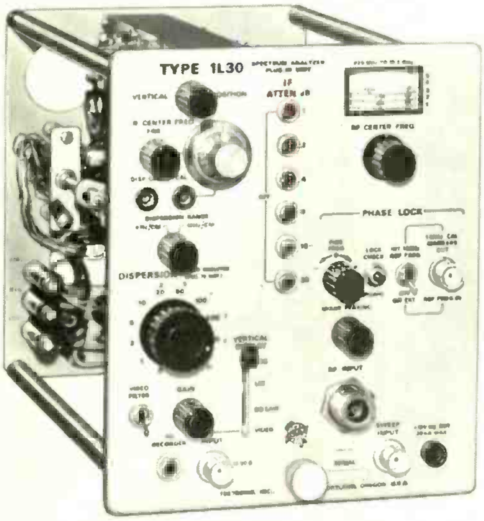
1 MHz to 36 MHz
TYPE 1L10

Here is broad spectrum analysis capability for Tektronix oscilloscopes that accept letter and 1-series plug-in units.

These units permit accurate and reliable measurements of the frequency distribution of your signal directly from the CRT display—with signal energy along the vertical axis and frequency along the horizontal axis. The controls optimize performance for a wide variety of signals, and all four units have recorder outputs.

The new Types 1L5 and 3L5 offer calibrated vertical and horizontal deflection for both frequency-based and time-based applications. For spectral displays, deflection factors of 10 μV/cm to 2 V/cm (RMS) are available. For time-based displays, deflection factors are 1 mV/cm to 100 V/cm in a 1-2-5 sequence with a bandwidth of 10 Hz to 1 MHz ±3 dB.

The Types 1L20 and 1L30 feature internal phase lock for stable displays with very narrow dispersion at high frequencies. All four offer calibrated dispersion with coupled resolution, permitting frequency measurements directly from the display.



925 MHz to 10.5 GHz
TYPE 1L30

10 MHz to 4.2 GHz
TYPE 1L20

Plug-in Unit	TYPE 1L5	TYPE 1L10	TYPE 1L20	TYPE 1L30	TYPE 3L5	TYPE 3L10
	(for use in Tektronix oscilloscopes accepting letter and 1-series plug-in units)				*(for use in Type 561A, 564 and 565)*	
Frequency Range	50 Hz to 1 MHz	1 MHz to 36 MHz	10 MHz to 4.2 GHz	925 MHz to 10.5 GHz	50 Hz to 1 MHz	1 MHz to 36 MHz
CW Sensitivity	10μV (RMS)/cm	—100 dBm	—110 dBm to —90 dBm	—105 dBm to —75 dBm	10μV (RMS)/cm	—100 dBm
Calibrated Dispersion	10 Hz/cm to 100 kHz/cm	2 kHz/cm to 10 Hz/cm	10 MHz/cm to 1 kHz/cm		10 Hz/cm to 100 kHz/cm	2 kHz/div to 10 Hz/div
Resolution	500 Hz to 10 Hz	1 kHz to 10 Hz	100 kHz to 1 kHz		500 Hz to 10 Hz	1 kHz to 10 Hz
Incidental FM	≤3 Hz to 9900 Hz, ≤ 10 Hz to 1 MHz	IF: 5 Hz LO: 25 Hz + 1 Hz/MHz dial frequency	With internal phase lock, less than 300 Hz		≤ 3 Hz to 9900 Hz, ≤ 10 Hz to 1 MHz	IF: 5 Hz LO: 25 Hz + 1 Hz/MHz dial frequency
Display	Log, linear (RMS V/cm) and video	Log, linear, linear X10 and video	Log, linear, square law and video		Log, linear (RMS V/cm) and video	Log, linear and video
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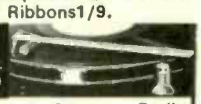

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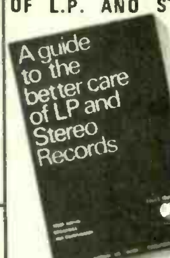

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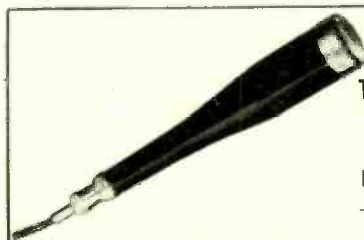

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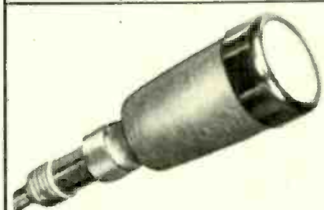

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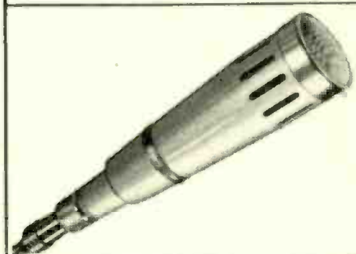

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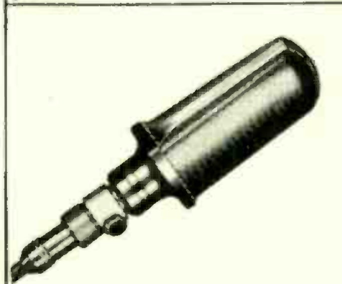

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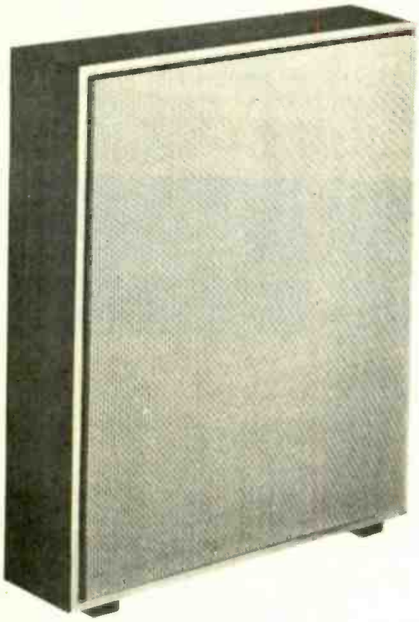

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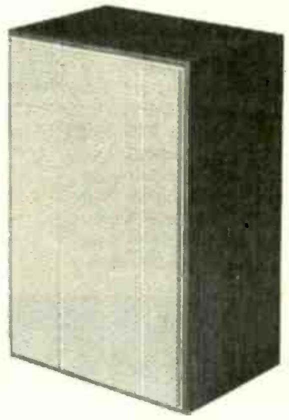

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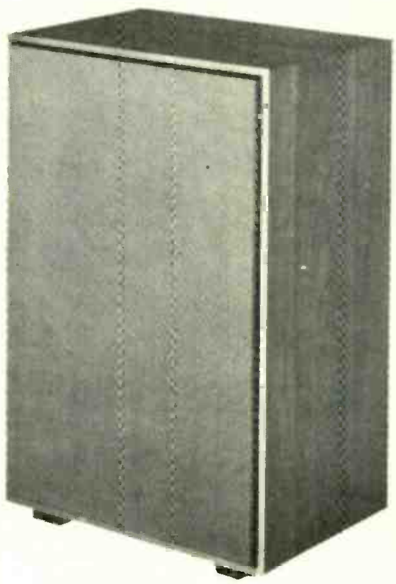

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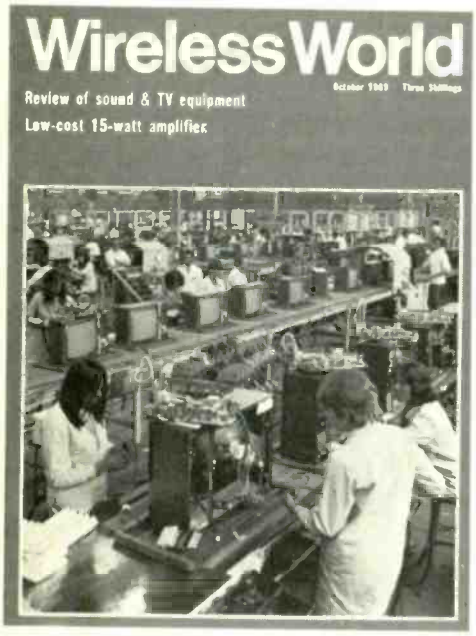
Wireless World

Electronics, Television, Radio, Audio

Fifty-ninth year of publication **October 1969** **Volume 75 Number 1408**



This month's cover shows the monochrome television receiver production line at the British Radio Corporation's factory at Gosport, Hants. In this issue we review the latest techniques in television and sound receivers.

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OUR NEXT ISSUE

A Design in Retrospect—the designer looks back at the comments, compliments and criticisms of the Dinsdale amplifier.

Living with Hi-Fi—a wife's definition of "tolerance" by Heather Dinsdale.

Review of the German Radio Show in Stuttgart.

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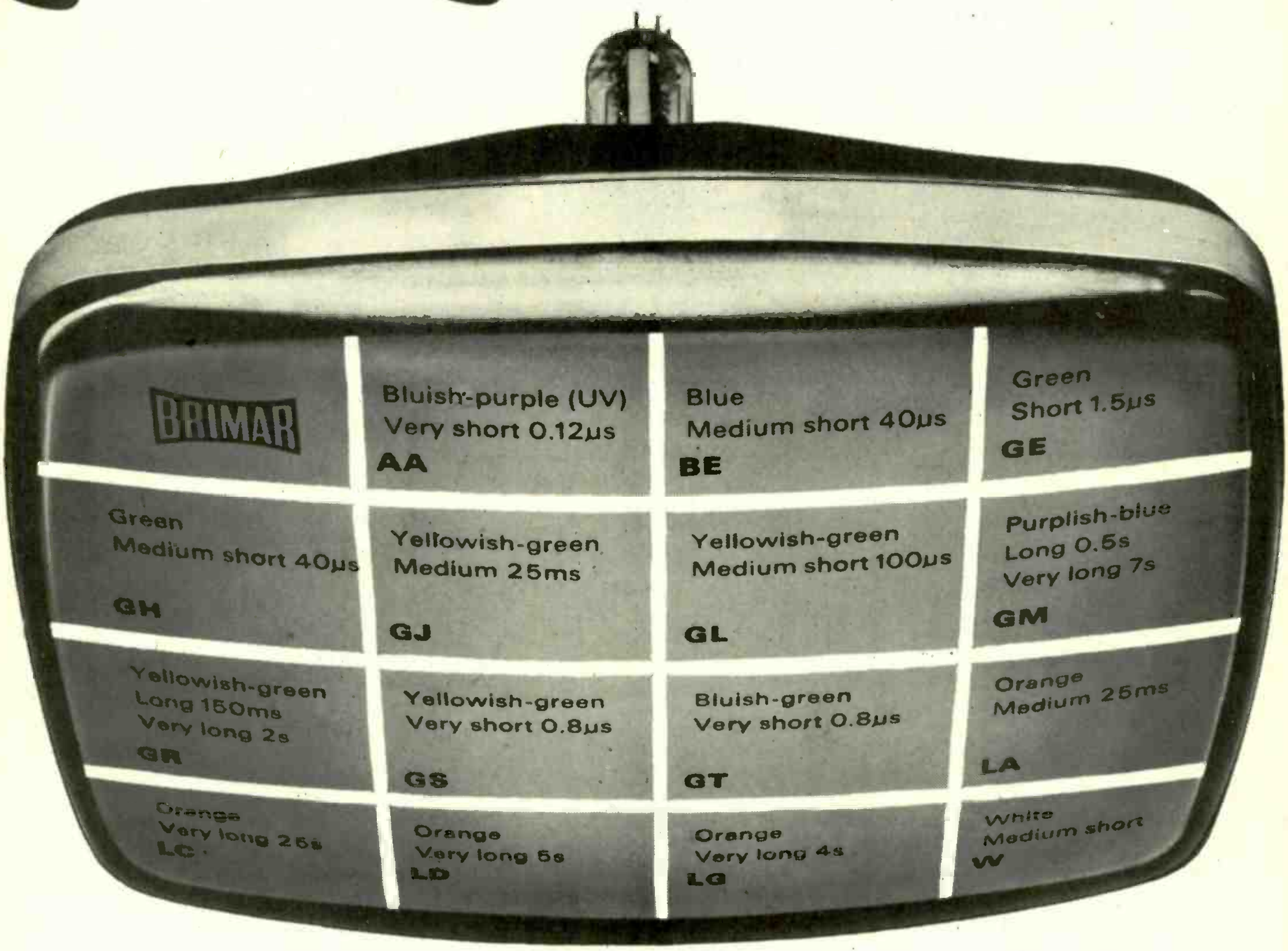

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WW—101 FOR FURTHER DETAILS

Wireless World

A Shrinking Universe

A few years ago, in our annual reviews of domestic equipment, we used to announce, with somewhat monotonous regularity, that everything was getting smaller. After a while it became obvious that size reduction was now a constant factor in the design of radio, television and audio equipment and there seemed little point in commenting on it. Nonetheless the trend continues. This year one of the most striking illustrations is that a colour television set, with all the extra circuitry we know it must contain, is now almost indistinguishable from a monochrome set. A sage remark of the older generation used to be "Ah, but you can't miniaturize the watt". The younger generation, with all that lack of principle that is supposed to be characteristic of it, has simply sidestepped this axiom by avoiding the use of components and systems that dissipate watts.

One naturally asks oneself, where is the curve of size reduction going to end? Is it asymptotic—in which case we shall not live long enough to know the answer—or does it have a predictable final value? It seems pretty certain that still advancing semiconductor technology will allow electronic circuitry to continue shrinking. It is only a matter of time before the whole circuit of a receiver or audio amplifier will be available in a single i.c. package. The limiting factor in domestic equipment is, of course, the necessary *or required* size of the acoustic or optical transducer. What do the ear or the eye need for satisfaction? The distinction between "necessary" and "required" is important, because it is obvious that technology does not set a necessary limit on the size of picture displays or sound transducers. If loudspeakers have to be large to reproduce bass frequencies then you can go to headphones. Television pictures will sooner or later be displayed on solid-state panels. But what is *required* by human beings is a different matter.

Here one important influence is the size of our homes. In succeeding generations, for the majority of the population, the rooms of houses are likely to get smaller. The question then is: what proportion of their living space will people be prepared to devote to audio-visual equipment? With growing prosperity and materialism people are stuffing their homes with more and more manufactured goods, and inevitably they are beginning to get worried about *lebrensraum*. Perhaps they will grow less materialistic and the problem will solve itself; perhaps the species will adapt to its self-made environment and get physically smaller.

Another unanswerable question is whether people will continue to regard and want audio-visual entertainment as a social activity. If television and sound programmes are to continue to be shared by people in groups using common transducers then the sizes of screens and loudspeakers must remain much as they are now. If we no longer want the social element of viewing and listening then personal transducers will be sufficient—we are seeing this trend already in the growing enthusiasm for stereo headphones by audio aesthetes. Technology can then forge ahead once more to devise transducers that can be even more intimately connected to the human body, ending up possibly with direct electrical stimulation of the brain.

What actually happens will depend on us in electronics, for people do not really make these decisions for themselves. Always it is the availability of a particular product of technology which sets a fresh course for human behaviour.

Domestic TV and Sound Equipment

Some of the highlights of the London Shows

The recently held London radio and television trade shows afford us an opportunity to review some of the trends in receiver design. Having discussed these we then deal briefly with a few of the items which will be seen at the London Audio Fair (see p. 476 for list of exhibitors).

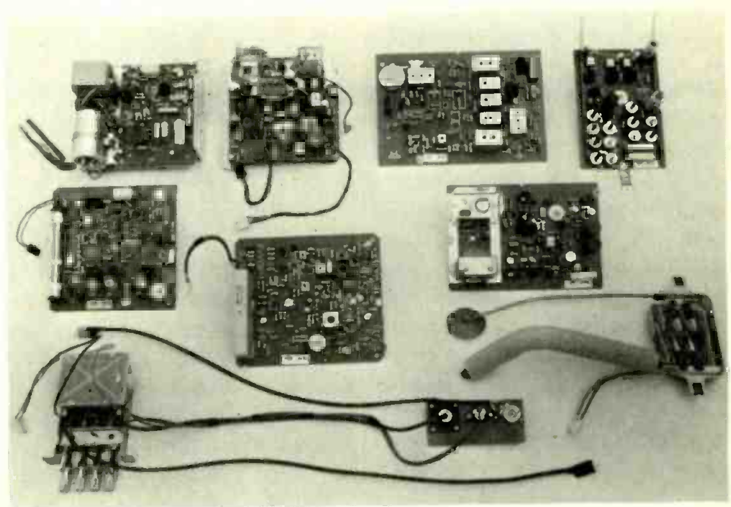
Television

From 15th November the B.B.C. and I.T.A. will start to transmit all their television programmes (BBC-1, BBC-2 and those of the various commercial companies) on u.h.f., using the 625-line standard. Total coverage of the country by these transmissions will take two or three years. A large proportion of the programmes will be in colour, and the transmissions will be the compatible PAL signal. This, of course, is identical to the ordinary monochrome 625-line (present BBC-2) signal when no colour is being transmitted, is received and displayed as a monochrome picture on black-and-white sets, and as a colour or monochrome picture on colour sets. At the same time BBC-1 and commercial television programmes will continue to be transmitted on v.h.f. for the benefit of people with 405-line, v.h.f.-only monochrome sets and 405/625-line v.h.f./u.h.f. colour or monochrome sets—and particularly for those living in areas where it will not be possible to receive the new u.h.f. 625-line transmissions for some time.

This situation provides an immediate opportunity for the receiver manufacturers to produce and sell two new types of set —colour and monochrome, both for u.h.f.-only, single-standard (625-line) operation. Most of the set makers holding private trade shows in London at the end of August were in fact demonstrating receivers of this kind, in addition to new dual-standard v.h.f./u.h.f. types for areas where they will still be needed. It is an "opportunity" for the manufacturers because a single-standard set can be made simpler, smaller, more reliable and cheaper than a dual-standard one. This is because of the elimination of components required for v.h.f. 405-line operation, the elimination of change-over switching (often a source of trouble) and the avoidance of circuit design compromises, for example in the i.f. and video responses, that are normally necessary for dual standard operation. Prices are in fact not much lower—about 10% less than those of dual-standard sets—but it is now possible to buy a colour television set (e.g. a 19-inch table model) at a price nearer to £200 than to the £300 that was the rule last year. This reduction, plus the increase of colour broadcasting time, should provide a stimulus—much needed by the manufacturers—to the sale of colour receivers.

With the introduction of these new sets, and new types of cathode-ray tubes now becoming available, there is an almost embarrassing range of screen sizes (and shapes) for the public to choose from—19in, 20in, 22in, 23in, 24in and 25in. This arises from the fact that we are in a transitional period when established colour and monochrome tube sizes, usually with 5:4 aspect ratios, are gradually being replaced or complemented by new sizes with 4:3 aspect ratios. In monochrome the 19in and 23in established sizes are being replaced by 20in and 24in tubes, respectively, with so-called "squared-up" (more rectangular and flatter) screens. All these have 110° deflection angles, incidentally. In colour shadow-mask tubes, the established 19in type is likely to continue for some time and there is the familiar 25in tube, both with the 5:4 aspect ratio; but there is now also a 22in "squared-up" type with a 4:3 aspect ratio. These colour tubes have 90° deflection angles. Because the screen of the "squared-up" tube fits the raster of the transmitted picture more exactly it does not need a mask for framing purposes, and this enables the set makers to mount the tube with its face well out from the front surface of the cabinet ("push-through" presentation) and thereby make the cabinet less deep and more acceptable to a public, forced to live in smaller and smaller "boxes".

Technically the single-standard receivers now available fall into two classes: those that are virtually the manufacturers' earlier dual-standard sets with the v.h.f. and 405-line circuitry removed; and those that are completely new single-standard designs. In the first group, for example, are the receivers of Philips, Pye Group, KB and G.E.C. Some of these designs, without being radically new, do incorporate a number of changes. In the G.E.C. 19-inch table colour receivers (G.E.C. C2040 and Sobell C1040), for example, the mechanical layout of the hybrid circuitry has been improved to give better accessibility for servicing, there is a cut-out for overload protection in the event of line drive failure, the booster diode is now a solid-state device and therefore cooler, and the colour "beacon" indicator has been omitted. The G.E.C. monochrome single-standard sets (models 2047 and 2048) exemplify an i.f. design technique which is now



Replaceable modules constituting the circuitry of the British Radio Corporation's new single-standard colour television receiver (chassis type 3000).

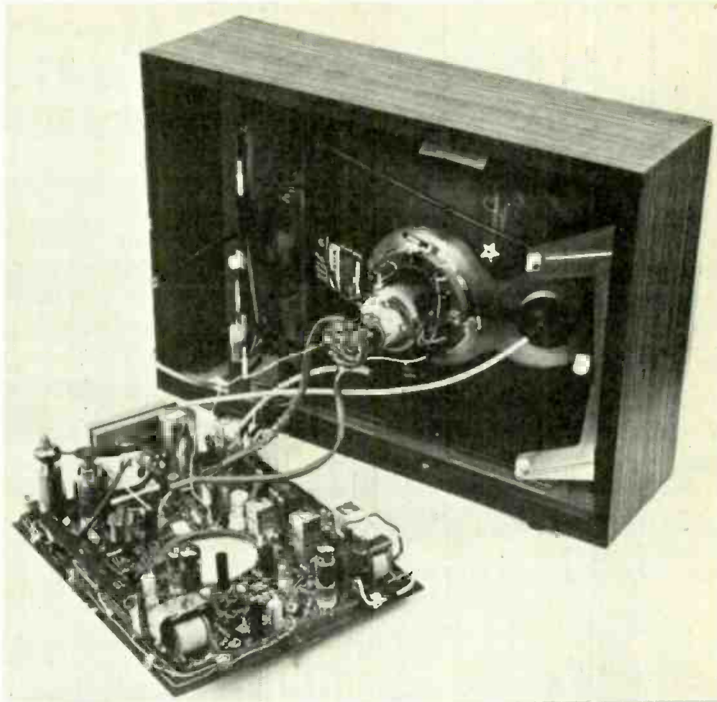
becoming common practice. To simplify alignment the first two i.f. stages are made broad-band amplifiers and the required i.f. response characteristic is provided by a separate filter unit in a screened can attached to the u.h.f. transistor tuner. Changing the tuner is apparently no problem. Also in these receivers, an integrated circuit is used for intercarrier sound i.f. amplification and f.m. detection; and the 18V d.c. supply for the transistor stages is obtained by diode rectification and a smoothing network from the 15kHz line scanning waveform (taken from a tap on the line output transformer).

Completely new designs of single-standard receivers were introduced by the British Radio Corporation and by Rank Bush Murphy. The B.R.C. colour television chassis, type 3000, used in Ferguson, HMV, Ultra and Marconiphone receivers, has transistor circuitry throughout. This is mounted on nine modules (including the u.h.f. tuner) as shown in the photograph. If a fault develops in a module the dealer can un-plug it and send it back to the manufacturers who will replace it: alternatively the dealer can keep a stock of spare modules. The vision i.f. section is a four-stage broad-band amplifier with response shaping in the input circuit; a.g.c. is applied to the first two stages (not to the tuner) and has a range of 40dB. In the video section the back porches of the colour output signals are stabilized at a fixed d.c. level and the effect of the brightness control is to set the black level only: R, G, B drive is applied to the cathodes of the cathode-ray tube. The line output stage has two power transistors connected in series with their bases driven in parallel (from transformer secondaries). This stage drives two output transformers, one producing the line scan waveform and the other an 8kV input pulse for the e.h.t. voltage tripler.

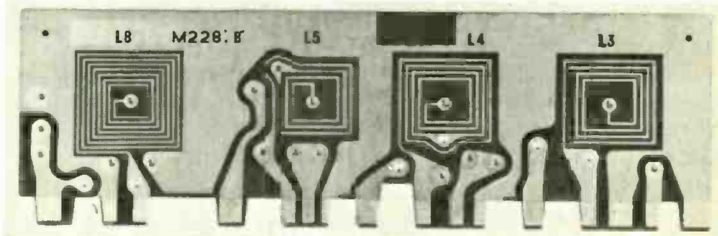
The most unusual part of the circuitry of this set, however, is the main power supply, which uses a chopper stabilizing system to provide the high-current 30V stabilized supply required by the line, frame and sound (Class B) output stages. The idea is first to obtain good supply regulation—the source impedance is said to be less than one ohm—and as a result it has been possible to dispense with e.h.t. regulation; secondly to reduce power dissipation and heat; and thirdly to reduce the physical size of the power unit. In the chopper system a 240V d.c. supply, obtained by half-wave rectification from a tapping on the set's main auto-transformer, is fed to a chopper transistor which is switched on and off repetitively at line scanning frequency. The on-period is normally about 20μs, but the mark-space ratio is continuously varied according to the load requirements by a feedback circuit which monitors the power supply output voltage. This feedback system stabilizes the output voltage and smooths out the 50Hz mains ripple. During the on-period the chopper transistor passes current through a reservoir inductor; when the transistor is turned off the feed end of the inductor is clamped to chassis potential by a diode and the magnetically stored energy flows into the load.

Another unusual feature of the set is that the shadow-mask c.r.t. is mounted with the blue gun downwards (normally it is put uppermost). The purpose of this subterfuge is to minimize the effect of pin-cushion distortion on the eye, which it does when the picture is viewed from above the screen's horizontal centre-line. No electrical correction for pin-cushion distortion is included.

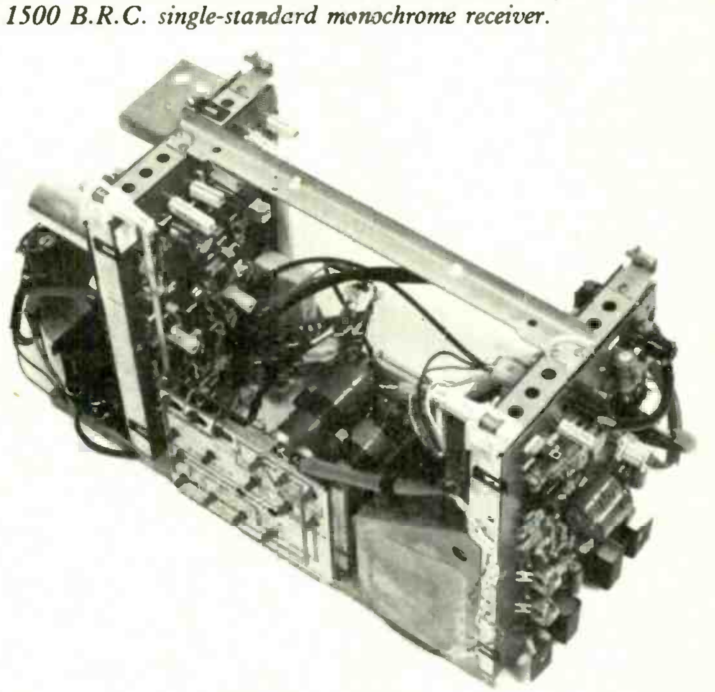
B.R.C's monochrome single-standard receiver is also a completely new design. This has hybrid circuitry, and the mechanical design is not modular. There is hardly any metalwork and almost all the electronic components are on a single printed-circuit board (measuring 13in × 10in) mounted parallel with the c.r.t. screen. The most unusual circuit design feature is that the i.f. section uses printed-circuit non-adjustable coils (see photo). This is part of a general i.f. design approach, aimed at simplifying manufacture and testing, in which circuit L/C ratios and amplifier gain (four i.f. stages) are made high, but heavy resistive damping is applied to restore the bandwidth and to swamp out the effects of manufacturing variations.



Monochrome single-standard receiver by B.R.C. with almost all electronic circuitry on a single printed-circuit board (chassis type 1500).



Printed-circuit coils used in the i.f. section of the type 1500 B.R.C. single-standard monochrome receiver.



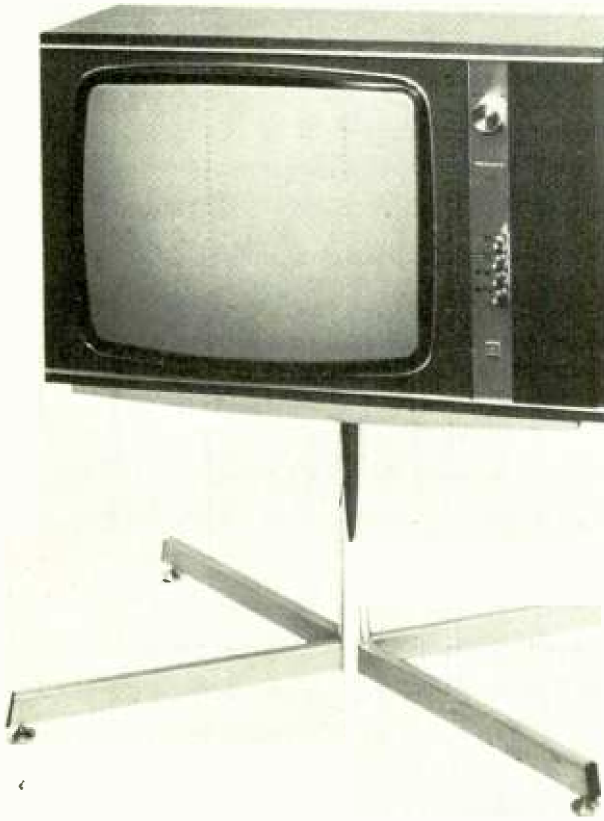
Chassis of the Rank Bush Murphy single-standard colour receivers.

The single-standard colour receiver introduced by Rank Bush Murphy has wholly transistor circuitry and, like that of B.R.C., uses plug-in printed circuit panels to facilitate servicing. (In both receivers conventional plugs and sockets are used, not p.c. edge connectors.) The circuit continues to incorporate the i.c. providing colour decoding functions that was introduced in the Bush and Murphy dual-standard sets last year*, but now has an additional i.c., in the intercarrier sound amplifier. A more significant design change is a departure from normal vision i.f. amplifier practice in that the set has been provided with a separate i.f. amplifier for the chrominance signal. This has been done in order to avoid an effect described as "cramping of the yellows". Because the yellows occurring in nature often have high values of both brightness and saturation, the transmitted signal for these yellows is a highly modulated luminance carrier with a large-amplitude chrominance signal superimposed on it. Under certain propagation conditions, such as aircraft flutter, the chrominance signal is selectively enhanced and at these moments the carrier signal can be reduced to zero amplitude. Consequently there is distortion due to clipping (the so-called "cramping"). By the use of a separate chrominance i.f. amplifier R.B.M. have been able to shape the i.f. response characteristic in such a way that the vision carrier level can be raised, relative to the chrominance subcarrier level, so that it is prevented from being reduced to zero. A further benefit of this arrangement is that automatic chrominance control can be applied at i.f. rather than at chrominance frequencies; as a result the possibility of cross-talk between the subcarrier reference and the chrominance amplifier is reduced.

*"Colour Receiver Integrated Circuit", *Wireless World*, August 1968, p. 263.

Yet another circuit development in these receivers is that the phase-locked oscillator for recovering the subcarrier reference has been dispensed with, partly because of a tendency to cause leakage of oscillation back into the chrominance section (producing a colour cast on the picture) and partly because of setting-up difficulties. Instead R.B.M. have used what they call a subcarrier regeneration circuit. It is basically a very narrow-band crystal filter which is caused to "ring" by the colour synchronizing burst of 10 cycles of subcarrier frequency. Because of the high Q of this filter it continues to "ring" with constant phase throughout the line period and so produces the required reference signal. Clearly the system is simpler than the phase locked oscillator as it is an open-loop rather than a closed-loop control system.

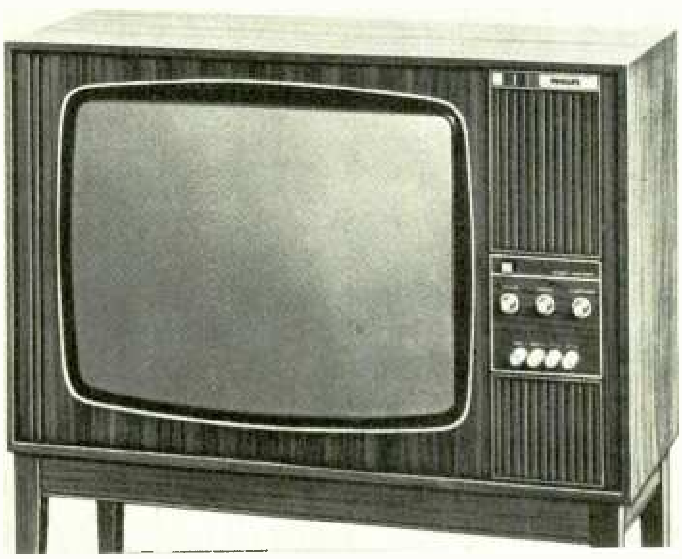
Apart from the home-produced ranges of receivers, there were also on show an imported 10-inch monochrome single-standard portable set that could be operated from re-chargeable batteries or the mains (Sanyo), and a 13-inch colour portable using a new type of picture tube with a single electron gun called a Trinitron (Sony), but the last-mentioned receiver is not available on the British market because of the PAL patent situation. The much-publicized £150 Teleton 12-inch portable colour receiver, to be made in Belgium by a company associated with Mitsubishi (Japan), is at the time of writing no more than a statement of intent. Teleton Electro (UK) Co. Ltd. were unable to show our reporter an actual set or to give satisfactory answers to his technical questions about its design.



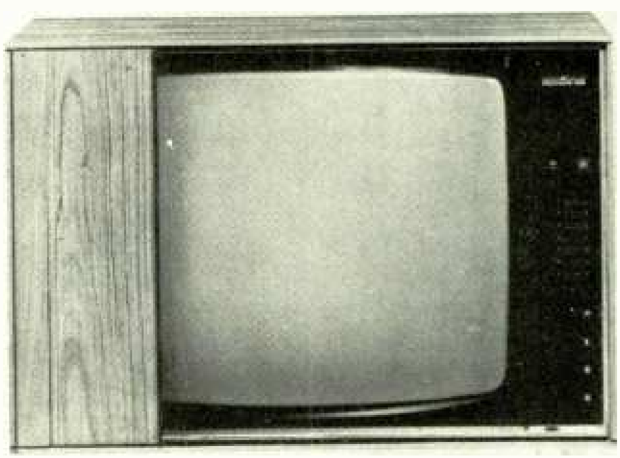
The Murphy V2015S, a 20-in single-standard monochrome table model.

Radio receivers

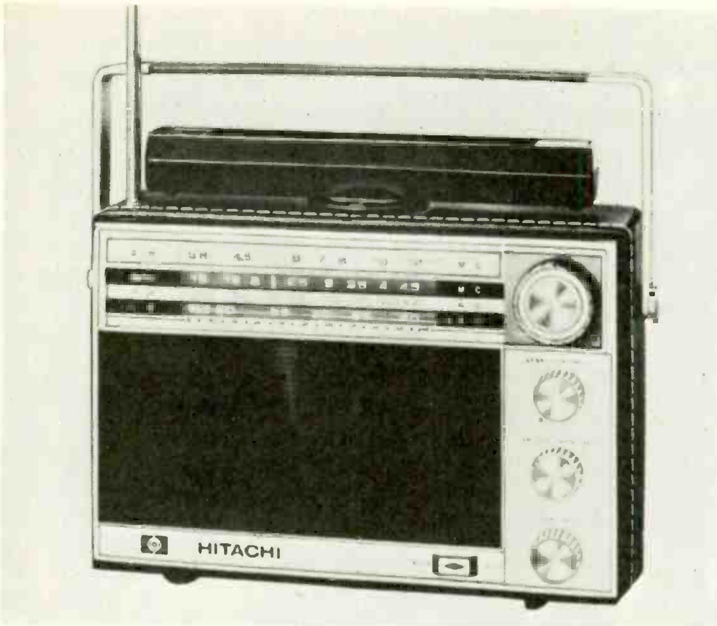
The proposed extension of the use of Band II (for more local radio stations and other B.B.C. programmes) has undoubtedly stirred manufacturers to produce a wider variety of radio receivers covering this band. A significant move is the introduction of one or two sizeable receivers for v.h.f. only which attempt to do justice to the service provided. One such receiver is the Hacker Herald (RP37) which although portable has an 8 × 5 in.



The Philips 511 single-standard colour receiver, which has a 22in screen.



Bang and Olufsen Beovision 1400KJ monochrome dual-standard receiver with 24in screen. It provides connections for external loudspeaker and tape recorder.



Hitachi portable, which covers the marine band (67-188 metres) and l.w., m.w. and s.w. bands, embodies a rotatable aerial.

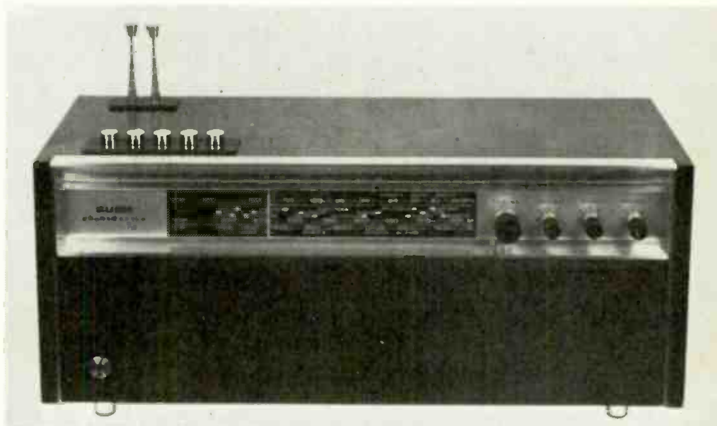
loudspeaker. The principal features of the RP37, which covers the band 87.5-101 MHz, are automatic frequency correction ensuring accurate tuning; switchable muting device to cut out noise between stations when tuning; independent bass and treble controls and a tape recording socket.

Bush have introduced an a.m./f.m. receiver with what they have called "sealed sound". The mains table receiver (model VHF 102), which covers l.w. and m.w. as well as Band II, is acoustically sealed in its cabinet—even the push-button controls are in rubber grommets. The output (10W music power from a 6 × 4 in. speaker) was certainly pleasing. (Price 39 gn.)

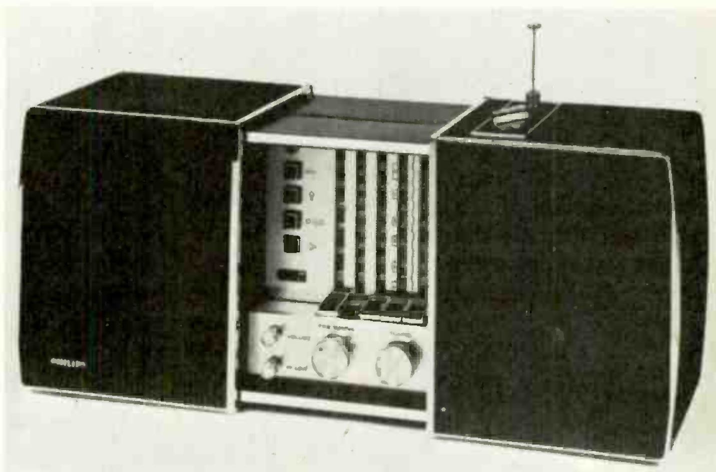
A mains/battery portable (RL693) of unusual external design is announced by Philips. Its cabinet slides apart to reveal the controls and vertical scales for the l.w., m.w., s.w. and v.h.f. bands. It has switchable a.f.c. on the v.h.f. band and its two loudspeakers (one 7 in. and a 2 in. "tweeter") are housed in the extending case (one in each half) which when closed measures approx. 17 in. wide (21 in. extended) and 9½ in. deep. (Price £78 16s.) Philips have also introduced a combined radio receiver and cassette recorder (RR290). The radio covers the l.w. and m.w. bands and the recorder can be used with the microphone provided, a pickup or another recorder. (£31 10s.)

A four-stage audio amplifier, which includes a complementary push-pull output circuit separately stabilized against voltage and temperature changes and delivering 1½W audio output on battery and 2.8W output when using the built-in mains unit, is employed in the GEC (model 2541) and Sobell (model 1541) a.m./f.m. portable receiver introduced at the group's London show. It covers the l.w.., m.w. and v.h.f. bands plus short-waves (1.6-27.3 MHz) in three overlapping bands. Switched a.f.c. is included for v.h.f.

Hacker Herald, v.h.f. portable which has a sensitivity better the 1μV for 10dB s/n ratio.



Bush VHF 102 "Sealed Sound" mains receiver



Philips RL 693 mains/battery receiver with a.f.c. on v.h.f. and a fine tuner on the short-wave band.

Audio equipment

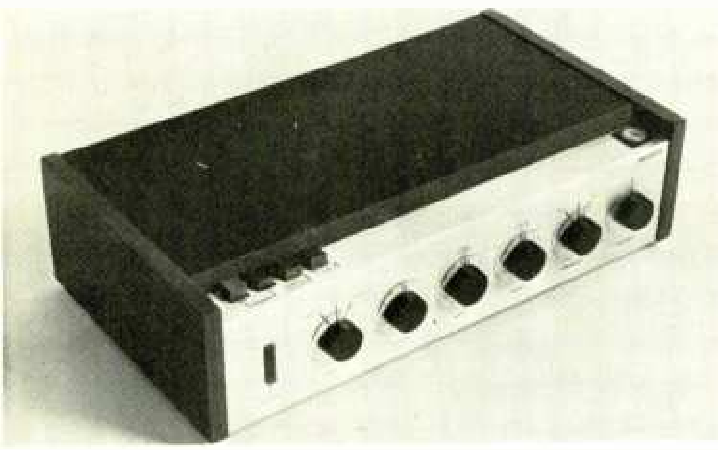
New audio components and systems displayed at the recent trade shows in London embodied no striking technical innovations. The manufacturer has to choose a style of presentation. The radiogram and the completely separate units are the extremes in this respect, but a few "audio units" combining radio tuner, record-playing deck, and amplifier have appeared. These are for use with separate speakers and are, acoustically, an improvement on the stereogram with its speakers fixed close together. Such audio units, with suitable speakers, showed various degrees of sophistication and very different prices (K.B., G.E.C., Hacker). Variously priced radiograms are still in production but several manufacturers who have until recently made only television and radio sets and radiograms, have entered the audio component market with expensive items that must be judged more by their performance than by their appearance. Amplifiers of the 3W-per-channel variety are disappearing as the wider and smoother frequency response desired is being obtained only with low efficiency speakers. The unwritten rule of "hemi-fidelity" seems to be that where the audio system is not itself seen as a piece of furniture and bought as such, it must be reduced to minimum size regardless of consequences. Everyone to his taste of course, but it does seem rather strange that having paid to hear the singer we should enjoy him gagged.

ITT KB have combined a stereo v.h.f. tuner, a stereo amplifier and a record player in a single unit to sell for £67. There are two types of matching loudspeakers available. The novel speaker design offered is a cylindrical unit with a deflector cone spreading the sound out over 360°. Conventional rectangular enclosures are also offered at the same price of £31 for each speaker enclosure.

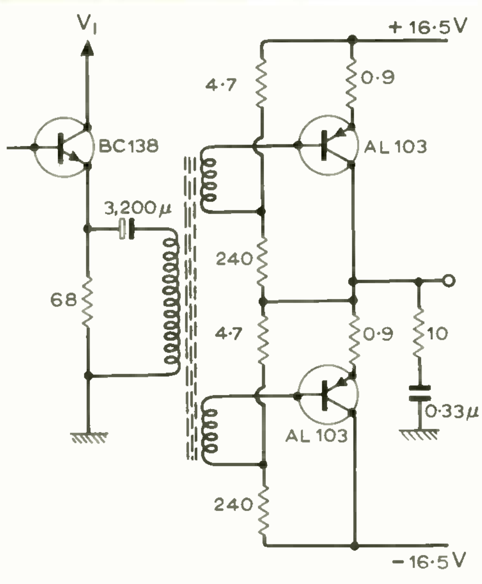
The Bush Sound System offers "high fidelity sound at radiogram prices". The range comprises a record player, tuner, amplifier, tuner/amplifier and three alternative sets of speakers. Units can be bought separately or systems built up from 94gn to just over 179gn. The stereo amplifier A746 uses silicon transistors up to the drive stages and germanium output transistors. The driver transistor is capacitively coupled to the primary of a transformer the secondary windings of which drive the bases of the output transistors in push-pull. Frequency response is 40Hz-20kHz (-3dB) and output power 11W per channel with both channels driven at 1kHz.

From Bang & Olufsen the Beomaster 3000 tuner amplifier has a stereo f.m. tuner incorporating f.e.ts, ceramic filters and i.cs. The aerial signal is fed via a tuned circuit to the r.f. stage consisting of two junction field effect transistors in a cascode arrangement. Tuning is by four capacitance diodes controlled by a 100k Ω potentiometer. There is also a bank of six miniature tuning potentiometers, each covering the 87.5-104MHz band and brought into action by push-buttons. Six stations can thus be "pre-tuned". The receiver's usable sensitivity is quoted as 2 μV.

The amplifier can deliver 30W (r.m.s. signal) per channel. The output stage is a quasi-complementary arrangement. Their new stereo tape recorder the Beocord 2400 employs hyperbolically ground tape heads giving better contact between head and tape and reducing noise.



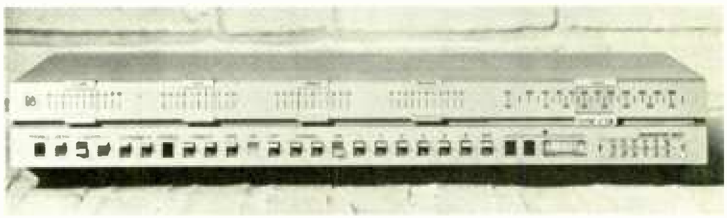
Bush stereo amplifier model A746



Driver and output stage of Bush A746 amplifier.

Two amplifiers from Grundig, the SV85 and the SV140, employ sliding potentiometers for the volume and "tone" controls. The SV140 is capable of delivering 50W per channel (sine wave drive) into 4/5 Ω loads. It has five tone controls giving lift and cut about five frequency points the first being 40Hz and the last 16kHz. This same model has meters to monitor the channel at the outputs and electronic protection of each output stage. Grundig's tuner RT100 has five wavebands—long, medium and two short wave and v.h.f.—and five auxiliary v.h.f. scales for press-button selection. This feature has been mentioned with respect to the Beomaster 3000, and the Grundig "Tunoscope", showing the correct direction to turn the tuning knob by means of two lamps, also has its counterpart in the B & O unit.

A new unit from G.E.C., model 2803, combines the stereo tuner model G989/1 with a stereo amplifier and Garrard record playing deck. The tuner employs an R.C.A. 40468 silicon m.o.s.f.e.t. in the tuned v.h.f. stage, and sensitivity is given as 2 μV for 20dB signal-to-noise ratio. The amplifier can deliver 10W (sine wave drive) from each channel simultaneously, at 1% t.h.d. A Garrard single play turntable unit (SP25 Mk II) is employed using an Acos GP104 ceramic cartridge with a diamond stylus in



The Beomaster 3000 tuner/amplifier.

Telefunken M202 tape recorder with automatic level control.

Brenell stereo tape-recorder model ST200.

the l.p. section. Two types of matching loudspeaker are available: a floor-standing system (9001), and a shelf mounting system (9002).

Rank Audio Visual demonstrated a range of Japanese produced equipment. The new brand is Rotel made by Roland Electronic Co. Ltd., of Tokyo. Eight items are available: a stereo amplifier, a stereo tuner, and six tuner amplifiers. The f.m. tuning sections all employ f.e.ts.

Telefunken showed their automatic tape recorder Magnetophon 202. The tape speed is $3\frac{3}{4}$ i.p.s. During record the machine is switched either to 'speech' or 'music' and an automatic level control operates. A plastic cover fits over the spools leaving the controls free. The recorder works in the upright position.

Hacker showed a gramophone audio/radio unit consisting of a record player, stereo audio amplifier and a radio tuner all combined in a single cabinet for shelf operation. This is available in two versions, one with an a.m./f.m. tuner marked GAR.1000 and the other with an f.m. only tuner, marked GAR.1001. The audio amplifiers operating in class A can give 10W into a 15Ω speaker. With 8 Ω speakers operation becomes class AB and the output increases to 15W maximum. The output transistors are protected against overload. The f.m. section of the tuner has a sensitivity better than 1 μV for 10dB signal to noise ratio with full limiting at 5 μV. The record player is Garrard model AP75 fitted with a Goldring 800H magnetic pickup complete with diamond stylus. The LS.1000 loudspeaker has three Goodmans units and is claimed to be the finest possible loudspeaker for its size and price (£24). The GAR.1001 with stereo decoder fitted costs £147.

Audio Fair Preview

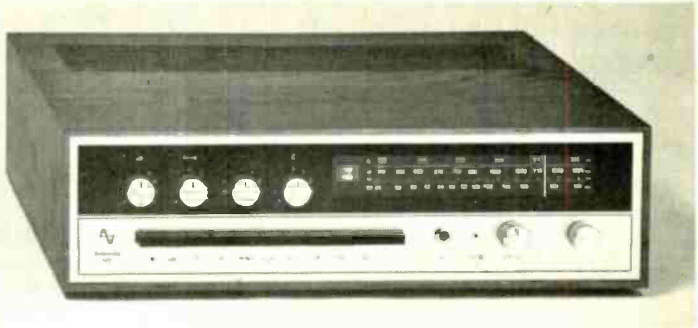
Brenell will be displaying the first of a new range of tape recorders. The ST200 (two-track stereo) and ST400 (four-track stereo) use three motor decks and have three speeds—$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. Built-in amplifiers can deliver 6W per channel. Wow and flutter is 0.08%, 0.1% and 0.12% for the three speeds and the signal-to-noise ratio is 56dB. The bias frequency is 100kHz. There are inputs for microphone and radio source and outputs for 15 Ω loudspeakers, monitoring headphones, and external amplifiers. Interesting features include a lever operated lockable pause mechanism, and tone controls which operate on the signal being recorded.

Koss model ESP-9, self- or mains-energized binaural headphones with a response range of 10 octaves, will be shown in the U.K. for the first time. Almost linear response is claimed down to below 20Hz. The push-pull electrostatic arrangement is claimed to cancel 2nd harmonic distortion. Operation is from a low-impedance source.

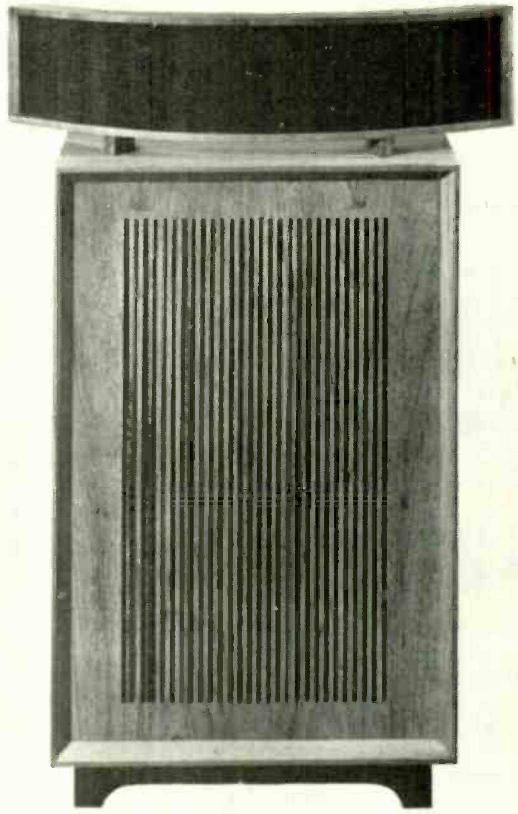
Model SL 95B, an automatic record turntable from Garrard, is the successor to model SL 95. Features include automatic play of single records, cue and pause facilities, and calibrated fine stylus force adjustment. The low-resonance wood and aluminium pickup arm incorporates a counter-balance weight and is fitted with gimbal-type pivots. A slide-in cartidge carrier is a further feature. On this model, as on several other new models to be shown, tab controls are employed.

Armstrong will be demonstrating for the first time two new stereo tuner-amplifiers, the 525 f.m. and the 526 a.m./f.m., which supersede the 425 and 426. The 525 f.m. combines the 521 amplifier and 524 f.m. tuner and costs £87 16s 9d. The 526 combines the 521 amplifier and the 523 a.m./f.m. tuner and costs £98 15s 6d. An f.m. stereo decoder, type M8, is available for both these tuner amplifiers.

Two loudspeaker systems, the 215 and 315, will be shown for the first time by E.M.I. The 315 system comprises a 15in. round bass unit with a resonance of 20Hz and capable of handling 35W; two 5in round mid-range speakers; two high-frequency units with low magnetic leakage, a switch plate and a crossover network. The 215 system comprises a 14 in by 9in bass unit capable of handling 30W; two of the 5in mid-range speakers and one of the high frequency units used in the 315 system, a switch plate and a crossover network.



Armstrong 526 tuner amplifier.



Model 70 loudspeaker from Bowers and Wilkins.

From Sinclair comes the Z30, an amplifier module using silicon epitaxial transistors throughout. This amplifier, it is claimed, is "uniquely flexible and has a lower distortion than any other amplifier on the market". The power output is 15W continuous sine wave into 8 Ω using a 35V supply. Frequency response is given as 20Hz to 300kHz ±1dB. Distortion is 0.02% (total harmonic) at full output into 8 Ω and at all lower powers. Damping factor is given as 500. Two such Z30 modules may be driven by a pre-amplifier, the Stereo 60. Two new power supplies, one stabilized and the other unstabilized, will be part of the new range. The Q14 loudspeaker has changed its appearance and will be presented as the Q16.

Bowers and Wilkins have developed a new loudspeaker, model 70, incorporating model 701 electrostatic unit covering all frequencies above 400Hz (distortion is given as 0.5% for 30W input, and dispersion over 60° arc shows variation of not more than ±1.5dB) and a low distortion bass unit and enclosure. The complete speaker will be available in both horizontal and vertical styling.

Low-cost 15-W Amplifier

A directly coupled design with a symmetrical output stage and a differential amplifier input

by Ian Hardcastle and Basil Lane*

The transistors used in this amplifier are from the Silect range produced by Texas Instruments—devices with a plastic encapsulation. The complete circuit employs only five capacitors and can be built for about £5.

Circuit operation

Fig.1 shows a diagram of the amplifier circuit. Transistors Tr_1 and Tr_2, arranged as a long-tailed pair, form the input stage. The use of this type of circuit brings a number of advantages over the more conventional arrangements. Assuming a temperature change in Tr_1 is matched by a similar temperature change in Tr_2, and that they are both the same type of transistor, then the V_{BE} of each will be changed by a similar amount. Since an error signal can only be produced when there is a difference in the two potentials, this configuration is characteristically more stable than a single transistor.

The virtue of a differential signal at the two bases producing a suitable output also results in the possibility of feeding the source signal to Tr_1 base, and a feedback signal to Tr_2 base, thus separating these two signal paths, and avoiding the dependence of a.c. closed loop gain on source impedance at the amplifier input.

*Texas Instruments Ltd.

In a similar fashion, the d.c. stability of the quiescent voltage at the output stage is ensured by applying a large d.c. feedback to Tr_2.

The potentiometer RV_1 has been included to allow for tolerances in the bias resistor chain.

The quiescent d.c. voltage at the collector of Tr_1 is about 37.5V. Since the pre-driver stage (Tr_3) requires a base potential of around 45V, a zener diode has been selected as the simplest method of giving a suitable d.c. voltage shift whilst minimizing the signal attenuation. There is, however, the slightly alarming side effect of producing a thump in the loudspeaker when the power supply is turned on. Bootstrap feedback is applied to the collector of Tr_3. The output swings in phase with the collector of Tr_3 but displaced from it by about $\frac{1}{2}V_{CC}$. This constant voltage applied across R_{13} forms a constant current sink and ensures that the minimum collector current of Tr_3 is only one third of its maximum, thus helping to stabilize stage gain.

Of considerable importance is the temperature stability of output quiescent current provided by transistor Tr_4. Here, RV_2 is used to self bias the transistor, and set the ratio of V_{CE} to V_{BE} to approximately two. As mentioned earlier, the V_{BE}

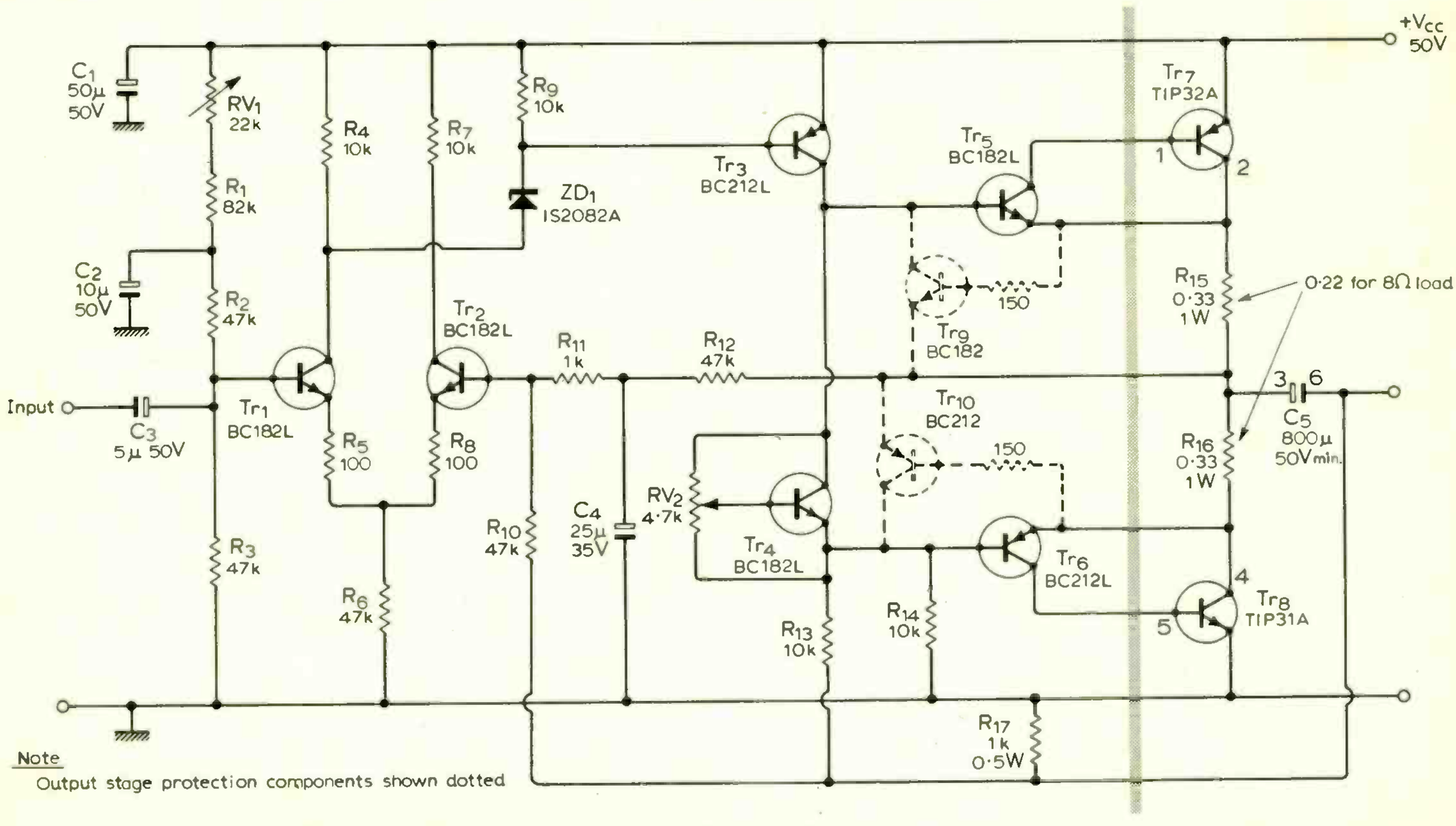


Fig.1 Amplifier circuit for driving resistive and inductive loads of 15Ω or 8Ω

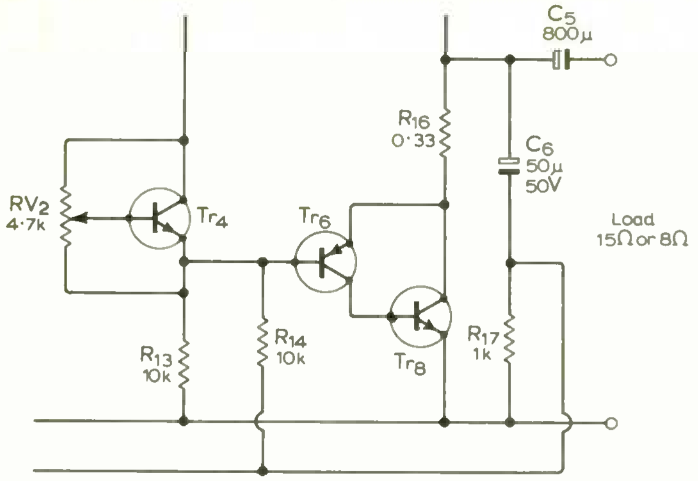


Fig.2 Modified output stage required to drive an electrostatic loudspeaker (capacitive load)

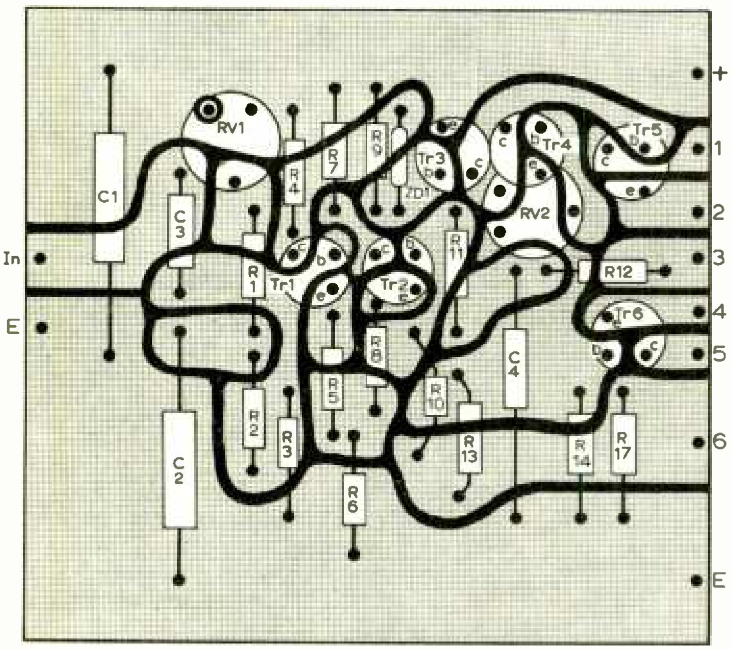


Fig.3 Printed circuit board layout (actual size) for all components except the output transistors and their emitter resistors, and the speaker series capacitor

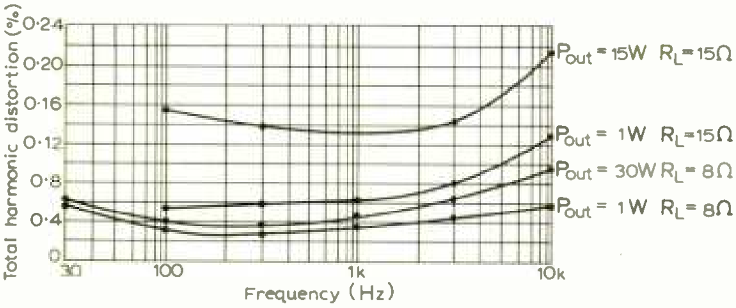


Fig.4 Curves of total harmonic distortion against frequency for different powers and loads

of a transistor is temperature dependent, and any change of V_{BE} in Tr_5 or Tr_6 would result in a rise of the output stage current. If Tr_4 is placed in thermal contact with Tr_5 or Tr_6, a similar temperature change would result in the V_{BE} of Tr_4 changing and producing approximately double the change in V_{CE}. By this action, the potentials at the bases of the drivers would be moved in a direction to compensate for the variations in both transistors.

The a.c. closed loop gain and the d.c. quiescent voltage on the collectors of the output stage are set by two feedback loops. In the case of the former the loop gain, set at 48, is determined by the divider action of R_{10} and R_{11}— one end of R_{11} being at a.c. earth via C_4. The d.c. feedback used to define the quiescent d.c. output voltage is set by the combination of the load, R_{10}, R_{11}, and R_{12}, these resistors reducing the output d.c. voltage by a half at the base of Tr_2. The base potential of Tr_1 is set to a similar value by the bias chain RV_1, R_1, R_2 and R_3. Assume a possible rise in the d.c. output voltage. This is transmitted via the feedback loop to the base of Tr_2 causing a similar rise of potential. The resulting increase of current in the tail resistor R_6, will cause a corresponding increase in the p.d. developed across it. This will cause a reduction in the difference of potential between the emitter and base of Tr_1 and cause a rise in collector voltage. The current drive to Tr_3 is reduced and this in turn reduces its collector voltage affecting the potentials at the bases of Tr_5 and Tr_6.

In this fashion compensation occurs for any shift in the d.c. level at the output.

The authors consider that a simple fuse is not an adequate form of output stage protection since the rise of collector current to destruction point can occur much before the fuse blows.

A suitable protection circuit for the amplifier is shown dotted. The collector current flowing in the output stage defines the base potentials of Tr_9 and Tr_{10}. If these voltages should rise, these transistors turn on and cut off the bases of Tr_5 and Tr_6, thus preventing a further rise in the output current. Fig.2 shows a circuit modification for use with electrostatic speakers.

Construction and setting up

Although other layouts may work perfectly well, possible faults have been reduced to a minimum in the layout of Fig.3. The power supply is fed first to the output stage and then to the amplifier panel.

The size of the heat sink will depend upon the power output which the amplifier will be expected to develop under working conditions. In a domestic situation this will be low and only a small dissipation (approx. 1 watt) would be expected in the output stage. In this case about 4 in. sq. of aluminium would suffice. A finned aluminium heat sink is more suitable for long periods at high power.

Before turning the power supply on for the first time, terminate a suitable load at the output, and set RV_2 to minimum resistance between the collector and base of Tr_4. Connect a low resistance meter (100mA scale) in series with the emitter of Tr_7 and a suitable 100mA fuse. Switch on the power supply and after the initial surge adjust the quiescent current to 20mA by means of RV_2. Turn off the supply and permanently reconnect the emitter of Tr_7 to the power supply. With the power switched on and an oscilloscope connected at the load, inject a 1kHz signal at the input at a level sufficient to cause clipping. Potentiometer RV_1 should now be adjusted to produce a symmetrical waveform. The amplifier is now set up and ready for use.

Specifications

With a 15 Ω load the maximum power output at clipping is 17.3W. For 15W into 15 Ω frequency response is 20Hz–100kHz requiring an input of 312mV (into 20k Ω). Signal-to-noise ratio is 73dB, referred to 312mV at 1kHz. Intermodulation distortion is between 0.021% and 0.073%. Total harmonic distortion for both 15 Ω and 8 Ω loads is shown in Fig. 4.

News of the Month

Broadcasting in the seventies

The recent publication "Broadcasting in the seventies" which outlined the B.B.C's proposals for the future of broadcasting during the next decade caused a good deal of criticism and discussion at all levels.

Following publication, at a meeting held on August 4th, the Prime Minister, the Postmaster General and the Chairman and Director General of the B.B.C. made the following decisions in relation to the future of broadcasting.

The B.B.C. will introduce a general local radio service. Eight stations are already in operation and a further 12 should be transmitting by September 1970. Twenty more should follow during the subsequent four years.

The combined television/radio licence fee will be increased to £6 10s from April 1st 1971 and the sound only licence will be abolished.

In the light of public criticism and parliamentary debate it was decided not to proceed with the B.B.C's proposal of restricting radio-3 to v.h.f.

Finally, because of the new licensing arrangement, the B.B.C. intend to revise their plans concerning the future of the various orchestras.

Radio and television sales fall

Despite a slight increase in monochrome television receivers delivered to the home trade during the first six months of this year the overall radio and television position continues to show a falling trend indicated towards the end of last year, according to the Economic and Statistical Division of the British Radio Equipment Manufacturers' Association.

June figures for monochrome receivers show a fall of 23,000 compared with the previous month and 13,000 less than for the same month of last year. For the period from January to June, however, the overall total of 816,000 is 11,000 higher than for the first six months of 1968.

Colour television estimates of deliveries for the six months of this year at 42,000 show a drop of 21,000 compared with the same period of last year.

Radio receivers are considerably lower for January to June this year at 356,000 compared with 531,000 for 1968. Car radios were also lower than for the same period last year at 182,000 compared with 220,000 for the first six months of last year, and radiograms at 77,000 show a drop of 28,000 overall for the same period.

"Voice with a smile" system

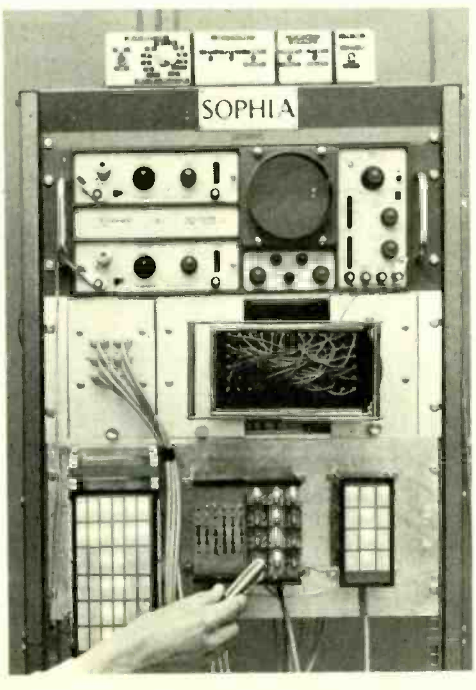
An automatic telephone call intercept system, which informs callers when they have dialled an incorrect number or a number which has not been assigned, and advises them on the correct action to take, is to be installed in 25 major American cities.

The system, which has been called the "voice with a smile" system, was designed by Bell Telephone Laboratories and is being built by the Western Electric Company. A 96-track magnetic drum store contains a number of recorded phrases, words and digits that can be assembled, under computer control, to form a sentence to fit a very large number of situations. In addition a large number of the messages have been recorded twice, once with a neutral voice inflection and once with a falling voice inflection, so that the last word in any composite message always has a falling voice inflection to make the message sound more natural.

A central exchange will have a disc memory which stores each unassigned number in the area together with its status — changed, disconnected etc.—and the number of calls made to that number for record purposes.

All this information, which is contained in a 46-bit word, is used in a central processor to address the words and phrases in the drum store to form a sentence suitable for the occasion. Information in the disc stores can be quickly updated using a typewriter so that, in addition to routine changes, a caller could automatically be given his doctor's telephone number should he have dialled the surgery when the doctor is, in fact, at home or at the hospital. The system can also be used for giving weather forecasts, the time, sports event scores etc.

Sophia, shown below, is a prototype learning machine developed by the University of Kent at Canterbury and is the forerunner of a much more powerful machine being developed and built at the University under a Science Research Council grant. Sophia learns to recognize *simple patterns sensed by 36 photocells or a light pen. The stored logic adaptive elements used by Sophia are on 2mm square silicon chips reducing the cost of the system by a factor of some thousands when compared to conventional methods.*



Service to exporters

The B.B.C. External Services broadcast in 40 languages and the output totals 100 hours in the course of every day. In addition, the B.B.C. sends many recorded programmes to overseas radio stations for local rebroadcasting. These broadcasts are a means of reaching big audiences throughout the world.

A large part of the output is of interest to exporters since it deals with developments in British Industry. The primary aim of the broadcasts is to report Britain's achievements as an industrial and trading country and thus help to create a favourable climate for exports. It is not a service of advertising; but new products are featured regularly and the names of manufacturers are given. Many enquiries result from the broadcasts and are passed on to the firms concerned.

Research has shown that programmes on industrial subjects are well received by their audiences, provided only that they are well presented and interesting in their own right. Recent market surveys in four West European countries showed that B.B.C. listeners have a stronger tendency than the general population to buy British goods.

The B.B.C. maintains close contact with the Board of Trade and the British National Export Council, and makes every effort to encourage individual firms to provide the External Services with information about their new products and developments.

To speed the flow of information and get it to the right programmes the B.B.C. has an Export Liaison Officer, to whom all information should be sent (B.B.C., Bush House, London W.C.2. Tel. 01-240 3456, Extn. 2295/2039). Exporters with an interest in a particular part of the world should telephone the Export Liaison Officer who will be glad to put them in touch with the appropriate regional expert in the External Services.

Intelsat failure review

The National Aeronautics and Space Administration has appointed a failure committee to determine why the Intelsat-3 (F-5) communications satellite did not achieve its programmed orbit after launch from Cape Kennedy, Fla. on board a Delta rocket on July 25th.

Intelsat-3 was launched by NASA on behalf of the International Telecommunications Satellite Consortium (INTELSAT). Everything appeared to be normal in the flight throughout the second stage engine burn. No signals were returned from the third stage as it was not designed to transmit telemetry.

Several hours after the third stage ignition, when the spacecraft was to have been placed into the correct transfer orbit, tracking stations in Australia, Italy and the U.S. failed to acquire the spacecraft at the proper time. Radar data later showed the satellite and third stage to be in a low orbit ranging about 175 to 3,400 miles instead of the intended orbit of 175 to 23,000 miles.

Because of the low orbit, it would not have been possible to inject the spacecraft into the intended synchronous orbit.

A huge 20-ton, electron microscope has been built by the Japanese company, Hitachi Ltd, for the British Central Electricity Generating Board's Berkeley nuclear laboratories in South-West England. The microscope is 7.1m tall and employs a 1MV accelerating potential.

Military TV system

A range of compact television equipment has been introduced by the Electro-Optical Systems Division of the Marconi Company. The new range, comprising a number of units which can be built up as required, caters for a wide variety of military applications, and camera tubes are available to cover light levels from the brightest sunlight to night-time conditions (quarter moon).

The camera equipment (type V323) consists of two basic units, the camera and the camera control unit. The camera may be fitted with either a vidicon (normal) or the SEC Vidicon (dark conditions) tube. To ensure accurate alignment of the camera tube with the centre line of the optical system, the camera tube scanning and focusing yoke is attached directly to the chosen optical system.

The camera control unit consists of two main sub-units, the power supply unit, which provides the d.c. operating potentials for the camera tube, and the control electronic equipment which consists of six plug-in boards.

The display unit is equipped with a rugged cathode-ray tube having electromagnetic deflection and electro-static focusing, producing high resolution at high brightness levels.

The display consists of two main subassemblies, the tube module and the power supply unit. These sub-units may be either combined to form a single unit or separated, by up to 12 feet, and interconnected by multi-way cable.

The V323 camera system is designed for operation in situations which are too exposed for the safety of the operator. The remote control unit enables the operator to control the system from a protected position.

Aircraft flight information display study

A computer-driven display system that will help determine the best methods of presenting a large variety of easily readable information to aircrews on civil supersonic transports has been delivered to the Boeing company by Sanders Associates, Inc., of America.

The Sanders Advanced Data Display System (ADDS/900) will be used in exploring new techniques for providing flight information not furnished by conventional aircraft instruments. The system will be installed at Boeing's supersonic transport simulator which consists of a computer and a development aircraft cabin.

The ADDS/900 system accepts process data from the main simulator computers and presents it on an 8-inch cockpit display and also on a 13-inch monitor at the simulator computer.

The displays will provide graphics, alphanumerics and special symbols simultaneously to present current aircraft situation, past events, short- and long-term predictions, instrument symbology and can serve as back-up display for the flight director system to increase this system's reliability.

The studies will help determine what information to display and what is the best format to be used. For instance, when the on-board computer determines the best takeoff and cruise flight-path for a given fuel and passenger load, this data will be displayed on the screen in graphic form. An aircraft symbol on the graph would indicate the immediate location of the airplane, a vector line would indicate its course and solid curved lines would present the desired safe flight profile.

Among the simulation studies to be investigated with the ADDS/900 are noise abatement during initial climb, vertical navigation and fuel management, electronic altitude director indication, mach-altitude climb profiles, air traffic control during descent and airport approach, instrument landing aid, and centre of gravity limits.

Wildlife tape recording contest

A Tandberg Model II battery-driven field recorder, value £175, is the major award in the Wildlife Sound Recording Competition organized for the second year by the 3M Company in association with the Wildlife Sound Recording Society.

The recorder will be awarded, together with a Grampian 24-in parabolic reflector, to the "Scotch Magnetic Tape Wildlife Sound Recordist of the Year", selected from the winner of three classes—for (1) individual species of birds, (2) mammals and insects, and (3) outdoor wildlife "atmosphere" recordings. Each of the class winners will receive a trophy given by 3M and a supply of Scotch Dynarange magnetic tape.

This year a special class for junior recordists up to 17 years of age has been formed, for which any wildlife recording is eligible. The prize for the Junior Recordist of the Year is a Bush TP60 portable cassette recorder, complete with microphone and carrying case.

Entry into the competition is free, and there is no limit on the number of recordings which may be submitted.

All recordings must be of wild and free creatures, recorded without provocation or disturbance, and made in the British Isles (including N. Ireland and Eire). Closing date for entries is November 30th, 1969. Copies of the rules and entry forms may be obtained from W. R. Bowles, 3M Company, 3M House, Wigmore Street, London W1A 1ET.

Capital equipment output up

Figures released by the Ministry of Technology show increases in output of nearly all types of electronic capital equipment for the first quarter of this year. At £125.5M the total figure is 14% higher than the same period last year. The most significant relative increase was in broadcasting equipment which jumped by 105% to £3.7M but in terms of cash the biggest contribution was made by computers with a £6.1M increase to £29.5M, a rise of 29.5%. Another large contribution was made by radio communication equipment sales which rose by 45% to £13.9M.

Home consumption was 9% higher and exports were 25% higher than the same period last year. Of the total, exports accounted for 36% as against 33%. In terms of cash the value of exports was £42M.

British audio equipment in Japan

Five well known British makers of high-fidelity equipment are combining to show their latest models to the Japanese during British Week, which opens in Tokyo on September 26th. Top quality British equipment already has a foothold in the Japanese market, despite intense local competition. The five firms—Accoustical Manufacturing, Garrards, Goodmans, SME and Tannoy—are all represented in Japan by the Shriro Trading Company who have organized the joint exhibit through their London associates, Shriro (U.K.) Ltd.

Data transmission—opinion required

The views of interested parties on future developments in data transmission to and between computers are sought by the Advisory Group on Data Transmission of the Post Office Economic Development Council.

The advisory group has been set up to review these developments and to help the Post Office assess the implications, for their investment programmes, of the rapidly growing demand for services to transmit data to and between computers.

Users of data transmission facilities (large firms, scientific users, computer bureaux etc) and the telecommunications and computer industries are not directly represented on the Group, but approaches are being made to leading organizations of this kind asking for their views on the subject being investigated by the Group. In addition the Group would welcome views from anyone with a particular interest in, and knowledge of, the subject. They should write to the Secretary of the Group. Mr. I. J. Blakey, at the National Economic Development Office, 21/41 Millbank, London, S.W.1.

Telephone for the deaf

A new telephone which will allow the deaf to "see" messages in coded flashes of light and the blind to "feel" them in the vibrations of a finger pad is being developed by Bell Telephone Laboratories in America. Called the Code-Com set, it will make calling possible for handicapped persons.

The Code-Com set is for people who are totally deaf, deaf and blind or deaf and mute.

The Code-Com set converts the transmitted signals into flashes of light and vibrations of the disc or sensor pad. Thus, a deaf or deaf and blind person can "read" simple messages by using a question and answer system, or more complex messages, by using a pre-arranged code such as Morse code. Using the sending key, a person without normal speech can send light or vibration signals to another Code-Com set or coded sound signals to a regular telephone.

The set may be used with a separate signal control unit, which is connected to the ringing circuitry of a conventional telephone. A telephone "ring" is indicated when the control unit switches a light, electric fan, or some other light-duty appliance, on or off.

Field trials of experimental models of the Code-Com set have been held in Indianapolis, New York City, and Columbus, with the assistance of handicapped persons and local telephone companies. After some practice with Morse code, users were able to attain speeds of ten words per minute.

M-O Valve celebrates golden jubilee

The M-O Valve Company was formed in October 1919 from G.E.C.-Osram which set up operations manufacturing valves for military communications as early as February 1917. Much research was done into transmitting valves and resulted, in the 20s, in valves such as the CAT14 which was used in the Daventry transmitters (later Droitwich) and the CAT15 which was employed in the B.B.C's first television transmitter at Alexandra Palace.

The CAT15 was the prototype of the VT58, a valve which was extensively used throughout the Second World War. In 1940 a magnetron was produced which became the first efficient 10cm copper block magnetron for airborne use which was used in the famous H2S equipment and the Mk. VIII enemy interception gear.

Many other firsts are attributable to the company which claims to be the largest producer of instrumentation and radar cathode-ray tubes in Europe.

Colour trade test material

Trade test programmes are now radiated six days a week on B.B.C-2, as set out below, subject to programme commitments and engineering work. During test and colour bar transmissions the following sequence of sounds will be transmitted as far as is possible: 440Hz tone—four minutes; silence—one minute; recorded music—15 minutes. At the starting time for a sound sequence if less than five minutes are available music will be transmitted only.

Monday to Friday

09.00-09.30	Colour Bars
09.30-09.55	Test Card F
09.55-10.00	Service Information Caption
10.00-10.05	Service Information
10.05-10.30	Test Card F
10.30-10.43	Colour Receiver Installation Film
10.43-10.55	Colour Film
10.55-11.00	Test Card F
11.00-11.25	'Play School' or Colour Film
11.25-11.30	Service Information Caption
11.30-11.35	Service Information
11.35-11.55	Colour Film
11.55-12.00	Colour Bars
12.00-12.05	Test Card F
12.05-12.18	Colour Receiver Installation Film
12.18-12.23	Colour Bars
12.23-12.30	Test Card F
14.00-14.10	Test Card F
14.10-14.15	Colour Bars
14.15-14.25	Test Card
14.25-14.30	Service Information Caption
14.30-14.35	Service Information
14.35-15.00	Colour Film
15.00-15.10	Test Card F
15.10-15.23	Colour Receiver Installation Film
15.23-15.30	Test Card
15.30-15.55	Colour Film
15.55-16.10	Test Card F
16.10-16.15	Colour Bars
16.15-16.30	Test Card F
16.30-16.55	Colour Film
16.55-17.10	Test Card F
17.10-17.15	Colour Bars
17.15-17.30	Test Card F
17.30-17.55	Colour Film
17.55-18.00	Colour Bars
18.00-18-15	Test Card F
18.15-18-40	Colour Film
18.40-18.55	Test Card F

Saturday

Test transmissions cease at 18.15 but follow the above sequence except between 14.00 and 14.25 when transmissions are as follows:

14.00-14.05	Test Card F
14.05-14.20	Colour Film
14.20-14.25	Test Card F

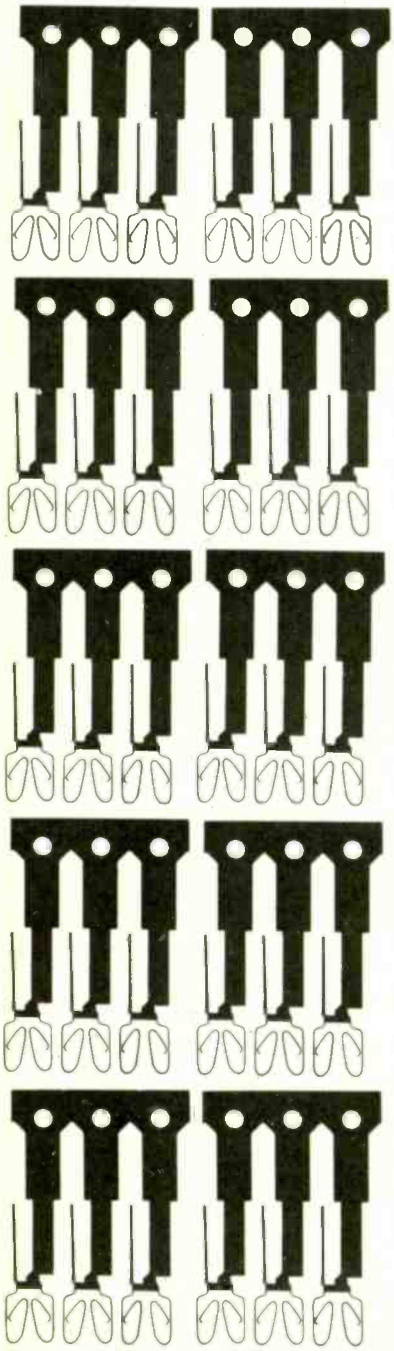
On enquiry we learn that both B.B.C-1 and I.T.A. hope to have started colour test transmissions by the end of September.

Daventry transmitter maintenance

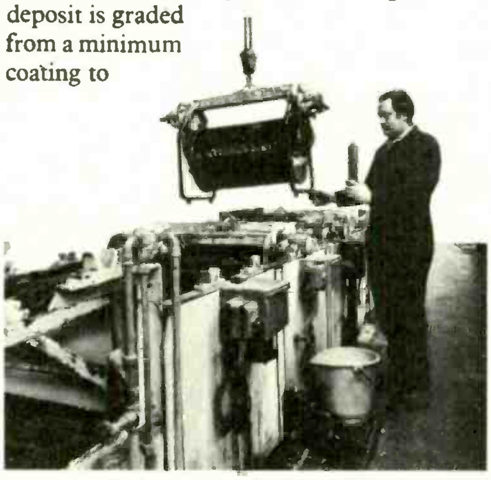
The 725ft aerial mast for the main Radio-3 medium-wave transmitter at Daventry, which operates on 464 metres (647 kHz) will be out of service for approximately two months from August 5th, for maintenance work to be carried out. A reserve aerial will be used during this period. The main effect will be a reduction in the strength of signals received from Daventry which will be most noticeable towards the limit of the area served by this station, which extends to approximately 100 miles.

Radio-3 can be received on v.h.f. throughout the whole of the area served from Daventry and on the service from the medium-wave relay stations at Bournemouth, Brighton, Fareham, Leeds, Liverpool and Preston.

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



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

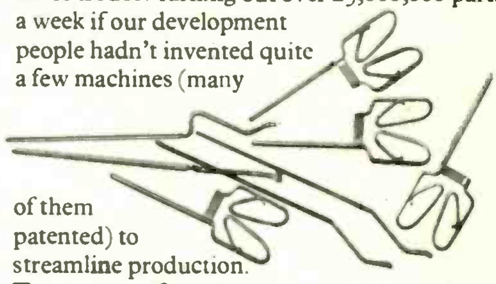


give long-life protection, up to 5 microns thick at points subject to wear.

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

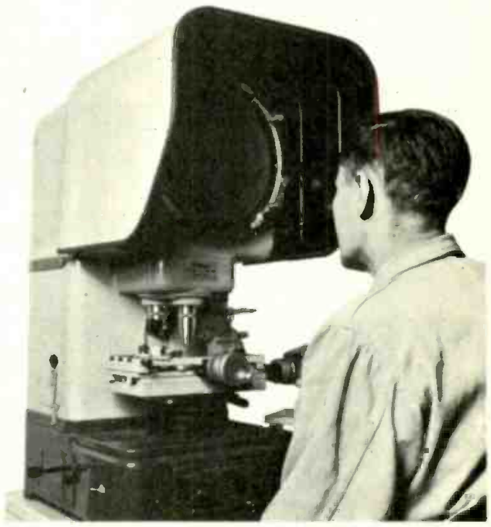
Plating is only one of the processes we use in producing over twenty five million fasteners, connectors and related components per week. We also solder, rivet and bond parts together. Or encapsulate them in compression or injection mouldings.

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



of them patented) to streamline production.

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



Carr Fastener Company Limited,
Stapleford, Nottingham
Telephone: Sandiacre 2661 G7

CARR FASTENER

WW—102 FOR FURTHER DETAILS

Active Filters

3. Properties of passive and non-feedback CR networks

by F. E. J. Girling and E. F. Good**

CR networks can give transfer functions of the same form as those given by the LCR networks discussed in Part 2, but are subject to a most important limitation—namely that the Q factor cannot exceed one-half.

The addition of purely buffer amplifiers does not overcome this limitation, but can give greater freedom in choice of component values and facilitate variable control of frequency and Q factor.

Simple 2nd-order networks

1. Low-Pass

Two simple lags in cascade clearly give a 2nd-order low-pass response. In Fig. 1 the two lags are isolated from each other by an ideal buffer (an ideal voltage amplifier of gain 1), and consequently

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+pT_2}\cdot\frac{1}{1+pT_1} \qquad (1)$$

$$= \frac{1}{1+p(T_1+T_2)+p^2T_1T_2} \qquad (2)$$

Comparison with the standard form

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+\frac{1}{q}pT+p^2T^2}$$

gives

$$T = (T_1T_2)^{\frac{1}{2}} \qquad (3)$$

and

$$\frac{1}{q} = \left(\frac{T_1}{T_2}\right)^{\frac{1}{2}} + \left(\frac{T_2}{T_1}\right)^{\frac{1}{2}} \qquad (4)$$

Now any expression of the form $(x + 1/x)$ has its minimum value when $x = 1/x$, i.e. when $x = 1$, and consequently has a minimum value of 2. Hence the minimum value of $1/q$ is 2, i.e.

$$q_{max} = \tfrac{1}{2} \qquad (5)$$

and is obtained when $T_1 = T_2$.

When the network does not contain a buffer amplifier as above, we have the familiar problem of interaction, and we cannot straightaway write down the voltage transfer ratio as a product of two simple lags. The voltage transfer ratio can, however, readily be found by standard methods of circuit analysis, and for the network shown in Fig. 2 is

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+p[C_1R+C_2(1-b)R] + p^2C_1bRC_2(1-b)R} \qquad (6)$$

It will be noticed the two resistors have been given values such that while they can have any ratio their sum is always R. Consequently if we re-express equn. (6) in terms of two time constants defined as: (1) the total resistance, i.e. the value of the two resistances in series, multiplied by C_1; (2) the value of the two resistances in parallel multiplied by C_2, i.e.

$$T_1 = C_1R \text{ and } T_2 = b(1-b)C_2R, \qquad (7), (8)$$

we obtain

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+p(T_1+T_2/b)+p^2T_1T_2} \qquad (9)$$

Whence, as before, by comparing with the standard form,

$$T = \sqrt{(T_1T_2)} \qquad (10)$$

and

$$\frac{1}{q} = \left(\frac{T_1}{T_2}\right)^{\frac{1}{2}} + \frac{1}{b}\left(\frac{T_2}{T_1}\right)^{\frac{1}{2}} \qquad (11)$$

The latter may be written

$$\frac{1}{q} = \left(\frac{1}{b}\right)^{\frac{1}{2}}\left\{\left(\frac{bT_1}{T_2}\right)^{\frac{1}{2}} + \left(\frac{T_2}{bT_1}\right)^{\frac{1}{2}}\right\}, \qquad (12)$$

i.e. in the form $1/q = y(x + 1/x)$, which has minimum value $2y$ given when $x = 1$. This shows that a maximum value of q is obtained when

$$T_1/T_2 = 1/b \qquad (13)$$

i.e. when

$$C_1/C_2 = 1 - b \qquad (14)$$

and is

$$q_{max} = \sqrt{b}/2 \qquad (15)$$

Hence since $b \ngtr 1$, the absolute maximum value of q is $\frac{1}{2}$, obtained when $(1 - b) \to 0$ and $C_2/C_1 \to \infty$. Obviously in a practical situation, because it will be necessary to avoid having $(1 - b)R$ and C_1 unacceptably small, or C_2 unacceptably large, b will be limited to a value < 1.

Two cases which often turn up in practice are shown in Fig. 3. In (a), $b = (1 - b) = \frac{1}{2}$. Hence condition for maximum q is $T_1/T_2 = 2$, i.e.

$$\left.\begin{array}{l} C_2 = 2C_1, \\ \text{and} \\ q_{max} = 1/2\sqrt{2} = 1/2{\cdot}828 \text{ approx.} \end{array}\right\} \qquad (16)$$

If $T_1/T_2 = 4$, $1/q = 2 + 2/2 = 3$; i.e. when

$$\left.\begin{array}{l} C_2 = C_1, \\ q = \frac{1}{3} \end{array}\right\} \qquad (17)$$

which is only slightly less than q_{max}, above.

In Fig. 3(b) $b = \frac{2}{3}$ and $(1 - b) = \frac{1}{3}$.

Hence for maximum q

$$\left.\begin{array}{l} C_2 = 3C_1 \\ \text{and} \\ q_{max} = 1/\sqrt{6} = 1/2{\cdot}45 \text{ approx.} \end{array}\right\} \qquad (18)$$

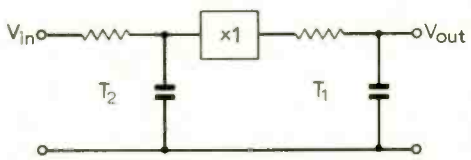


Fig. 1. 2nd-order CR network (low-pass connection) consisting of two simple lags separated by a buffer amplifier.

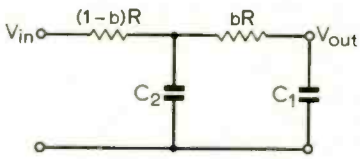


Fig. 2. Low-pass network of the two-lag type without buffer amplifier. The resistances are marked with values according with the idea of a single resistance R divided into two parts.

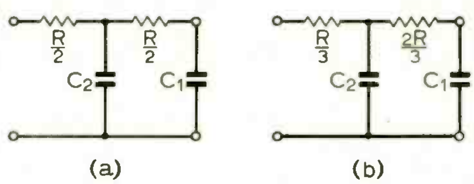


Fig. 3. Two-lag CR networks in which: (a) the two resistances are equal; (b) are in the ratio 1 : 2.

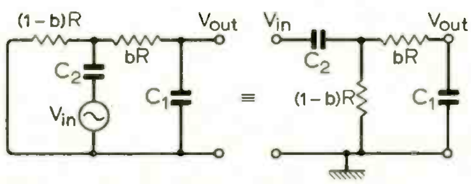


Fig. 4. Showing source (V_{in}) and output terminals connected to give band-pass response.

*Royal Radar Establishment.

2. Band-pass

With all voltage sources short-circuited, there is only one arrangement of two Cs and two Rs—a parallel connection of a C and an R with a series CR branch connected across it—if the network is not to degenerate into what is essentially one C and one R. To obtain other types of response, therefore, the voltage source must be placed in a different branch, and/or a different pair of output terminals chosen. Thus Fig. 4 shows the two-lag network of Fig. 2 reordered into a lead-lag network to give a bandpass response

$$\frac{V_{out}}{V_{in}} = \frac{\dfrac{pT_2}{b}}{1 + p\left(T_1 + \dfrac{T_2}{b}\right) + p^2T_1T_2} \quad (19)$$

A reordering which results in a lag-lead network is shown in Fig. 5. This also gives bandpass response

$$\frac{V_{out}}{V_{in}} = -\frac{pbT_1}{1 + p\left(T_1 + \frac{1}{b}T_2\right) + p^2T_1T_2} \quad (20)$$

A third reordering, Fig. 6, gives the so-called Wien-bridge network (i.e. the frequency-dependent half of a Wien bridge) and the voltage transfer ratio

$$\frac{V_{out}}{V_{in}} = \frac{p(1-b)T_1}{1 + p\left(T_1 + \frac{1}{b}T_2\right) + p^2T_1T_2} \quad (21)$$

Many will be more familiar with the last three results in the form

$$\frac{V_{out}}{V_{in}} = \frac{kp(C_1R_1 + C_1R_2 + C_2R_2)}{1 + p(C_1R_1 + C_1R_2 + C_2R_2) + p^2C_1R_1C_2R_2} \quad (22)$$

where $R_1 = bR$, $R_2 = (1-b)R$, and C_1 and C_2 are as above; or

$$\frac{V_{out}}{V_{in}} = \frac{\dfrac{k}{q}(pT)}{1 + \dfrac{1}{q}(pT) + p^2T^2} \quad (23)$$

The frequency of maximum transmission is always given by

$$\omega_0 = 1/T = 1/\sqrt{(C_1R_1C_2R_2)}, \quad (24)$$

and k is equal to V_{out}/V_{in} at ω_0. Expressions for k for the different connections are given in Table 1. As is well known, when $C_1 = C_2$, and $R_1 = R_2$ (i.e. $b = \frac{1}{2}$) all three arrangements give the same voltage transfer ratio,

$$\frac{V_{out}}{V_{in}} = \frac{pT}{1 + 3pT + p^2T^2} \quad (25)$$

for which $k = \frac{1}{3}$, and $q = \frac{1}{3}$.

3. High-pass

As for the low-pass case, Fig. 2, there is only one arrangement of the two-C two-R network that gives 2nd-order high-pass

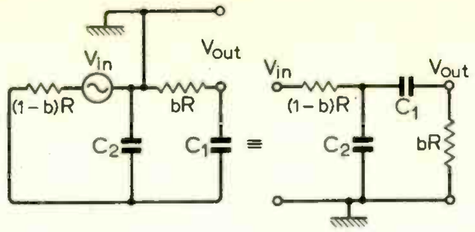


Fig. 5. Alternative connection for band-pass response.

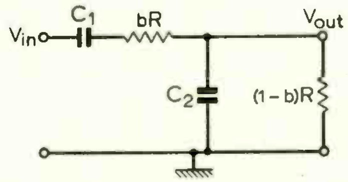


Fig. 6. Another band-pass connection—the Wien-bridge network (i.e. a Wien bridge less the ratio arms).

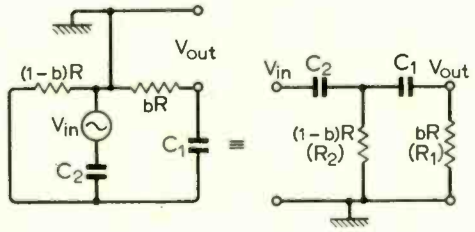


Fig. 7. Here the basic 2nd-order CR network is connected to give high-pass response.

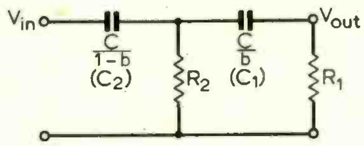


Fig. 8. The same connection as in Fig. 7 with the elements remarked to conform with the idea of a single capacitive reactance C divided into two parts.

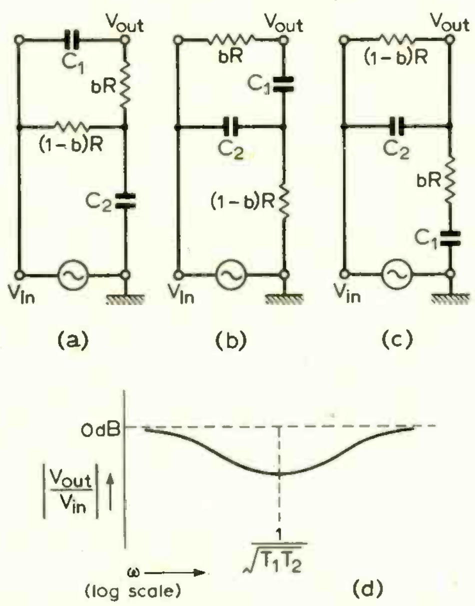


Fig. 9. Three connections of the basic 2nd-order CR network which give attenuation at middle frequencies, $T_1 = C_1R$, $T_2 = C_2R$.

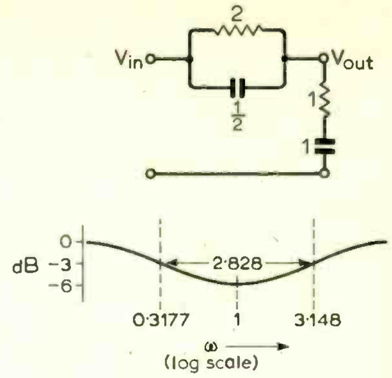


Fig. 10. Inverted Wien-bridge network showing relative component values for minimum bandwidth when maximum attenuation is 6dB.

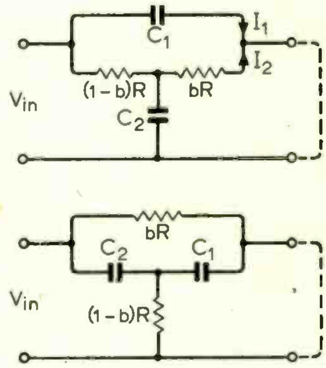


Fig. 11. Network of Figs. 9 (a) and (b) redrawn to show the two paths between input and output.

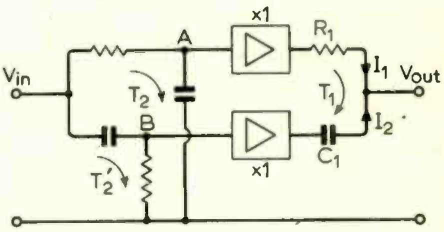


Fig. 12. Two-path network which gives a null (zero transmission) when $T_2' = T_2$.

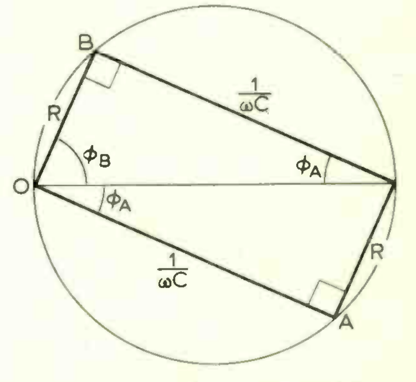


Fig. 13. Showing the 90° phase difference between the voltages at A and B when $T_2' = T_2 = CR$.

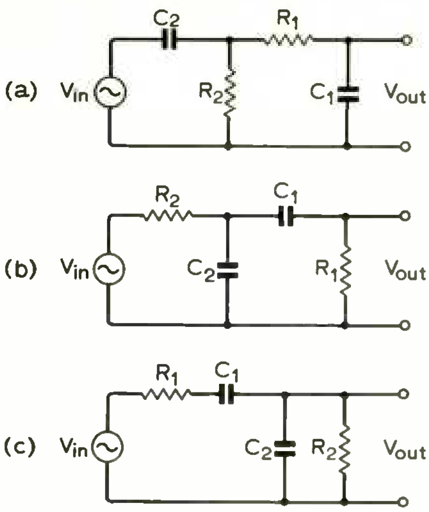


Table I

$$\frac{V_{out}}{V_{in}} = \frac{k\frac{pT}{Q}}{1+\frac{pT}{Q}+p^2T^2}$$

	k	Q	T
(a)	$\frac{C_2R_2}{C_1R_1+C_1R_2+C_2R_2}$		
(b)	$\frac{C_1R_1}{C_1R_1+C_1R_2+C_2R_2}$	$\frac{\sqrt{(C_1C_2R_1R_2)}}{C_1R_1+C_1R_2+C_2R_2}$	$\sqrt{(C_1C_2R_1R_2)}$
(c)	$\frac{C_1R_2}{C_1R_1+C_1R_2+C_2R_2}$		

response. This is shown in Fig. 7, and the voltage transfer ratio is

$$\frac{V_{out}}{V_{in}} = \frac{p^2T_1T_2}{1+p(T_1+T_2/b)+p^2T_1T_2} \quad (26)$$

or

$$= \frac{p^2C_1R_1C_2R_2}{1+p(C_1R_1+C_2R_1+C_2R_2)+p^2C_1R_1C_2R_2} \quad (27)$$

The denominator is the same as for other arrangements of the network, as it must be, since it is characteristic of the network itself. Consequently with the same component values the Q factor is the same, and the maximum value is $\frac{1}{2}$.

In this arrangement of the network the arbitrarily defined T_1 and T_2 are no longer particularly useful. Let us relabel the elements as in Fig. 8. This is consistent with the idea that the end-to-end capacitive reactance is $1/pC$, and that this is divided into two parts $(1-b')/pC$ and b'/pC. By analogy with the previous analysis we now define

$$T_1' = CR_1 \text{ and } T_2' = \frac{CR_2}{b'(1-b')}, \quad (28), (29)$$

and obtain for the voltage transfer ratio

$$\frac{V_{out}}{V_{in}} = \frac{p^2T_1'T_2'}{1+p(T_1'/b'+T_2')+p^2T_1'T_2'}, \quad (30)$$

which will be found useful in the analysis of CR notch networks.

From equn. (30) we have

$$\frac{1}{q} = \left(\frac{T_2'}{T_1'}\right)^{\frac{1}{2}} + \frac{1}{b}\left(\frac{T_1'}{T_2'}\right)^{\frac{1}{2}} \quad (31)$$

This is minimum when $T_1'/T_2' = b$, i.e. when

$$R_1/R_2 = 1/(1-b'), \quad (32)$$

and

$$q_{max} = \sqrt{b'}/2. \quad (33)$$

Although expressed in terms of a different parameter, these results must be the same as those obtained before, equns. (14) and (15). So, the absolute maximum of q is $\frac{1}{2}$, obtained when $b' \to 1$, i.e. when the second mesh (C_1, R_1) does not load the first mesh (C_2, R_2) and $C_1R_1 = C_2R_2$.

4. Imperfect notch (or dip in the middle)

If we take any of the three CR band-pass networks and take for the output the voltage that was the difference between the input and the output, we obtain the three rearrangements shown in Fig. 9 and an amplitude response with a minimum at the frequency where formerly there was a maximum. For Fig. 9(a) we obtain by using equn. (19)

$$V_{out} = V_{in}\left(1 - \frac{pT_2/b}{1+p(T_1+T_2/b)+p^2T_1T_2}\right)$$

$$= V_{in}\cdot\frac{1+pT_1+p^2T_1T_2}{1+p(T_1+T_2/b)+p^2T_1T_2} \quad (34)$$

from which it can be seen that at the centre frequency, $\omega = 1/\sqrt{(T_1T_2)}$, the voltage transfer ratio is equal to $T_1/(T_1+T_2/b)$. Thus the depth of the notch or depression depends on the two independent parameters T_1/T_2 and b, and there is not a single family of curves but an infinite number of families.

A limiting case is $b = 1$, i.e. when the impedance of the top two elements is infinitely greater than that of the bottom two. Then, if we normalise by putting $T_1 = x$ and $T_2 = 1/x$ (so that $T_1T_2 = 1$), the voltage transfer ratio becomes

$$\frac{1+px+p^2}{1+p\left(x+\frac{1}{x}\right)+p^2} \quad (35)$$

For $x = 1$, the depth of the notch is 6dB, $q = \frac{1}{2}$, the maximum possible value, and it is found that the width between -3dB points is 1·414. For $x < 1$ the depth of the notch increases as x decreases, but q also decreases and the notch broadens. Thus if the notch is deep it is also very broad.

In the arrangement just considered a CR lead is connected on top of an RC lag. In Fig. 9(b) the order of connection is reversed; and, as may be guessed, analysis shows the same relationship between width and depth of notch, though now the role of T_1 and T_2 is reversed, a deep notch being obtained for large T_1/T_2.

In Fig. 9(c) we meet a different situation. Here for $b \to 1$, for which $q \to \frac{1}{2}$, there is no attenuation at any frequency. To produce a useful dip or notch b must be considerably less than 1. Consequently q must be considerably less than $\frac{1}{2}$, since $q_{max} = \sqrt{b}/2$. It appears, therefore, that this connection is less efficient than the other two (see Fig. 10).

The redrawings of Fig. 11 reveal more clearly the (a) and (b) connections of Fig. 9 as two path networks which can feed into a virtual short circuit two currents I_1 and I_2 which in the limit [$\omega \to 0$ for (a); $\omega \to \infty$ for (b)] have a phase difference of 180°. For zero output at a finite frequency I_1 and I_2 must show 180° phase difference (and equal magnitude) at that frequency. To obtain this whilst keeping the network CR and passive, a third C and a third R must be added.

The balanced parallel-T network

1. Symmetrical notch

The right-hand side of equn. (38) in Part 2 (September issue) may be looked at as an identity: notch response is the addition of low-pass and high-pass response. From this notion is derived Fig. 12. The two unity-gain buffer amplifiers isolate the three time constants, and so

$$\frac{V_{out}}{V_{in}} = \frac{1}{(1+pT_2)(1+pT_1)} + \frac{p^2T_2'T_1}{(1+pT_2')(1+pT_1)} \quad (36)$$

For this to be identically equal to a function of the form required it is necessary for

$$T_2' = T_2 \quad (37)$$

so that

$$\frac{V_{out}}{V_{in}} = \frac{1+p^2T_1T_2}{1+p(T_1+T_2)+p^2T_1T_2} \quad (38)$$

This is, therefore, a straightforward method of obtaining a notch going down to zero. The Q-factor cannot, of course, be greater than $\frac{1}{2}$.

The physical reality behind the condition for a zero, equn. (37), is that when $T_2' = T_2$ the phase difference between the voltages at points A and B is at all frequencies 90° (Fig. 13). The two output currents into a virtual short circuit then have 180° phase difference, since the current through R_1 will be in phase with the voltage at A, while the current through C_1 will be 90° leading on the voltage at B. Hence, when I_1 and I_2 are equal in magnitude, $I_1 + I_2 = 0$, and so the output voltage is zero even after the short circuit is removed. It is interesting to notice that equn. (37) is independent of T_1. Consequently the notch can be moved along the frequency scale by varying T_1 only, the frequency of the null or zero being given by $\omega_0 = 1/\sqrt{(T_1T_2)}$.

A zero can still be obtained when the upper buffer amplifier is removed (Fig. 14), the necessary equal-time-constant condition with short-circuited output being

$$T_2' = T_2 = b(1 - b)C_2R \qquad (39)$$

We know also, from equn. (9), that the upper path makes a contribution to the output voltage

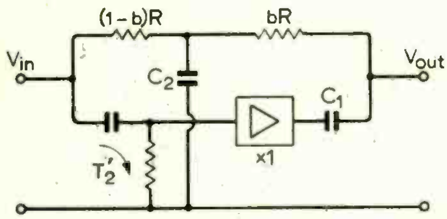


Fig. 14. For a null $T_2' = T_2 = b(1 - b) C_2R$.

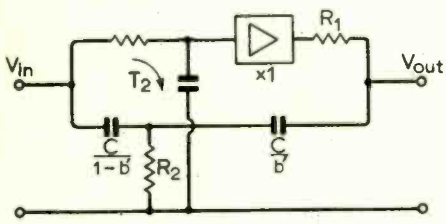


Fig. 15. For a null $T_2' = b'(1 - b') R_2 = T_2$. Then, if $T_1 = CR_1$ $\omega_\infty = 1/\sqrt{(T_1T_2)}$.

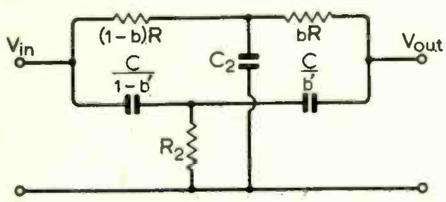


Fig. 16. For a null $T_2' = \dfrac{CT_2}{b'(1 - b')} = T_2 = b(b - 1)C_2R$. Then $\omega_\infty = \omega_0 = 1/\sqrt{(T_1T_2)}$, where $T_1 = CR$.

Fig. 17. The general case and three particular cases of the balanced parallel-tee network with o–c output when $b' = b = \frac{1}{2}$ (see text).

$$\frac{1}{1 + p(T_1 + T_2/b) + p^2T_1T_2} \cdot V_{in}.$$

Therefore, since the complete voltage transfer ratio is of the form

$$\frac{1 + p^2T^2}{1 + \dfrac{1}{q}pT + p^2T^2},$$

it must be

$$\frac{V_{out}}{V_{in}} = \frac{1 + p^2T_1T_2}{1 + p(T_1 + T_2/b) + p^2T_1T_2}. \qquad (40)$$

As before, the condition for a zero, equn. (39), is independent of T_1, and consequently single-element control of the frequency of the zero is possible by varying C_1 (R_1 is not now available as an independent element).

Similarly, by using equn. (30), the voltage transfer ratio for Fig. 15 can be found to be

$$\frac{V_{out}}{V_{in}} = \frac{1 + p^2T_1T_2}{1 + p(T_1/b' + T_2) + p^2T_1T_2}, \qquad (41)$$

where $T_1 = CR_1$, provided the condition for the existence of a null is met,

$$T_2' = \frac{CR_2}{b'(1 - b')} = T_2 \qquad (42)$$

Single-element control of the frequency of the null is possible by varying R_1.

Removing both buffer amplifiers leads to the familiar parallel-tee network, Fig. 16. The necessary condition that must be satisfied if there is to be a null is, as before, $T_2' = T_2$, where T_2 is defined by equn. (8) and T_2' by equn. (29), i.e.

$$T_2' = CR_2/b'(1 - b') = T_2 = b(1 - b)C_2R \qquad (43)$$

Then

$$\frac{V_{out}}{V_{in}} = \frac{1 + p^2T_1T_2}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2}, \qquad (44)$$

as can be found by straightforward analysis. Here $T_1 = CR$.

The frequency of the null is found by equating the numerator of the frequency-response function to zero, $1 - \omega^2T_1T_2 = 0$, which gives $\omega_\infty = 1/\sqrt{(T_1T_2)}$; and it can be seen from the denominator that this is also the undamped natural frequency of the network, ω_0. Hence

$$\omega_\infty = \omega_0 = 1/T = 1/\sqrt{(T_1T_2)}, \qquad (45)$$

and

$$\frac{1}{q} = \frac{T_1/b' + T_2/b}{\sqrt{T_1T_2}} = \frac{1}{b'}\left(\frac{T_1}{T_2}\right)^{\frac{1}{2}} + \frac{1}{b}\left(\frac{T_2}{T_1}\right)^{\frac{1}{2}} = \frac{1}{(b'\,b)^{\frac{1}{2}}}\left\{\left(\frac{bT_1}{b'T_2}\right)^{\frac{1}{2}} + \left(\frac{b'T_2}{bT_1}\right)^{\frac{1}{2}}\right\}. \qquad (46)$$

So

$$q_{max} = \tfrac{1}{2}(b'b)^{\frac{1}{2}}, \qquad (47)$$

obtained when

$$\frac{bT_1}{b'T_2} = 1. \qquad (48)$$

By substitution from equns. (43) it is found that

$$\frac{bCR}{b'} = T_2 = b(1 - b)C_2R = T_2' = \frac{CR_2}{b'(1 - b')}$$

Hence if C, R, b, b', are given, the simultaneous conditions for a null and maximum q are

$$\left.\begin{aligned} C_2 &= \frac{C}{b'(1 - b)} \\ \text{and} \quad R_2 &= b(1 - b')R \end{aligned}\right\} \qquad (49), (50)$$

From equns. (45) and (48)

$$\omega_\infty = \omega_0 = \left(\frac{b'}{b}\right)^{\frac{1}{2}} \cdot \frac{1}{CR} \qquad (51)$$

In practice it is often convenient to make $b = b' = \frac{1}{2}$. The condition for a zero, equn. (43), then becomes

$$4CR_2 = \frac{C_2R}{4} \qquad (52)$$

which is met if $R_2 = xR/4$ and $C_2 = 4xC$ (Fig. 17). Then $T_1 = CR$ and $T_2 = xCR$. Consequently

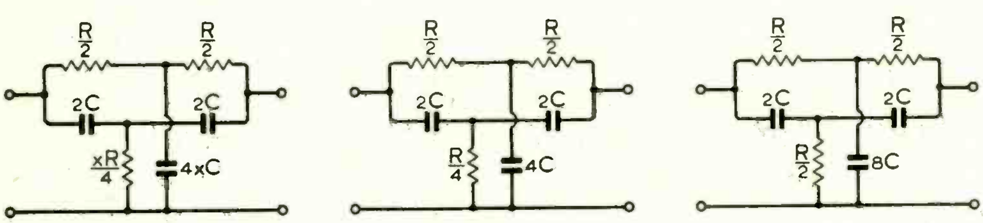
$$\omega_0 = 1/(T_1T_2)^{\frac{1}{2}} = 1/x^{\frac{1}{2}}CR, \qquad (53)$$

and

$$q = \frac{1}{2\left(x^{\frac{1}{2}} + \dfrac{1}{x^{\frac{1}{2}}}\right)} \qquad (54)$$

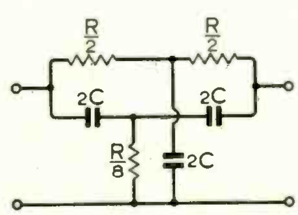
Hence for the popular set of relative values shown in Fig. 17(b), for which $x = 1$, $\omega_0 = 1/CR$, $q = \frac{1}{4}$. Also shown are the results for (c) $x = 2$, three equal resistors; and (d) $x = \frac{1}{2}$, three equal capacitors.

For all these cases the notch is wide: e.g. for (b), if $\omega_0 = 1$, the −3dB frequencies are 0·2361 and 4·2361, i.e. there is considerable attenuation over more than four octaves. For this case, if $\omega_0 = 1/CR = 1/T$,



(a) (b) (c)

	x	$\omega_\infty (= \omega_0)$	1/q
(a)	x	$1/\sqrt{x}.CR$	$2(x^{\frac{1}{2}} + x^{-\frac{1}{2}})$
(b)	1	1/CR	4
(c)	2	$1/\sqrt{2}.CR$	$3\sqrt{2} = 4{\cdot}242$
(d)	$\frac{1}{2}$	$\sqrt{2}/CR$	,,



(d)

the voltage transfer ratio may be written in a form easy to remember and often used,

$$\frac{V_{out}}{V_{in}} = \frac{1 + p^2T^2}{1 + 4pT + p^2T^2}. \qquad (55)$$

2. Unsymmetrical notch

Not only the network of Fig. 12 but all the parallel-tee networks so far considered directly reproduce the identity: notch response is the addition of low-pass and high-pass response—the upper path (as drawn here) contributing the fraction 1/(denominator), and the lower path p^2T^2/(denominator). It follows, therefore, that if attenuation is introduced in one or other path without otherwise altering transmission from input to output an unsymmetrical notch response is obtained corresponding to equn. (40) and Fig. 19(b), or to equn. (42) and Fig. 20(b) all in Part 2; and that in the extreme cases where no signal passes through one or other path the response becomes simple low-pass or high-pass.

Thus in Fig. 18 with $a' = 0$ and $a = 1$ the response is low-pass, equn. (44) without the second term of the numerator; while with $a = 0$ and $a' = 1$ the response is high-pass, equn. (44) without the first term of the numerator. With $a = 1$, a' variable (and < 1) low-pass asymmetrical notch response is obtained

$$\frac{V_{out}}{V_{in}} = \frac{1 + a'p^2T_1T_2}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2} \qquad (56)$$

As before (see equn. (41) in Part 2) if $a' < 1$,

$\omega_\infty > \omega_0$, since

$$\omega_\infty = 1/\sqrt{(a'T_1T_2)} = \omega_0/\sqrt{a'},$$

Fig. 19(b) Part 2. Similarly, with $a' = 1$, a variable (and < 1), high-pass asymmetrical notch response is obtained, the numerator being $a + p^2T_1T_2$ (c.p. equn. (42) in Part 2). Of course, the denominator is that of a passive CR network, and $q \not> \frac{1}{2}$ (equns. (46) and (47)). Consequently the notches are all broad, and there can be no peaking as shown in Part 2 in the figures mentioned above.

The same technique can, of course be applied to the networks of Figs. 12, 14 and 15. In these, however, it may not be necessary to add a buffer: the required effect can be obtained by varying the gain of the existing buffer amplifier. When the buffer amplifier is at the input it will usually be of the nature of an enhanced emitter follower (gain = 1 very, very nearly) fed from a potentiometer. Where, however, the attenuation is required in the low-pass path, a potential divider may be used by itself, Fig. 19, provided its output resistance is absorbed into the following resistance.

In principle a capacitive potential divider could similarly be used at the input of the high-pass path. But in practice the capacitance thrown across the input terminals of the network would probably be an unacceptable load on the signal source, leading to instability or reduced signal handling capacity in higher frequency bands.

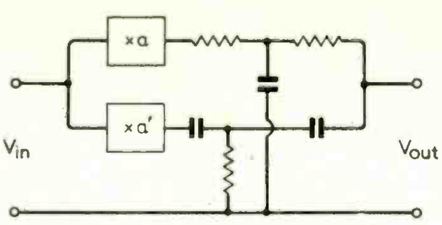


Fig. 18. Network for unsymmetrical notches: low-pass if $a > a'$; high-pass if $a' > a$.

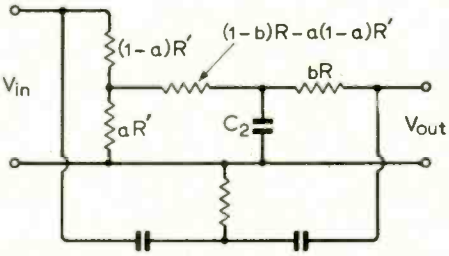


Fig. 19. High-pass unsymmetrical notch network—reduced input to l.p. path obtained by potential divider.

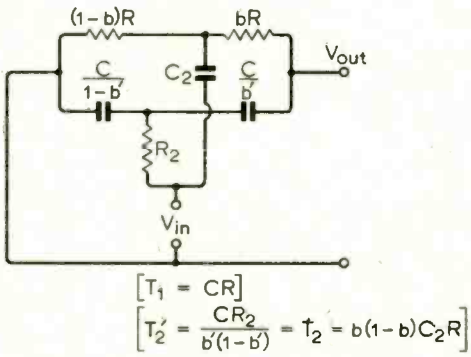


Fig. 20. Balanced parallel-tee network with output taken for "tuned-circuit" or band-pass response with $|V_{out}/V_{in}|$ (max) = 1.

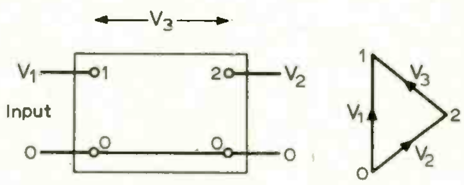


Fig. 21. Three-terminal network: If $V_2/V_1 = F_1$,

$$F_2 = \frac{V_3}{V_1} = \frac{V_1 - V_2}{V_1} = 1 - F_1.$$

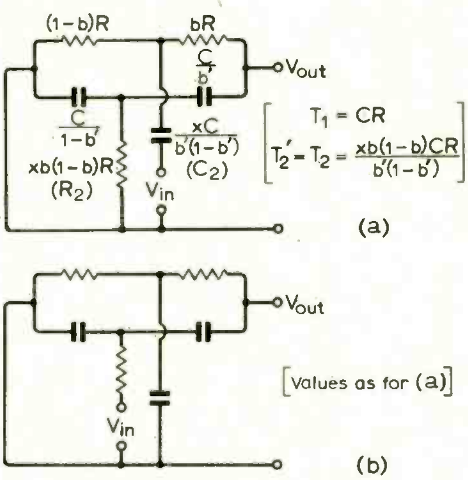


Fig. 22. Parallel-T networks connected to give "tuned-circuit" or band-pass response with peak gain < 1.

3. Some other connections for a balanced parallel-T network

Of considerable interest is the response when the input is applied to the feet of the uprights of the tees as in Fig. 20.

If a three-terminal network, Fig. 21, gives between terminals 1,0 (input) and 2,0 (output) the voltage transfer ratio V_2/V_1, then between terminals 1,0 (input) and 1,2 (output) the voltage transfer ratio

$$\frac{V_3}{V_1} = \frac{V_1 - V_2}{V_1} = 1 - \frac{V_2}{V_1}; \qquad (57)$$

and if $V_2/V_1 = 0$ at some particular frequency, at that frequency $V_3/V_1 = 1$.

This is the situation in Fig. 20:

$$V_{out}/V_{in} = 1 - F(p),$$

where $F(p)$ is the voltage transfer ratio for Fig. 16. Hence

$$\frac{V_{out}}{V_{in}} = 1 - \frac{1 + p^2T_1T_2}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2} \qquad (58)$$

$$= \frac{p(T_1/b' + T_2/b)}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2} \qquad (59)$$

Normally V_{in} and V_{out} will be reckoned with respect to the common rail; but as this is a reversal of sense for both, compared with V_1 and V_3 in Fig. 21, equn. (59) is unaffected. It is of the form of equn. (26) in Part 2, tuned-circuit or 1st-order band-pass response, with a gain at "resonance", $\omega = 1/\sqrt{(T_1T_2)}$, equal to unity for all values of q. This is a difference from the lag-lead and similar networks, Figs. 4 to 6, which always give voltage gain < 1. On the other hand there is still the restriction $q \not> \frac{1}{2}$. It should also be remembered that equn. (59) is valid only if the parallel-T network is balanced, $T_2' = T_2$. If the network is not so balanced, the maximum voltage gain may be either greater or less than one.

Connections to the parallel-T network which give voltage transfer ratios more nearly like those of lead-lag networks are shown in Fig. 22. The input voltage is fed to only one tee, and the voltage transfer ratios are:

for Fig. 22(a)

$$\frac{V_{out}}{V_{in}} = \frac{pT_2/b}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2}, \qquad (60)$$

and for Fig. 22(b)

$$\frac{V_{out}}{V_{in}} = \frac{pT_1/b'}{1 + p(T_1/b' + T_2/b) + p^2T_1T_2}. \qquad (61)$$

The sum of the two is, of course, equal to the expression given in equn. (59); and when $b' = b = \frac{1}{2}$, and $T_1 = T_2 = T$, both equns. reduce to $\dfrac{V_{out}}{V_{in}} = \dfrac{2pT}{1 + 4pT + p^2T^2}$. (62).

Correction. In Part 2, September issue, Fig. 5 (page 404) was inadvertently printed upside down. The whole diagram should be rotated 180° so that the common lines of the two networks appear at the bottom.

Wireless World Logic Display Aid

6: Complete logic diagrams of basic instrument. Some modifications and additions that increase the usefulness of the aid

*Designed by B. S. Crank**

Last month we completed the description of the basic instrument. Fig. 76 shows the interconnection diagram for all the sub-units; the reader should consult the figure number shown in the shaded areas for details of each particular sub-unit.

The time has come for the reader to decide exactly what he wants his instrument to do and this will of course depend on the use he has in mind for it. The various additions and modifications that can be made to greatly increase the use of the instrument are described this month.

Several of the modifications are compatible, that is they may be incorporated at the same time, resulting in a fairly large number of different versions of the instrument that may be built. It is impracticable to describe each version in complete detail as this would take up a great deal of space.

Each modification is given a number and a list is incorporated in this article showing which modifications are compatible and the facilities each particular combination gives. Because each reader's instrument may be different it is impracticable to give any more than guiding constructional details. However, readers who have built the instrument so far, will have no difficulty in planning a suitable layout.

The method to be adopted is to select the circuits one wishes to incorporate and redraw them to show the various interconnections and to show integrated circuit pin numbers using the information given earlier as to the available types. This is exactly what was done for all the circuits that have appeared in this series of articles so far.

1: Adding a $\overline{Z}$ input

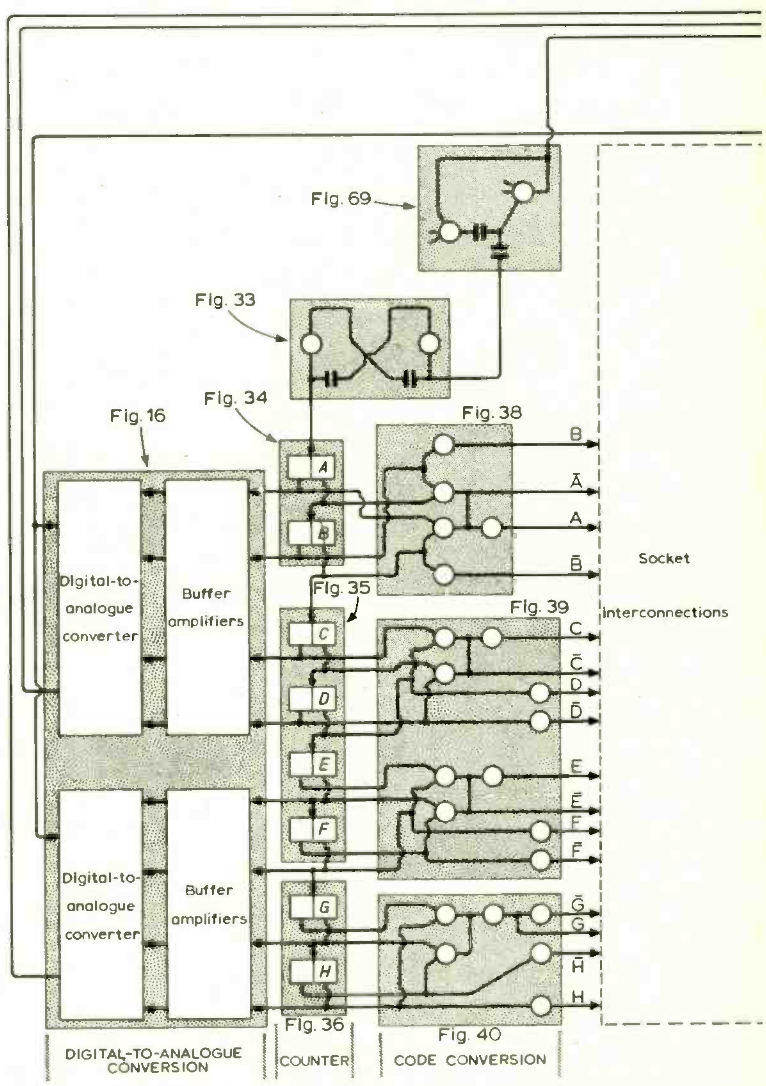
It is possible to have an instrument that will operate in the positive or negative logic convention if a $\overline{Z}$ input is provided. All that is required is to assume that the complement of the output variables is in fact the variable itself. For example, on the input side of the external logic circuit the instruments output variable A is called $\overline{A}$, and $\overline{A}$ becomes A. The output of the external logic circuit is fed to the $\overline{Z}$ input of the instrument, which is the Z input preceded by a simple inverter stage. The external logic circuit will then be operating in the negative logic convention. If desired one could have a positive logic input and a negative logic output, or vice versa.

* *Assistant editor Wireless World.*

The extra circuitry required for the $\overline{Z}$ input is shown in Fig. 77. The extra transistor merely inverts the output of the external logic to form $\overline{Z}$.

2: Switching between more than one external logic circuit

This is really so simple that it hardly warrants mention, however, it is included for the record. A second card socket is provided on the front panel and the output variables are wired to the pins in the same manner as the first



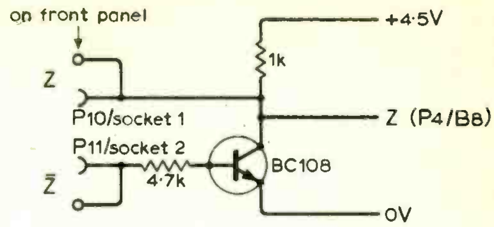
card. Pin 10 of each card socket is connected to the selector switch (Fig. 78). If this modification is incorporated with modification 1 it is necessary to provide an inverter stage for each input.

3: Comparison facility

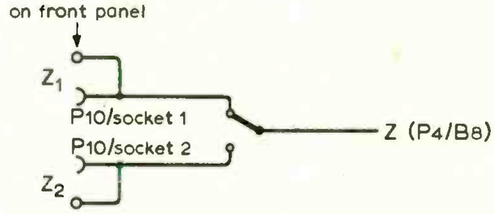
Sometimes it is helpful to be able to compare two circuits and show the difference between them; this applies equally to teaching and to industrial testing. The difference will be shown as a Venn diagram, Karnaugh map or Truth table. The modification enables two external circuits to be connected to the instrument and the display can be selected from either of these or from the difference between the two circuits.

The extra circuitry required is shown in Fig. 79. Two sets of true and complement Z input terminals are provided on the front panel which are in turn connected to pins 10 and 11 on the appropriate card socket (for external logic circuits) on the front panel. S_1 and S_2 are miniature radio push button switches (two button, double-pole change-over, available from G. W. Smiths).

Two double transistor inverters enable Z and $\overline{Z}$ inputs to be provided for each of the two external logic circuits. When S_1 is pressed S_1(a) feeds $\overline{Z}_1$ to a NAND gate which



Right Fig. 77. Simple inverter stage used to provide a $\overline{Z}$ input



Left Fig. 78. Switching between more than one external logic circuit.

will then have the output Z_1. In other words the display will show the function external circuit one performs. S_1(b) has no effect because it is in series with S_2(b) which is open.

If S_2 only is pressed the same NAND gate will have the output Z_2, via S_2(a), so that external circuit number two will be selected for display.

If both switches are pressed at the same time the two NAND gates are connected via S_1(b) and S_2(b) to perform the wired OR function. As the input to one gate is Z_1 and

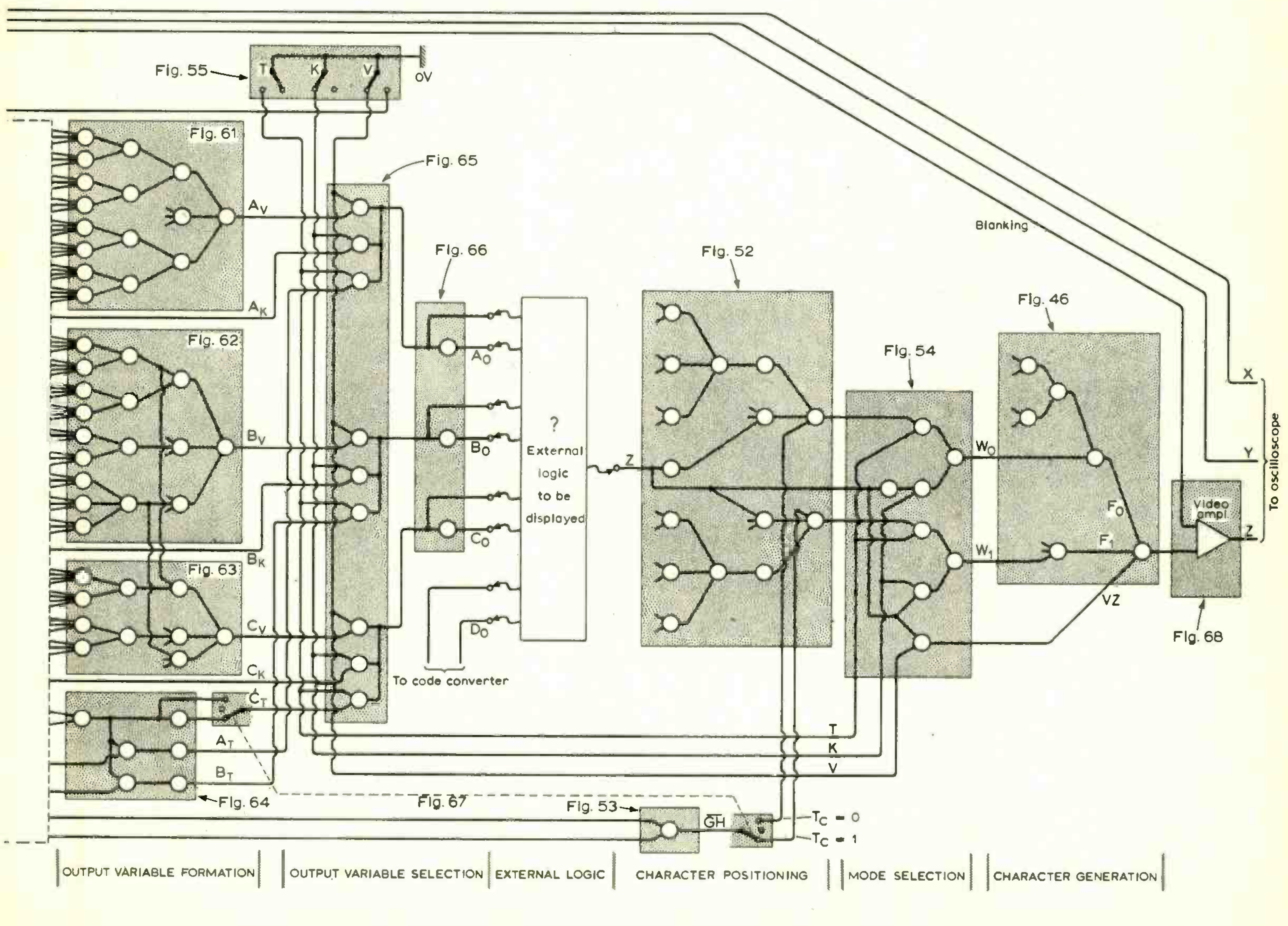


Fig. 76. The complete logic diagram for the basic instrument. Each shaded area corresponds to one of the drawings given earlier in the series. The various figure numbers appeared in the following issues: Figs. 1-14 May; Figs. 15-32 June; Figs. 33-46 July; Figs. 47-64 August; Figs. 65-75 September.

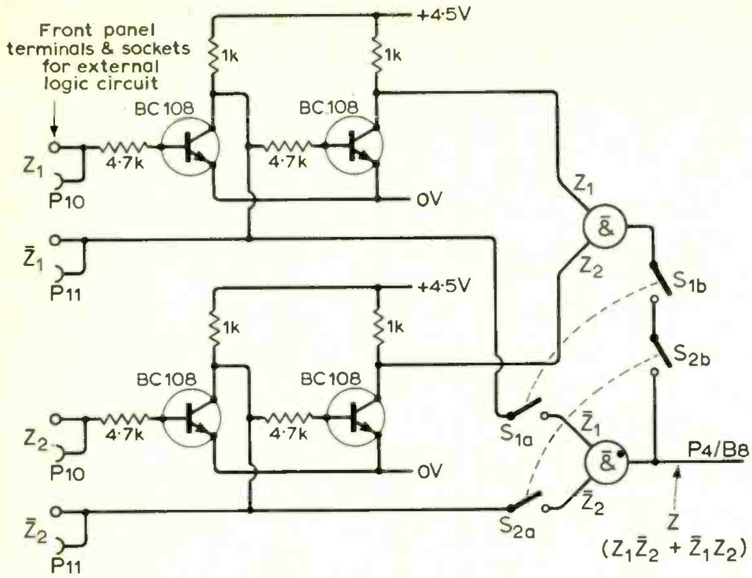


Fig. 79. Circuit that enables the instrument to display the output from one or other of two external logic circuits or to display the difference between the two circuits.

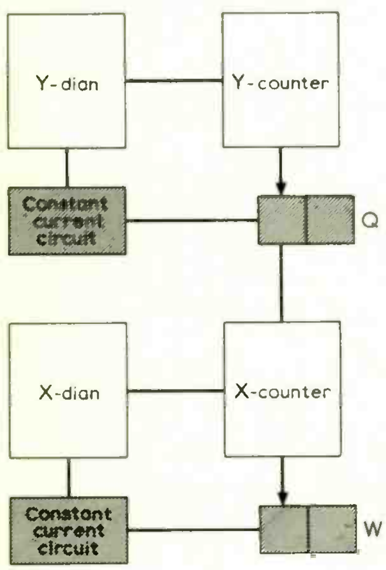


Fig. 80. Block diagram showing the additions required to produce four display areas

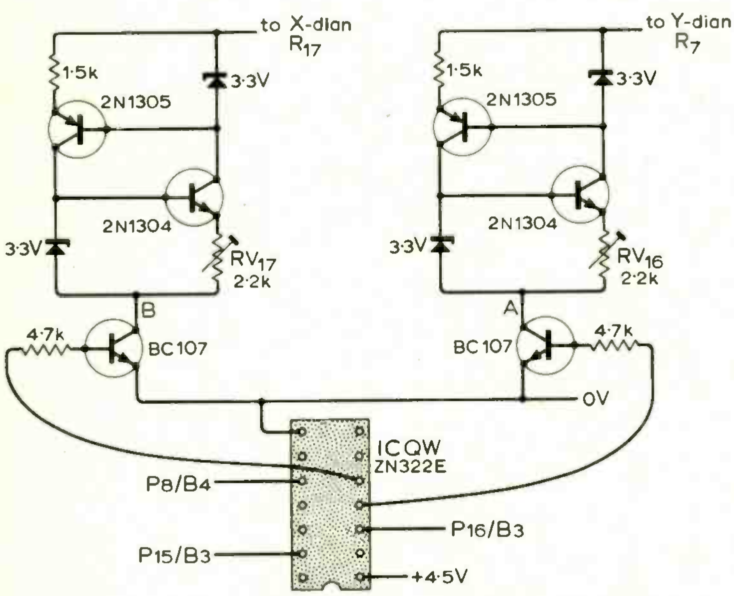


Fig. 81. Details of the circuitry needed to provide four display areas

Z_2 and the input to the other gate is $\bar{Z}_1$ and $\bar{Z}_2$ the output will be:

$$\text{output (Z)} = \bar{Z}_1Z_2 + Z_1\bar{Z}_2$$

This is the familiar exclusive OR function the Truth table for which is

Z_1	Z_2	Z
0	0	0
0	1	1
1	1	0
1	0	1

showing that only when there is a difference between Z_1 and Z_2 is there an output at Z. The only point to bear in mind when ordering the parts for this circuit is that the push button unit should be capable of having both buttons pressed at the same time. The circuit of course will work with only one external circuit when required.

4: Providing four display areas

The photographs of the oscilloscope screen showing the Display Aid in operation, published in the first article in this series (May), contain four 16 × 16 matrices in each photograph. To obtain this type of display it is necessary to modify both dians and to add some extra circuitry. It is stressed that this is not a complete modification in itself as all that it achieves is to present the same display four times on the screen. However, it is a stepping-stone to the modifications that follow.

In Fig. 80 the extra circuit blocks required are shown shaded. An extra bistable has been added to the X and the Y counter which doubles the capacity of both counters. The extra bistables, called Q and W, have their own constant current sources which are connected in parallel with the constant current sources in the dians.

A little thought will show that, because the capacity of the counters has been doubled, the matrix raster will have twice as many rows and twice as many columns as it did before. In other words the matrix will now consist of 32 rows and 32 columns giving 1024 dots in all.

Assume that at this point in time both counters hold zero. The next 15 pulses from the clock generator will set all the bistables in the original Y counter (A, B, C, D) and a vertical column of 16 dots will be traced on the screen (only 15 pulses because the zero starting position is one of the 16 possible states of the counter). The next pulse will set A, B, C and D to zero and set Q to 1 and, as the Q constant current source is connected to the Y dian, the spot will move another step down the screen face. More pulses from the clock generator will be counted up in A, B, C and D until these are full so that another vertical column of dots, below the first is traced out. The next pulse will reset all the bistables in the Y counter and advance the X counter by one, and so on.

It was shown above how each of the original bistables A, B, C, D, E, F, G and H now repeat themselves twice in tracing out one 32 × 32 matrix. And if we considered that the 32 × 32 matrix consists of four of our standard 16 × 16 matrices, it follows that any pattern that was displayed on one 16 × 16 matrix would be repeated on the other three.

The following modifications have to be carried out to the main logic unit to enable the extra bistables to be added:

(1) disconnect link from P10/IC6/B3 to P2/IC3/B3

(2) connect P10/IC6/B3 to P15/B3

(3) connect P2/IC3/B3 to P16/B3

The constant current generators have to be modified to take only about half the current they do at present.

Proceed as follows:-

(1) Change R_2 and R_{13} to 5.6kΩ

(2) " R_3 and R_{14} to 4.7kΩ

(3) " R_4 and R_{15} to 2.7kΩ

(4) " R_5 and R_{16} to 1.5kΩ

(5) Connect 1kΩ resistors in series with $RV_{2,3,4,9,10 \text{ and } 11}$

(6) Connect 470Ω resistors in series with $RV_{6 \text{ and } 13}$

The extra circuitry required is shown in Fig. 81. This is built on a piece of board which can be seen in Fig. 73 bolted to the main logic assembly. All it consists of is two bistables, two buffer amplifiers and two constant current sources.

Now it is necessary to re-adjust the dians as per the instruction given below. As before component reference numbers in brackets refer to the X dian.

(1) Remove boards 1, 2, 3 and 4 to disable the X and Y counters.

(2) Connect voltmeter to Y(X) dian output.

(3) Adjust $RV_{1(8)}$ to give 25V.

(4) Switch to Venn operation, or short circuit $R_{7(18)}$ to 0V.

(5) Short circuit junction of $RV_{2(9)}$ and $DZ_{3(13)}$ to 0V.

(6) Adjust $RV_{2(9)}$ to give 24.5V. Remove short circuit of (5).

(7) Short circuit junction of $RV_{3(10)}$ and $DZ_{5(15)}$ to 0V.

(8) Adjust $RV_{3(10)}$ to give 24V. Remove short circuit of (7).

(9) Short circuit junction of $RV_{4(11)}$ to 0V.

(10) Adjust $RV_{4(11)}$ to give 23V.

(11) Select Karnaugh or remove short circuit of (4).

(12) Adjust $RV_{5(12)}$ to give 22.5V. Remove short circuit of (9).

(13) Proceed as per (4).

(14) Short circuit junction of $RV_{6(13)}$ and $DZ_{9(19)}$ to 0V.

(15) Adjust $RV_{6(13)}$ to give 21V.

(16) Proceed as for (11).

(17) Adjust $RV_{7(14)}$ to give 20V. Remove short circuit of (14).

(18) Short circuit point A (B) of Fig. 81 to 0V.

(19) Adjust $RV_{16(17)}$ to give 19V.

(20) Remove all short circuits and replace boards removed at (1).

With the instrument switched on examine the display. If any of the 0s in the Karnaugh or Truth modes are slightly compressed it will be necessary to reduce the setting of the potentiometers in the appropriate dian. The actual current each constant current source supplies is not important as long as the ratios between the various sources are maintained. It is as well to make the final adjustments by observing the screen to produce four nicely symmetrical, and evenly spaced, 16 × 16 matrices.

5: Three-function no-switch version

This instrument will produce the Venn diagram, Karnaugh map and the Truth table simultaneously for any external circuit. The only control required is for switching the instrument on and off. The four display areas modification (4) must have been incorporated.

The two bistables Q and W provided four complete display areas and it is reasonable to assume that the four possible states of Q and W can be used to address each of the areas individually. That is, each of the states $\overline{Q}\,\overline{W}$, $Q\,\overline{W}$, $\overline{Q}\,W$ and $Q\,W$ only occur for a particular display area. Fig. 82 shows this.

In this modification display area addresses in terms of Q and W are gated out and used as the V, K and T control signals and as a substitute for the Truth table C and $\overline{C}$ switch required in the basic instrument.

This means that the instrument is automatically switched to the correct mode for a particular display area. In this modification area one displays a Truth table with C = 0, area two is the second part of the Truth table with C = 1, area three is a Venn diagram and area four is a Karnaugh map. In fact it is the same format as in photograph B published in the first of this series of articles. Other arrangements are possible if the circuitry is modified accordingly.

To achieve this display it is necessary to use the Q and W signals to provide the mode control signals (V, K and T) for the main logic unit. As areas one and two have to contain a Truth table, and area three a Venn diagram and area four a Karnaugh map the Boolean expressions will be as follows:

$T = \overline{Q}\,\overline{W} + Q\,\overline{W} = \overline{W}$ (areas 1 and 2)

$V = \overline{Q}\,W$ (area 3)

$K = Q\,W$ (area 4)

It is also necessary to provide gating to replace the switch which selects either all 0s or all 1s and C_T or $\overline{C_T}$ in the Truth table mode. This gating must provide the $C_T = 1, C_T = 0$ and T_C inputs to the main logic unit. The Boolean expressions are as follows:

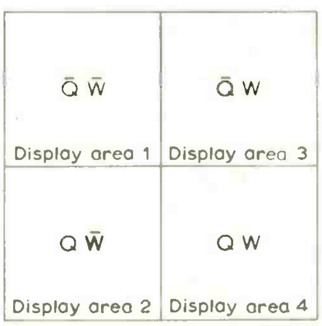


Fig. 82. The position and address of the four display areas

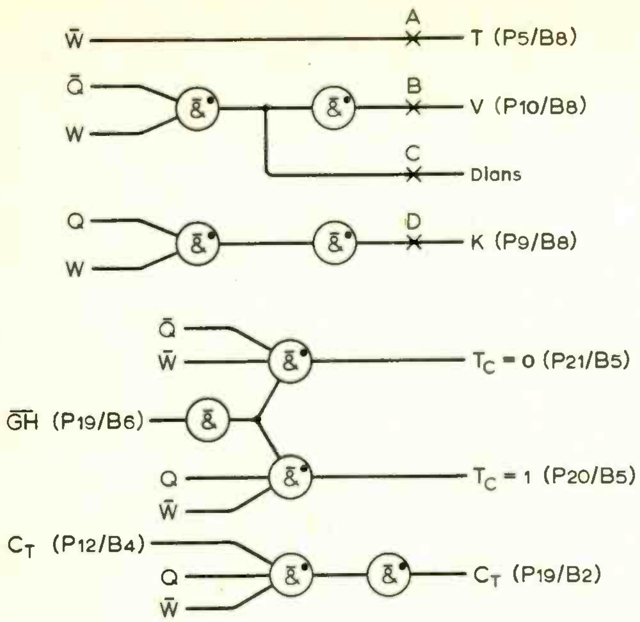


Fig. 83. Logic circuit needed to provide simultaneous display of a Venn diagram, Karnaugh map and Truth table

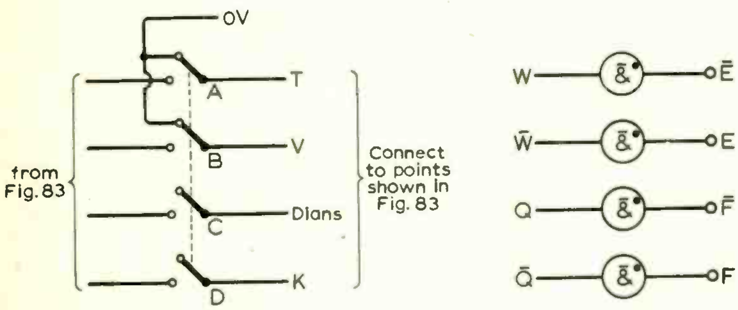


Fig. 84. Circuit which can be added to Fig. 83 to provide a six-variable Karnaugh map facility

$$(T_C = 0) = \overline{\bar{Q}\,\bar{W}\,G\,H}$$

$$(T_C = 1) = \overline{Q\,\bar{W}\,G\,H}$$

$$C_T\ (\text{modified}) = C_T\,Q\,\bar{W}$$

Note that the main logic unit requires the inverse of the $T_C = 0$ and $T_C = 1$ signals. The circuit that will perform these functions is shown in Fig. 83. In this circuit an output is provided to change the law the dians operate in for character spacing purposes.

6: Six-variable Karnaugh map version

This modification switches all four display areas to the Karnaugh mode of operation. The entire display can then be considered to be a single six-variable Karnaugh map. Extra terminals are provided on the front panel for the additional variables E and F. The particular circuit given here is for incorporation when modification 5 has been carried out.

A switch is incorporated in the output lines of Fig. 83 at the points A, B, C and D as shown in Fig. 84. In the position shown the V and T control signals are earthed so that the instrument will operate in the Karnaugh mode for all four display areas. The control signal to the two dians is open-circuited to obtain character separation. Four gates, acting as buffers provide the E and F output variables.

We end this month by presenting a table showing the various compatible modifications and the different facilities that they offer. It will be noticed that some of these modifications have not yet been mentioned; they will be the subject of next month's article.

Type	Modifications	Facilities Available
A	Nil	Basic instrument. Gives Venn diagram, Truth table or Karnaugh map for any external logic circuit.
B	1	Enables instrument to operate in the positive or negative logic convention.
C	2	Enables more than one external logic circuit to be connected for selection at will.
D	1, 2	Combines all the facilities offered by A, B and C
E	3	Enables two external circuits to be connected and enables the output of either circuit, or the difference between them, to be displayed.
F	4, 5	Has four display areas and shows, simultaneously, the Venn diagram and Karnaugh map for any external logic circuit.
G	1, 4, 5	Combines the facilities offered by B and F.
H	2, 4, 5	Combines the facilities offered by C and F.
I	3, 4, 5	Combines the facilities offered by E and F.
J	1, 2, 4, 5	Combines the facilities offered by B, C and F
K	4, 5, 6	As F with the capability of displaying a 6-variable Karnaugh map.
L	1, 4, 5, 6	Combines the facilities offered by B and K.
M	2, 4, 5, 6	Combines the facilities offered by C and K.
N	3, 4, 5, 6	Combines the facilities offered by E and K.
O	1, 2, 4, 5, 6	Combines the facilities offered by B, C and K.
P	4, 7	Enables any of the four display areas to be individually switched to Truth table, Karnaugh map or Venn diagram operation.
Q	1, 4, 7	Combines the facilities offered by B and P.
R	2, 4, 7	Combines the facilities offered by C and P.
S	3, 4, 7	Combines the facilities offered by E and P.
T	1, 2, 4, 7	Combines the facilities offered by B, C and P.
U	4, 7, 8	As per the prototype instrument. Has four display areas each capable of showing a Venn diagram, Karnaugh map or Truth table. Up to two external circuits can be individually switched to show the output from either of the two circuits or the difference between them. Will operate in the positive or negative logic convention.

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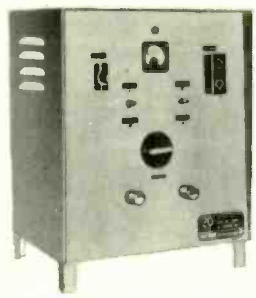

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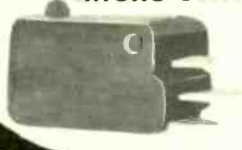

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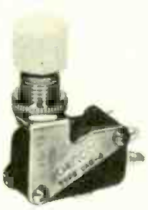

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Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

Linsley Hood class A amplifier

Recent measurements on this amplifier have indicated that the gain and power bandwidths of this design, using the component layout shown on page 152 of your April 1969 issue, are wider than indicated by the Figs. 4 and 5 of the article. The apparent fall-off in gain beyond about 100kHz was, in fact, due to shortcomings in the measurement apparatus, and measurements made with better equipment suggest that the -3dB points for voltage gain are above 1·5MHz although power output falls beyond 200kHz.

Since the output is in phase with the input, it is necessary to take care that the output leads and output capacitor are not close to the input. (A 2-inch separation will be adequate for normal lead lengths.) However, an additional point must also be noted. If a capacitive load is connected with *short* leads between the output and the earth line near the input connection, the potential developed along the earth line, due to its inductance, can inject an in-phase signal, and thereby cause instability, in the MHz region. To avoid this possibility, it is recommended that the earthy lead to the loudspeaker terminal be returned to the earth line at the same point as the emitter of Tr_1. The inclusion of a small r.f. choke (25 turns of 26–28 s.w.g. wire wound round the outside of a 10-ohm 1-watt resistor is ideal) between the output (point 'X') and C_2 will also prevent this possibility of trouble.

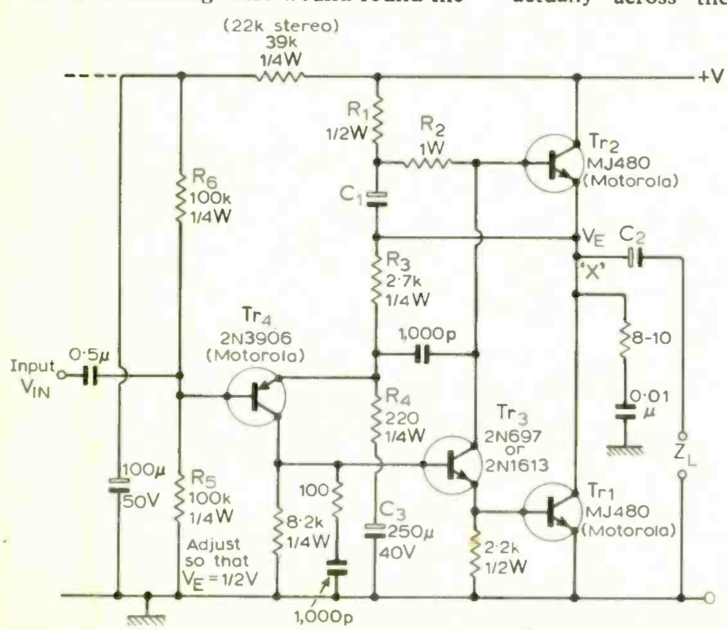
In practice, with the components and layout suggested, the inductance of the normal 12 to 18 inches (or more) of loudspeaker connecting lead prevents instability with capacitive loads, so this should be only of academic interest.

As an alternative, it is possible to reduce the r.f. response of the amplifier to give a smooth, 6 dB/octave, roll-off beyond 50kHz—which removes much of the need for care in the layout of the components, without detriment to the harmonic distortion in the audible range, and without any audible alteration to the performance—by connecting a 1,000pF capacitor between the collector of Tr_3 and the emitter of Tr_4; a 1,000 pF in series with 100 ohms between the collector of Tr_4 and earth; and a 0·01μF in series with 8 to 10 ohms between the output ('X') and earth. (It should be noted that either all of these components should be added or none at all, they are not alternatives.) If the r.f. response is reduced in this manner, the use of a series r.f. choke would be unnecessary.

A series of measurements has also been made, using the amplifier design exactly as described in the article (without r.f. chokes or other modifications), to determine the voltage waveform produced, actually across the loudspeaker, with a square wave input to the amplifier. It was found, in practice, with several different loudspeaker systems, that the output waveform was virtually identical to that obtained with an equivalent resistive load—photographs of which were reproduced in the April issue. It was, in fact, the discovery that a good square wave was reproduced up to the 1MHz limit of the generator in use which prompted a reassessment of the r.f. response of the amplifier. The absence of any overshoot or significant ringing also provides confirmation of the stability of the amplifier under practical conditions.

A correspondent has reported that this design has been up-rated successfully to 15 watts into a 15-ohm load, to give a direct power equivalent to the Williamson amplifier, using 2N3055 output transistors with a 43-volt supply (1·1 amp per channel), and rather larger heat sinks. There would seem no good reason why this could not also be done using MJ481s.

J. L. Linsley Hood,
Taunton,
Som.



Mr. Linsley Hood's amended circuit of his class A amplifier originally described in the April 1969 issue.

Who's to blame?

Having read W. R. Seymour's letter (July issue), I wonder whether his findings should not be more carefully considered before apportioning any blame to the industry concerned, lest we lose sight of the most important priorities in obtaining faithful sound reproduction.

The nominal impedance of the loudspeaker in question (i.e. at 400Hz) is 8 ohms, rising to 32 ohms at 2kHz; this is most certainly not typical of the transducer itself, even if this is a modest commercial unit. It is not clear from Mr. Seymour's letter that the curve shown represents the terminal impedance of the loudspeaker itself, but it would seem that a very poorly matched cross over circuit of some kind is employed, making the *system* quite unsuitable as a monitoring loudspeaker, regardless of efficiency or power handling capacity.

In the majority of cases, such non-uniformities are overcome by careful attention to the design of the cross over circuitry, and the acoustical system of the enclosure in the region of the velocity resonance frequency of the loudspeaker. Mr. Seymour has chosen an unfortunate example, but it would not be a difficult matter to correct the faults he complains of, which are not typical.

I see that I. G. Abelson in his letter in the August issue suggests that a smooth acoustic output from a direct radiator loudspeaker is the result of a balance occurring between the increasing electrical impedance and the increasing electro-acoustic efficiency. This is surely incorrect. The increasing reactance of the voice-coil is balanced by the decreasing motional electrical impedance, so that the total impedance is more uniform, and much more so than in this case. The acoustic output will therefore be the same at the higher frequencies under any drive conditions (constant voltage, current or power).

To suggest that a loudspeaker such as the one considered be supplied from a power amplifier with a much higher rated output than the system can accommodate is not merely paradoxical, it is absurd. If fidelity of reproduction is to be the highest priority, one would always do better to invest more in the loudspeaker, to solve the problem rather than mask it.

May I make one more point. There is constant reference in all branches of electronics to the term "r.m.s. power". R.M.S. values of voltage and current are defined as producing the same heating effect as a direct voltage or current of corresponding value. Hence a sinusoidal voltage, $V\cos\theta$ applied to a conductor produces a current, $I\cos\theta$; the instantaneous power is therefore:

$$V\cos\theta . I\cos\theta = VI\cos^2\theta = \frac{VI}{2}(1+\cos 2\theta).$$

This has an *average* value of $VI/2$, i.e. V r.m.s. $\times$ I r.m.s. Hence when we speak of "r.m.s. power" we in fact mean average power. The function $VI\cos^2\theta$ has also an r.m.s. value, but this is not the same as its average value. In fact it is $\sqrt{3/2}$. V r.m.s. $\times$ I r.m.s. Perhaps this fact is already recognized, and is turned into useful account by amplifier manufacturers when quoting the rated output of their products!

R. C. DRISCOLL
Northern Polytechnic,
London N.7.

Simplified op. amp. calculation

There are some instances where the finite voltage gain, A_{VOL}, of an integrated operational amplifier is not sufficiently high to be ignored in a calculation of closed loop gain, A_{CL}, and the "exact" expression for A_{CL} is required.

A quick method, used by the writer many years ago for valve circuits, saves the bother of remembering the formula. It is instructive and involves the minimum of algebra.

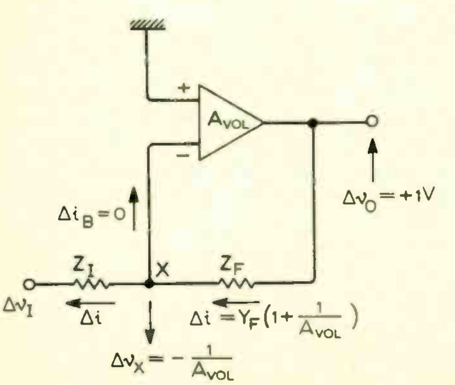
Consider the inverting amplifier of Fig. 1, in which $Y_F = (1/Z_F)$. A postulated change of +1V in output (Δv_o) produces the voltage and current changes shown on the diagram.

Clearly, $\Delta v_I = -(1/A_{VOL}) - Z_I\Delta i$

$= -(1/A_{VOL}) - (Z_I/Z_F)\{1 + (1/A_{VOL})\}$

Hence, $A_{CL} = \Delta v_o/\Delta v_I =$

$-1/[(1/A_{VOL}) + (Z_I/Z_F)\{1 + (1/A_{VOL})\}]$



Multiplying numerator and denominator by (Z_F/Z_I) gives the familiar standard expression. In a practical problem the numerical calculation of A_{CL} involves arithmetic steps without the need for algebra as such.

The same basic approach is, of course, applicable to the non-inverting configuration.

B. L. HART,
London, E.15.

F.M. tuner radiation

Mr. Newnham's f.m. tuner (June issue) looks most interesting and all credit is certainly due to an approach aimed at simplifying the alignment and constructional problems normally associated with a large number of "tweakables", in this elegant way. The only puzzle, as no reference is made to it in the text, is the way in which local oscillator radiation is avoided. The circuit reveals little in the way of reassurance.

It seems reasonable to expect about 100mV of local oscillator at the mixing point (pin 1 of i.c.1) for satisfactory conversion; let us settle for 80mV to be on the low side. Because of the low i.f. and the absence of an r.f. amplifier all the available oscillator power at this point is image-matched to the aerial, any losses being due to aerial coupling inefficiencies. The voltage on the aerial feeder would therefore be about 60mV. This level is more than 35dB above the level permitted in B.S.905.

British Standard and Post Office requirements apart, it is interesting to consider the implications of this in practice. In a typical suburban housing estate, facing houses on opposite sides of the road are spaced by, say, 25 yards. If each of two such houses has a dipole aerial in its loft we can, according to Bullington* expect some 40dB of attenuation between the aerials in band II. If both houses were to have receivers, one of this type and one of conventional design, the latter would receive 600μV from the oscillator of the former which could easily exceed the wanted station in a mediocre reception area by 20dB. This signal is only 160kHz away: only 1·6 times the 3dB half-bandwidth of the receiver (assuming a 200kHz bandwidth) and could easily "capture" the limiter of the conventional receiver. Even if the receiver were not actually "captured" the presence of such a strong signal so close in frequency would lead to complex intermodulation products in the i.f. stages and one can imagine the effect it would have on an a.f.c. system with a good pull-in range. The mind boggles at the thought of a street full of such devices, especially when it is remembered that the problem is likely to be 15dB worse between adjoining "semis". In this area one would need to be more than 200yd from the nearest radiating aerial before the wanted signal exceeded the interfering signal.

All this is, however, based on the ungenerous assumption that the radiation is substantial, a point which is not fully established even though the circuit does appear to be radiation prone. Nevertheless there must be many would-be constructors who, like myself, need to be reassured on a point having such serious social and potential legal implications before undertaking the construction of such a unit, the first intimation of trouble in which will probably be from the G.P.O. man at the door. Satisfactory operation of two units in close proximity is not enough!

A. J. HENK,
Bingley,
Yorks.

* "Radio Propagation Fundamentals", Bullington. *B.S.T.J.* Vol. XXXVI No. 3; May 1957, p. 593.

The author replies:

Mr. Henk is correct in his calculations of the residual local oscillator signal at the aerial terminal of the tuner. How much of this will be picked up by an adjacent receiver depends very much on the nature of the aerials used, their orientation and the nature of the path between them. However I am grateful to Mr. Henk for pointing out that particularly in areas of low field strength conditions of interference could occur.

It should have been pointed out in the original article that when used for its original purpose, i.e. sound distribution systems, an r.f. distributing amplifier would invariably be employed in order to supply say four tuners, one for each available programme. This amplifier had the additional function of isolating the tuners from the aerial by at least 40dB. It is well worthwhile considering the use of an r.f. amplifier stage with this tuner if oscillator radiation does cause trouble and this applies particularly in areas of poor field strength since the additional gain provided would help to keep a good s/n ratio.

The circuit and layout of a suitable r.f. amplifier stage using a 316—04 cascode amplifier are being prepared.*

For those interested in the historical aspects of this type of receiver the following issues of *Wireless World* contain articles by M. G. Scroggie, April 1956, June 1956 and April 1958.

J. G. NEWNHAM.

*We hope to publish these next month.—ED.

Measuring Crossover distortion

It was an interesting point made by D. R. Ray in his letter in the August issue. Actually just how much distortion one can measure satisfactorily depends essentially on the amplifier's noise performance. Conventionally, a sinewave signal carrying distortion of not much more than about one-fifth of the total harmonic distortion likely to be introduced by the amplifier is applied to an unequalized input. The r.m.s. value of the total harmonic distortion is then compared in ratio with the r.m.s. output of real signal power to yield a decibel or percentage figure.

Overall noise relative to full power output is currently not much better than about 78dB (this with the best of amplifiers using f.e.t. first stages). This figure takes into account the noise contribution of the pre-amplifier stages and is the value obtained with the volume control at maximum. Taking a 20-W amplifier of such noise performance, the noise voltage across, say 8 ohms works out to about 1.8mV. (e.g., 78dB below about 12.8V). Signal voltage at 10mV across the same value load is thus about 290mV, meaning that the maximum distortion measurable by the usual techniques to the noise threshold lies in the ratio of approximately 2900:18, which works out to about 44dB or 0.65%.

As so few amplifiers (overall) possess such a good noise figure it is thus seen to be impossible to measure low-level distortion at power around the 10mW mark, as the distortion falls into noise.

Even so, I have discovered that the distortion is not uncommonly above 0.65% at powers in the 10mW region from about 1kHz upwards, the distortion rising significantly with increasing frequency. Indeed, I have measured as much as 2.5% t.h.d. at 20kHz at 10mW! There is a red herring in this sort of measurement, depending on the readout device, for one is comparing the r.m.s. value of a true sinewave (or pretty near true) with the reading given by an r.m.s.-calibrated instrument on a distortion wave which is singularly removed from true sinewave form! Very rarely is the form-factor of the distortion wave taken into account in such readout comparisons. Moreover, the nature of the distortion wave changes significantly with increasing frequency of the input sinewave signal. I have seen the distortion wave displayed almost as a true saw-tooth wave at 20kHz, and such a wave gives more deflection on the type of readout device usually employed than the more 'peaky' waves attributable to t.h.d. from lower frequency sinewave inputs. Hence the 2.5% t.h.d. just mentioned at 20kHz and 10mW.

This, of course, brings us neatly to the fact that in the present stage of the art there is virtually no correlation between the subjective effect of crossover distortion and the effect as measured.

GORDON J. KING,
Brixham,
Devon.

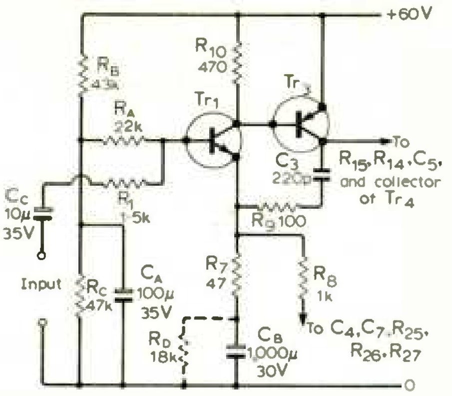
Crossover distortion in Bailey amplifiers

After studying a number of designs for audio power amplifiers, I recently decided to construct, for domestic use, a stereo pair of amplifiers using Dr. Bailey's single-rail 30-watt circuit, as described in November 1968.

However, when I began construction, I noticed an inherent snag in the design. The feedback resistors R_7 and R_8 allow a d.c. flow of approximately 20mA from the amplifier output to earth. As the quiescent current in the output stage, due to the bias from Tr_4, is only 25-30mA, the additional 20mA drain reduces the current through Tr_{10} to only 5 – 10mA. Running so close to cut-off in one half of the output stage is, I feel, bound to increase crossover distortion, and it seems strange that Dr. Bailey should use this circuit after going to such lengths to explain the need for output stage symmetry in his original article *(Wireless World,* May 1968).

In my own amplifiers, I have overcome the problem by using the popular 'floating emitter' configuration for the input transistor shown below.

With this circuit, which is identical to Dr. Bailey's original design for a.c. signals, the d.c.



flow through the feedback resistor R_8, and thus the output stage unbalance, is only 1.5 – 2mA. Even this can be reduced by the addition of R_D, (shown dotted). In my own amplifiers, this has reduced the d.c. in R_8 to 50μA. The values of C_A and C_B may seem excessively large, but this has been done deliberately to maintain the amplitude and phase of the a.c. feedback at the extreme low-frequency end of the audio spectrum.

There are two other minor advantages in the modification shown. First, the modified feedback circuit produces unity gain at d.c., therefore the bias stabilizer, Tr_2 can be omitted. Secondly, the time constant formed by R_B, R_C, and C_A produces a slow switch-on of the whole amplifier, thus removing the need for 'anti-thump' precautions in the power unit.

I do not claim that these modifications produce any audible or measurable improvements in performance, but having seen the snag, I feel that they are worth carrying out for 'peace of mind', if nothing else.

K. CLAYSON,
Redhill,
Surrey.

The author replies:
I entirely agree with Mr. Clayson that there is a small difference in the transistor emitter currents due to the d.c. in the feedback resistor. If the standing d.c. current in the n-p-n transistor is say 80mA, the distortion due to the d.c. bleed is negligible. I regret that I omitted to state in the original article that the quiescent current in the output stage should be between 60 and 120mA. Values lower than 40mA give crossover distortion and values over 120mA give no lower distortion. In fact, pure Class A operation gives slightly worse distortion figures.

Nevertheless I agree with Mr. Clayson's comments and his revised circuit. This is the problem with modified circuits, deciding where to stop. The original circuit was for two power supplies, but a demand arose for simple modifications to enable it to run on one supply. Once one supply is settled on, then the input circuit biasing is definitely not ideal, and I can recommend Mr. Clayson's circuit to the purists and also those who suffer switching surges.

ARTHUR R. BAILEY

National studio for electronic music

Mainly as a result of the survey of Electronic Music Studios undertaken last year, the British Society for Electronic Music was inaugurated in February with a committee consisting of Peter Maxwell Davies (Chairman), Peter Zinovieff, James Murdoch, Don Banks, Tristram Cary and Hugh Davies. Its main aim is the founding of a National Studio for Electronic Music but such a centre would also be expected to cover a wider field than this. Facilities would include:

(1) A first class electronic music studio, comprising central processing rooms with sound generation equipment, a tape room with comprehensive recording facilities, and a number of composers' rooms, each a self-contained working unit but linked to the central system.
(2) An acoustic research laboratory.
(3) A lecture hall which would also be used for small concerts.
(4) A large recital hall specially designed for multi-track speaker reproduction with easily adaptable seating and staging. The recital and lecture halls would be linked to the studio.
(5) A library/archive containing a large collection of tapes and discs.

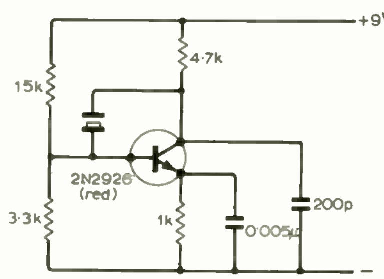
Further details can be obtained from the Society whose administrator at the moment is John Woolf, c/o Society for the Promotion of New Music, 29 Exhibition Road, London, S.W.7.

KEITH WINTER,
Arts Council of Gt. Britain,
London, W.1.

Ageing crystals

On p. 363 of the August issue D. R. Bowman, in the course of his description of his communications receiver advises us to buy new quartz crystals and not to attempt to use 25-year old war surplus articles.

About three weeks ago I tried out all the miscellaneous quartz crystals with frequencies between 1,000 and 10,000 kHz in my possession, plus various oddments found around in the labs. A simple Pierce oscillator (diagram) was coupled to a Marconi TF417/2 digital frequency meter. Rather to my surprise, no



less than 18 crystals duly showed life: there was one non-oscillator, an old regrind of an ex-service FT243 (8012 kHz), presumably not etched. Most of these crystals were over 20 years old. The oscillation frequencies did not differ greatly from the marked values: they depend, of course, on the oscillator actually used.

Before doing this little exercise I would, I think, have been of the same opinion as Mr. Bowman.

P. SHORT,
University of Newcastle-upon-Tyne.

Quartz Crystal Oscillator Circuit without Inductors

by D. F. G. Dwyer, J. Roberts* and G. Haynes**

Overtone crystals are used in precision frequency standards and also at high frequencies where fundamental mode plates become too thin and fragile.

Precision frequency standards usually employ 2·5 MHz or 5 MHz AT-cut fifth-overtone contoured units because of their very high Q and exceptionally low aging rate.

The crystals exhibit activity on the unwanted overtones and, in order to operate these units on the desired overtone, the maintaining circuit must have frequency selective properties but, because the maintaining circuit must also possess a high degree of phase stability, these requirements can be in conflict.

The main sources of phase change and resulting frequency variation in oscillator circuits are the components giving rise to phase shift; the transistor junction capacitances, external inductors and capacitors. These variations could be minimized by using stable low temperature-coefficient components, but while capacitors are available to meet this requirement, small highly-stable inductors are difficult to realize. Therefore, if the inductor could be eliminated and some other form of frequency selectivity introduced, the design problem would be much simplified.

A widely used oscillator circuit for overtone crystals is shown in Fig. 1(a). The crystal operates at or near series resonance and appears resistive, the combination of L_1 together with C_1, C_2 and C_3 providing the necessary frequency selectivity for the required overtone operation.

If L_1 is removed, the circuit becomes a parallel-resonant oscillator. This is because the elimination of L_1 reduces the phase shift and in order to maintain a loop phase shift of zero or 360°, which is the condition for oscillation, the crystal must become inductive. Under these conditions there is an apparent loss of frequency selectivity.

Fig. 1(b) shows a transistor version of Pierce oscillator. The transistor provides 180° of phase shift and the additional 180° required for the maintenance of oscillation is provided by the feedback networks Z_1, Z_2 and Z_3.

If in making a small-signal analysis of the circuit, the resistive components in Z_1 and Z_2 are ignored, the circuit appears active over a wide frequency range. However, on analysis of the maintenance condition (see Appendix), a degree of selectivity becomes apparent. The analysis takes into account g_m and the resistive and reactive components in which, to simplify calculation, $R_1 = R_3 = R$ and $C_1 = C_3 = C$ as indicated in Fig. 1(c). Various values of R and C yield values of negative resistance for the maintaining circuit that vary with frequency as shown in Figs. 3(a) and (b). The maximum value of (R_N) can be predicted and is dependent on the g_m of the oscillator transistor and R as illustrated in Fig. 2.

The greater the extent to which the negative resistance (R_N) exceeds the equivalent series resistance [R_X in Fig. 1(c)] of the crystal, the faster will be the build up of oscillation from "turn on". The circuit will not oscillate if R_N is less than R_s.

When operated in a stable maintaining circuit, such as the one described, with low crystal dissipation and at constant temperature, 2·5 MHz 5th-overtone crystal units regularly achieve, after some months of continuous operation, aging rates of 1×10^{-11} day and a short-term frequency stability of 9×10^{-12} r.m.s. for 1 second averaging.

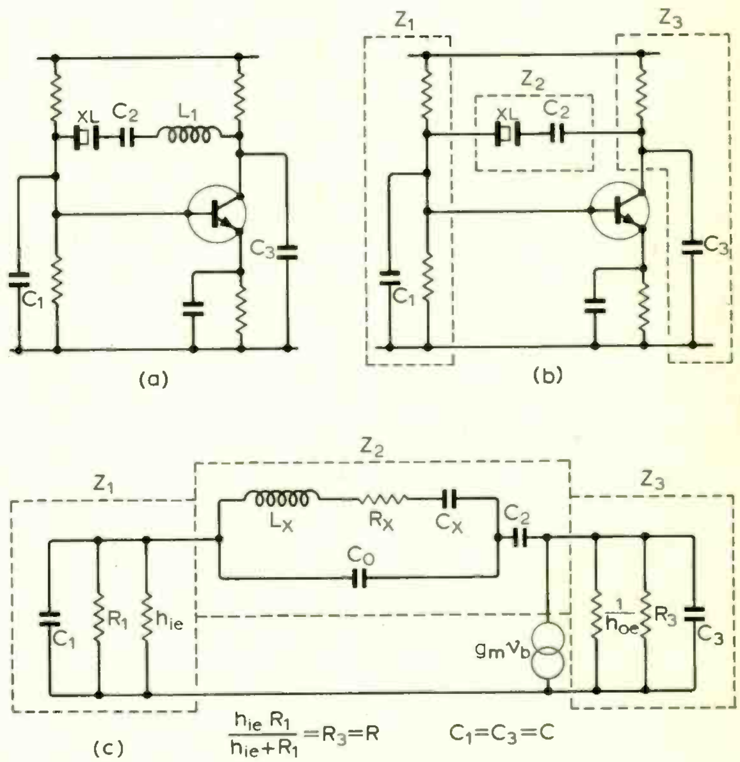


Fig. 1. Common crystal oscillator circuit (a) and with L_1 removed (b). The equivalent circuit of (b) is given at (c).

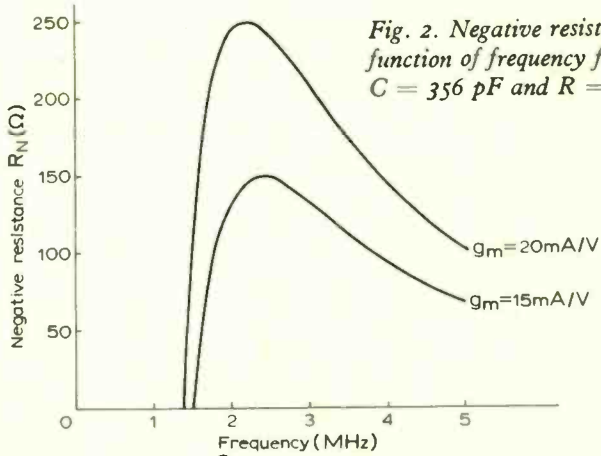


Fig. 2. Negative resistance as a function of frequency for $C = 356$ pF and $R = 416$ Ω.

* The Marconi Company Limited

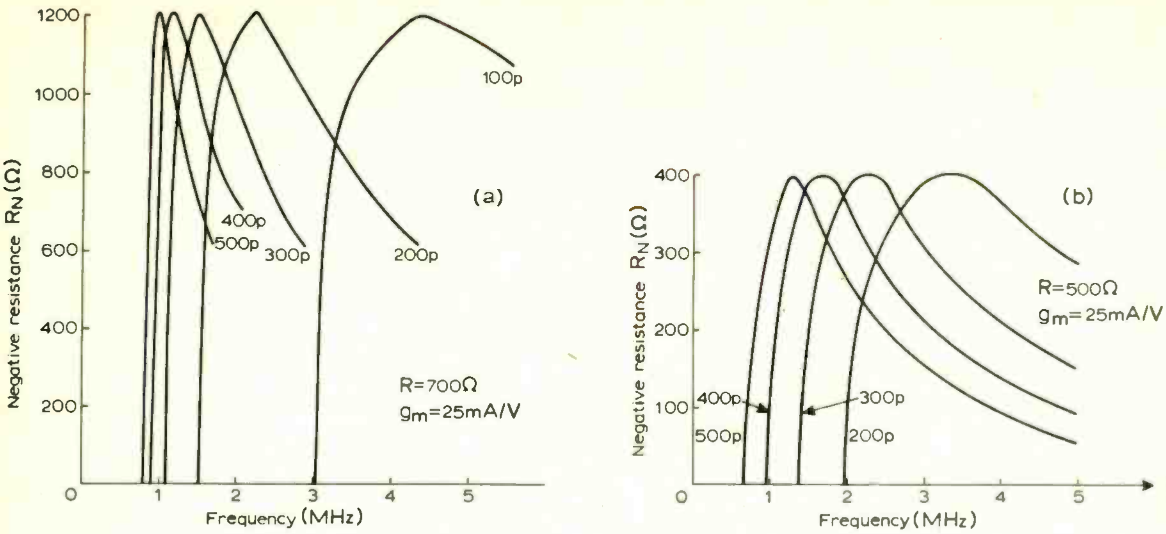


Fig. 3. Negative resistance R_N as a function of frequency (a) for $R = 700\ \Omega$ and (b) for $R = 500\ \Omega$.

Procedure for oscillator design

Consider the maximum series resistance of the crystal; for reliable starting, R_N should be between two and three times the crystal series resistance R_x. For a Marconi 2·5 MHz AT, fifth-overtone the manufacturers quote:

Inductance	18·5 H
Q	4×10^6
Therefore $R_x = \omega L/Q = 72{\cdot}5$ ohms	

From considerations of frequency adjustment, to compensate for manufacturing frequency tolerance, a variable input capacitance of nominal value 30 pF is required.

R_x is the equivalent series resistance at series resonance and is modified by operation between series and parallel resonance.

Modified R_x is given by: $R_x(1 + C_0/C_L)^2$ where C_L is the circuit input capacitance and C_0 the crystal shunt capacitance, which is typically 4·2 pF.
(From manufacturers' data)

The modified $R_x = 72{\cdot}5\ (1 + 4{\cdot}2/30)^2 = 94$ ohms

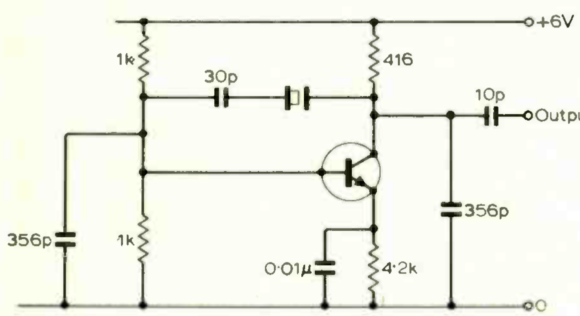


Fig. 4. 2·5-MHz oscillator incorporating calculated values.

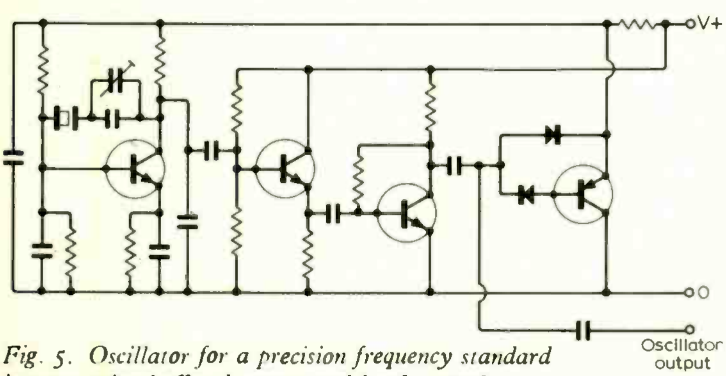


Fig. 5. Oscillator for a precision frequency standard incorporating buffered output and level control.

A negative resistance of 2·5 times "modified R_x" will ensure build up of oscillation within seconds for a crystal of this type and as will be shown, a small reduction in this value by reducing g_m provides a suitable means of level control.

Substituting a g_m of 20 mA/V and R_N of 250 ohms into equation (5) (Appendix) gives a value for R of 416 ohms.

From Fig. 3(b) it can be seen that the change in R_N for change in frequency, is more rapid on the low-frequency side of $R_{N\max}$, therefore, to improve discrimination against the 7th overtone, $R_{N\max}$ should be arranged to occur slightly below the desired crystal frequency. In this case, let $R_{N\max}$ occur at 2·25 MHz; substituting for ω, g_m and R in equation (4) gives a value for C of 356 pF.

Fig. 2 shows R_N as a function of frequency for $g_m = 15$ mA/V and 20 mA/V for these values.

To realize the equivalent-circuit values the combination of h_{ie} and the base-bias resistors should equal R. Similarly the resistive component in the collector should equal R, but $1/h_{oe}$ is large, therefore, the collector load resistor may simply be made equal to R. Since silicon planar transistors of high f_T would normally be used, the transistor capacitances will be insignificant compared with the 356 pF of C.

Using Shockley's diode relation[4] a close approximation to both g_m and the transistor input resistance may be obtained:

$$h_{ie} = 26\ h_{fe}/I_e \quad \text{and} \quad g_m = 39\ I_e$$

For a g_m of 20 mA/V $I_e = 0{\cdot}512$ mA and taking 50 as a typical h_{fe} $h_{ie} = 2539$ ohms.

Fig. 4 shows a circuit incorporating these results.

Output coupling to the oscillator is, because of the higher signal level, taken from the collector. To realize the best possible aging rate for a 2·5 MHz, 5th-overtone crystal, the power dissipated within the crystal should be stabilized to approximately 0·5 μW, this will result in a signal level of about 10 mV r.m.s. at the collector. Obviously most applications will require a higher output level than this and additionally a higher signal level will be required to derive a d.c. feedback voltage for output level control. Fig. 5 shows a circuit incorporating these requirements. Level control is obtained by varying the oscillator supply voltage, resulting in a lower collector current and reduced g_m, as shown in Fig. 2.

Because the circuit does not initially have a high R_N the level control range can be small and the severe limiting that would be required to control the level is not present.

It often occurs that an oscillator circuit is required to be suitable for a wide range of fundamental mode crystals. An inspection of Fig. 2 shows that at frequencies higher than the occurrence of $R_{N\max}$, R_N reduces towards zero at a varying rate dependent on circuit values and the frequency displacement away from $R_{N\max}$. Circuit values can be arranged so that R_N remains fairly constant at a specific value over a wide frequency range and R_N can be designed to be only slightly higher than the crystal resistance. The oscillator waveform will be sinusoidal and this low distortion will result in improved stability.

The analysis has enabled maintenance circuits to be designed for 3rd-overtone crystals in the range 20 to 60 MHz. By the use of a high g_m, sufficient selectivity can be obtained to ensure oscillation on only the third overtone. The small size of the crystal at these frequencies and the simplicity of the circuit enable the complete oscillator to be built on the header of a JEDEC TO-5 can.

The authors wish to thank Mr. C. Herbert for providing the data on the crystal used, Mr. E. Cook for his assistance in the presentation of the information and the Director of Engineering, The Marconi Company Limited, for permission to publish this paper.

Appendix

The conditions of unity loop gain for the circuit shown in Fig. 1(c) is:

$$Z_2 = -(g_m Z_1 Z_3 + Z_1 + Z_3) \qquad \ldots (1)$$

Since

$$Z_1 = \frac{R_1}{1 + j\omega CR} \text{ and } Z_3 = \frac{R_3}{1 + j\omega C_3 R_3}$$

$$Z_2 = -\left[\frac{g_m R_1 R_3 (1 - j\omega C_1 R_1)(1 - j\omega C_3 R_3)}{(1 + \omega^2 R^2 C_1^2)(1 + \omega^2 R_3^2 C_3^2)} + \frac{R_1(1 - j\omega C_1 R_1)}{1 + \omega^2 C_1^2 R_1^2} + \frac{R_3(1 - j\omega C_3 R_3)}{1 + \omega^2 C_3^2 R_3^2}\right] \qquad \ldots (2)$$

The real part of the impedance Z_2 is the equivalent series resistance of the crystal given by equation (1). The resistance R_s must be smaller than the negative resistance R_N provided by the right-hand side of equation (2) above. For the condition where $R_1 = R_3 = R$ and $C_1 = C_3 = C$ the real part of (2) may be written:

$$R_N = \frac{g_m R^2(\omega^2 C^2 R^2 - 1) - 2R(1 + \omega^2 C^2 R^2)}{(1 + \omega^2 C^2 R^2)^2} \qquad \ldots (3)$$

The variation of R_N with frequency and terminating capacitance is shown in Figs. 3 and 2.

The frequency at which R_N is a maximum for given values of C, R and g_m can be found by differentiating equation (3) with respect to ω and equating to zero. This maximum negative resistance $R_{N\max}$ occurs when

$$\omega^2 C^2 R^2 = \frac{(3 g_m R + 2)}{(g_m R - 2)} \qquad \ldots (4)$$

Substituting this back into equation (3) and simplifying gives

$$R_{N\max} = \frac{(g_m R - 2)^2}{8 g_m} \qquad \ldots (5)$$

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Audio Fair

This year's exhibitors

For the first time the London Audio Fair is being held in an exhibition hall instead of an hotel. It opens at Olympia on October 16th for six days. The majority of the 85 exhibitors will be demonstrating their equipment in the sound absorbent "studios" which are being specially erected.

Admission to the Fair, which will be open from 10.00 to 21.00 daily (except Sunday) will cost 4s.

Below we list the exhibitors at the time of going to press.

Elsewhere in this issue we have included a preview of some of the products to be seen and heard, and in our December issue we plan to include a more considered review of the Fair.

A.D.C.
AEG (GB)
Acoustical Manufacturing Co.
Agfa-Gevaert
Aiwa Co.
Akai Electric Co.
Arena Hede-Neilson Fabriker
Armstrong Audio
Audio Technica Corp.

B & W Electronics
BASF (UK)
BSR
Bang & Olufsen (UK)
Billboard Publications
Bosch
Brenell Engineering Co.
British Radio Corp.

Colton & Co.

Dansette Products
Daystrom
Decca Record Co.
Diamond Stylus Co.
Dual Electronics

EMI Electronics
Elstone Electronics

Fed. Brit. Tape Recording Clubs
Ferranti
Ferrograph Co.
Field, N. & S. B., & Co.

Garrard Engineering
General Gramophone Publications
Goldring Manufacturing Co.
Goodmans Loudspeakers
Grundig (GB)

Hacker Radio
Hammond, C. E., & Co.
Hanimex (UK)
Hansom Books
Haymarket Press
Helme, P. F. & A. R.
Hi-Fi Dealers' Association
Highgate Optical & Industrial
Howland-West

IPC Electrical-Electronic Press
IPC Magazines

Jordan-Watts

KEF Electronics

Leak, H. J., & Co.
Link House Publications
Lowther Manufacturing Co.
Lustraphone
Lux
Luxitone

Marubeni-Lida Co.
Metrosound Sales
Minnesota Mining & Mftg. Co.
Monks, Keith, (Audio)
Mordaunt-Short
Mullard
Multicore Solders

Ortofon

Philips Electrical
Philips Records

Rank Bush Murphy
Rank Wharfedale
Richard Allan Radio
Rola Celestion
Rotel

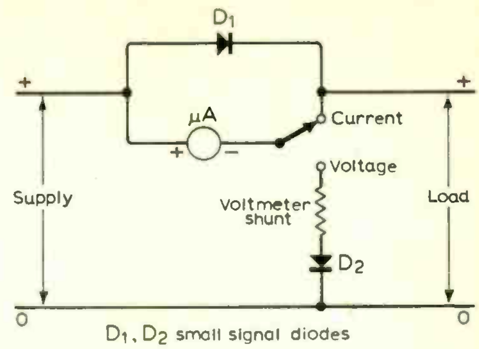
Sansui
Shure Electronics
Sinclair Radionics
S.M.E.
Sony
Sugden, A. R., & Co.
Swisstone

Tape Music Distributors
Tape Recorder Spares
Tape Recording Magazine
Teac Corporation
Teleton Electro (UK)
Thorens A/S
Transcriptors
Trio Corporation

Whiteley Electrical
Wireless World

Yamaha

Circuit Ideas



In situ current and voltage metering circuit.

Balanced f.e.t. R-C oscillator

The field-effect transistor *R-C* oscillator shown is characterized by a symmetrical, balanced circuit and is especially suitable for the generation of sinewaves of low frequency, high stability and extremely low distortion. The balanced push-pull configuration reduces all even harmonics of the oscillation frequency, whereas the double frequency selective networks attenuate the odd harmonics to a negligible value. The oscillator is essentially a spot frequency oscillator, as four elements will have to be changed to use the arrangement for variable frequency operation.

The circuit is basically a balanced (push-pull) version of the well known wien bridge oscillator, in which the *R-C* coupling between the first and second f.e.t. is replaced by a second frequency selective network. The frequency selective networks are identical, and the overall gain of the balanced oscillator is adjusted by varying R_F, and hence the effective dynamic load resistance of the f.e.ts. Complete symmetry of all resistors and capacitors (and identical f.e.ts) is assumed.

It can be shown that the attenuation of the frequency selective networks will have a minimum value of $\frac{1}{3}$ at only one frequency,

$$f = \frac{1}{2\pi RC}$$

which is the oscillation frequency for the oscillator. The gain of each amplifier must, therefore, be slightly more than three for sustained oscillations to occur. The correct value of R_F and R_L can now be obtained from the formula

$$|\text{voltage gain}| = g_m R'_L \geq 3$$

where $R'_L = R_L(\frac{1}{2}R_F)/(R_L + \frac{1}{2}R_F)$ is the effective dynamic load resistance of the f.e.t. (i.e., R_L and $\frac{1}{2}R_F$ connected in parallel). (It is assumed that the dynamic drain resistance r_d of the f.e.ts is much larger than R'_L and can be ignored).

Solving for R_F we obtain:

$$R_F \geq \frac{6R_L}{g_m R_L - 6}$$

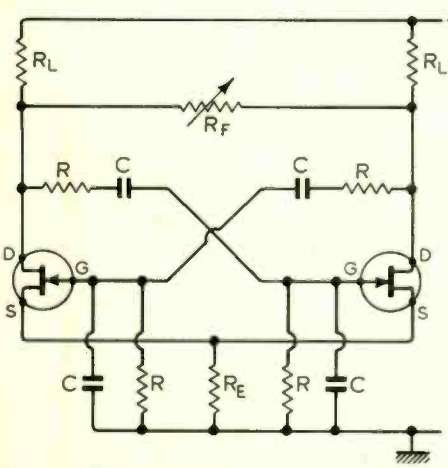
To ensure that R_F is neither negative nor excessively large, R_L must be chosen so that

$$R_L > \frac{6}{g_m}$$

An oscillator using type MPF104 f.e.ts ($g_m = 2{\cdot}2$mA/V at $V_{DS} = 5$V, $I_D = 1$mA) and with $R_L = 4{\cdot}7$kΩ, $R_F = 10$kΩ (potentiometer), $R_E = 820\,\Omega$ and $R = 200$kΩ and $C = 0{\cdot}5\mu$F, and a regulated supply of 12V, was tested and found to have excellent stability and low distortion at a frequency of 10 radians/sec. ($f = 5/\pi$Hz).

The adjustment of R_F at these low frequencies is somewhat tedious as the effect of any small maladjustment takes a substantial time to reach its final steady state. With a stabilized d.c. supply, no automatic amplitude control is necessary.

H. C. Viljoen
University of Stellenbosch,
South Africa



Push-pull low-frequency sinewave oscillator.

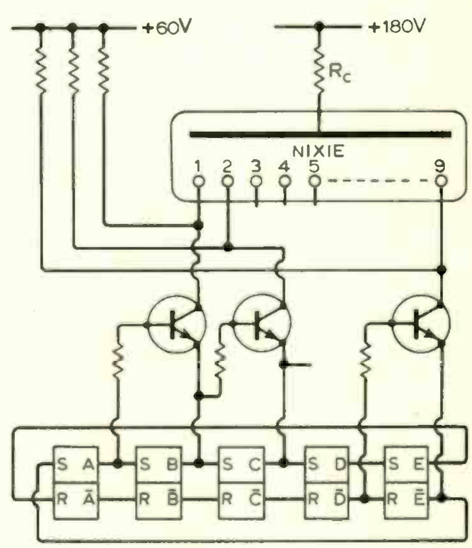
Metering a low-current supply

The circuit uses a microammeter to measure either voltage or current without interruption of the supply. In the "voltage" position, diode D_1 conducts current to the load, and the meter reads supply voltage. In the "current" position, D_1 is non-conducting because the voltage across the microammeter is less than diode forward-voltage; hence the meter now registers load current. This circuit is very similar to the conventional switched meter circuit, where D_1 is replaced by a meter shunt resistor. This is impracticable, however, where the load current is of the same order as the greatest, readily-available meter sensitivity. D_2, matched with D_1, should be added in low-voltage applications where the forward voltage drop across D_1 is not negligible. Note that D_1 also provides overload current protection for the meter. With a positive supply of 250V and a load current of 500μA max. the voltmeter shunt was about 1MΩ.

C. J. Doran
University of Nottingham

Johnson counter decoder

The Johnson counter, sometimes known as the switch-tail ring counter, consists of a standard shift register with feedback. Connections are the same as a recirculating register except that the feedback leads from input to output are crossed. If five bistables are used the counter will count to ten and the outputs may be decoded using two input AND gates as follows: $0 = \bar{A}\bar{E}$, $1 = A\bar{B}$, $2 = B\bar{C} \ldots 9 = \bar{D}E$. The two input gates can be replaced by single high-voltage transistors that will drive a



Counter decoder.

Nixie readout tube directly. The bases and emitters of these transistors are driven by pairs of complementary adjacent outputs as follows: $0 = \bar{E}A$, $1 = \bar{A}B$, $2 = \bar{B}C$, $3 = \bar{C}D$, $4 = \bar{D}E$, $5 = E\bar{A}$, $6 = A\bar{B}$, $7 = B\bar{C}$, $8 = C\bar{D}$ and $9 = D\bar{E}$.

R. Little
Poole,
Dorset

Simple Wideband Amplifier

by H. N. Griffiths, B.Sc.*

The amplifier is a general purpose design which has a power gain of 20dB and a flat response from 30 Hz to 3·5 MHz with the 3dB point at about 5 MHz. It requires a high impedance source (typically 20 k Ω) and drives a low impedance load (typically 50 Ω). Cheaply available general purpose high f_T n–p–n transistors are used in conjunction with the minimum of other components. Perhaps the most important criterion is the high stability of the amplifier. (The writer, although claiming to be a "dab hand" at getting almost any amplifier to burst into glorious oscillation in almost any circumstances, has failed, so far, to obtain any signs of instability from the prototype whatsoever.) The gain stability is also high due to negative feedback.

Circuit description

The amplifier consists of two directly coupled stages. The input stage is a shunt-series feedback pair whose a.c. current gain, A_i, is approximately given by the ratio R_f/R_e, providing the input is from a high impedance source (R_s). The output stage is an emitter follower which drives the low impedance load R_L. The overall power gain, A_p, at midband is given approximately by:—

$$A_p = (A_i)^2 \frac{R_c}{R_s\ R_L}$$

$$= \left(\frac{R_f}{R_e}\right)^2 \frac{R_c}{R_s\ R_L}$$

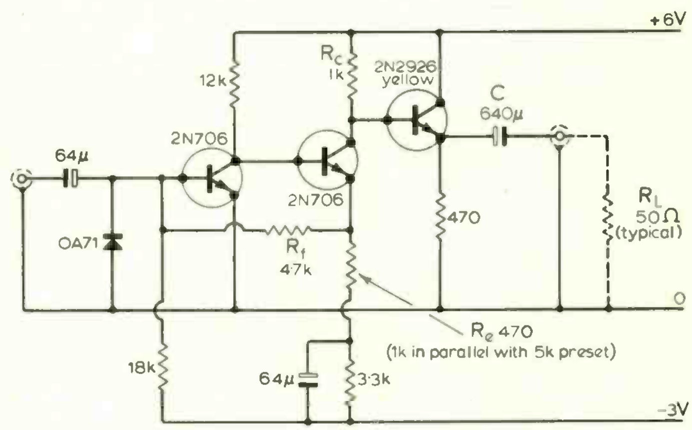
which, for $R_c = 1\ \text{k}\Omega$, $R_s = 20\ \text{k}\Omega$, $R_L = 50\ \Omega$, $R_f/R_e = 10$ gives the power gain $A_p = 100$; so A_p in dB = 20. For the component values used, the low frequency cut-off is determined by the time constant $C \cdot R_L$ of the output circuit and this occurs at a frequency of approximately 30 Hz. High f_T transistors (2N 706, 2N 2926) are used to ensure that the h.f. cut off occurs higher than 3·5 MHz.

Construction

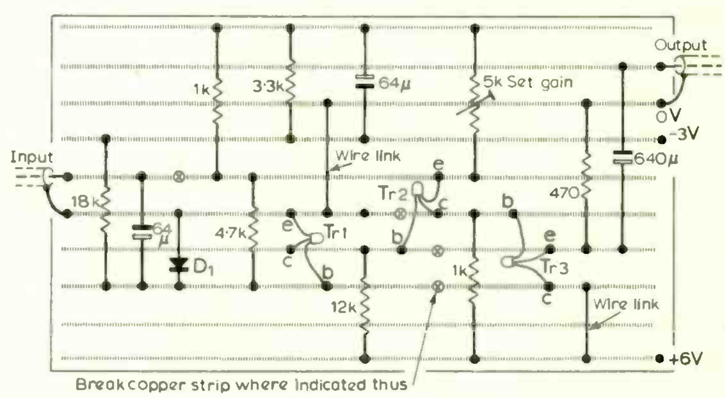
The prototype amplifier was built on a piece of 0·1-in matrix "Veroboard" of size 3 in × 1½ in. No special precautions were taken to prevent instability. The layout of components shown may have to be modified slightly to accommodate the components available. Good quality components should be used throughout, but any high gain ($\beta > 100$) high f_T (> 50 MHz) n–p–n transistors should be suitable. The total cost of the amplifier to the home constructor is estimated to be in the region of 25s.

Testing

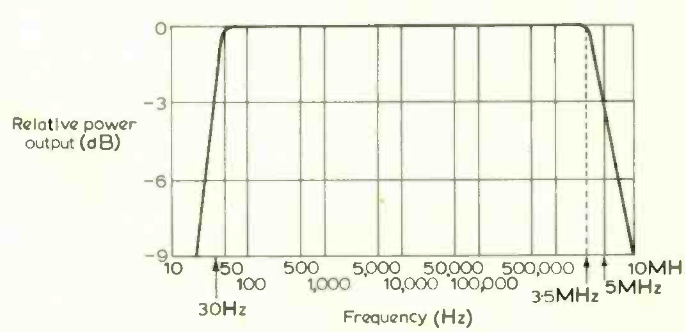
The frequency response of the completed amplifier can be obtained using a 0–5 MHz signal generator and an oscilloscope. A 2-volt peak-to-peak output from the signal generator is coupled to the amplifier via a 20 k Ω resistor and the preset gain control of the amplifier is adjusted to obtain a 1-volt peak-to-peak signal across a 50 Ω load resistor. The frequency response should be flat from approximately 30 Hz to 3·5 MHz.



Circuit diagram of direct-coupled wideband amplifier



Suggested layout of components on Veroboard



Amplifier frequency response

* Royal Radar Establishment

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WESCON, 1969

Some highlights of the San Francisco convention

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

There are two very large electronic shows every year in the U.S.A., the I.E.E.E. International Exposition held every March in New York and the Western Electronic Show and Convention (WESCON) located in California in August of each year. In recent years, the New York show has been losing popularity, with large drop-outs among both exhibitors and patrons. It must be considered somewhat of a tribute to the organizers of WESCON in that they have been asked to take over the management operation of the I.E.E.E. Show commencing 1970.

The WESCON show held this year, August 19th-22nd in San Francisco, drew an estimated 45,000 visitors to the exhibits of over 600 companies (including 22 from the U.K., and five from Germany), displayed at 1192 stands. However, the biggest main event, as always, was the technical programme concentrating on current electronics technology.

As in the case with every large technical conference nowadays there is the problem of attempting to compress the presentation of a very large number of papers into the space of three or four days. About the only solution seems to be the running of parallel meetings; in this case, it worked quite well and although often there were three simultaneous sessions, an effort had been made to see that there was as little overlap as possible between areas of interest in competing sessions. All the 107 papers presented were specially invited and were arranged into related sessions so that the papers complemented one another.

Systems applications of communications satellites

When considering satellite communications systems, conceived originally by Arthur C. Clarke (*W.W.* October 1945, p. 305), one very often associates them nowadays with television or telephone transmission over long terrestrial paths.

That there are many further applications for satellite transmission was brought out most forcibly in a series of interesting papers. The range of suggested uses includes transmission over long distances of photographic data, collection of information from earth orbiting scientific research vehicles, pick-up of various data from fixed ground observation stations and also domestic (national) long-distance telecommunications services.

A system for the transmission of aerial reconnaissance photographs (which could have future uses in "wire-photo" and facsimile fields) was described by Walter J. Gill (Philco-Ford). This equipment, known picturesquely as "Quick Look", at one ground station comprises a vidicon scanner system, an analogue to digital converter and data modulator. The signal is transmitted by satellite using multiple frequency-shift keying techniques at rates of 0.5, 1 or 2 mega bits per second. At the receiving end the signals are demodulated, converted from digital back to analogue, displayed on a c.r.t. monitor and recorded on film.

Opaque or transparency type originals are slow-scanned by the vidicon camera, which has a variable focal length lens; the bandwidth of the resulting analogue signal is approximately 68 kHz. Picture resolution is 1200 lines in both directions, frame scan one per 16 seconds, Kell factor is 0.7 and the scan efficiency 0.95. The A-to-D conversion is accomplished by a two-bit delta modulation technique requiring as few as 5.6 bits per cycle for performance comparable to five-bit p.c.m. requiring 14 bits per cycle.

This technique codes the quantized *change* in analogue signal as opposed to the actual quantized *level* in conventional p.c.m. Two-bit delta modulation codes large and small positive changes and large and small negative changes of the waveform into two-bit words. Fig. 1 shows a photograph of the image received at Washington, D. C., of a transmission from Hawaii at a data rate of 0.5 M.b./s. with other parameters indicated above. The 2:1 magnification (zoom ratio) used on the input scanner provides a modulation transfer function (m.t.f.) of 8.8 line pairs per mm.

It is envisaged that by 1975 there will be the need for, and technological availability of satellite collection of a large amount of data from many *in situ* sensors on and around the earth. These sensors might be of various types, for example, temperature and wind sensing buoys and balloons; volcanic and seismic detectors; agriculture sensors including soil, moisture and temperature and air temperature measurement; smoke detectors; river, stream, estuary and ocean level and flow gauges. These are collectively known as data collection platforms (d.c.ps) and many are already in use connected by physical conductors to observing stations.

In many cases it is the high cost of physically connecting a d.c.p. to a monitoring point that inhibits the installation of such a sensing device. Land line costs to a d.c.p. in a remote, inaccessible area might be in the region of £2,000 to £4,000 per mile. S. D. Dorfman (Hughes Aircraft) in his paper discussing some considerations associated with this type of data collection gave an approximate estimate of 20,000 d.c.ps, being in use throughout the world in five to six years' time.

Most weather and climatic-type measurements would be collected at regular intervals, for example, every six hours. However, there are other requirements where data must be collected on an emergency basis (seismic activity) or on an irregular schedule (research expedition transmissions to fixed-base monitoring points and computers).

Repetitive six-hour data collection could be accommodated fairly well by low altitude orbiting satellites, but for emergency or "on-demand" data pick-up a geostationary orbit would be

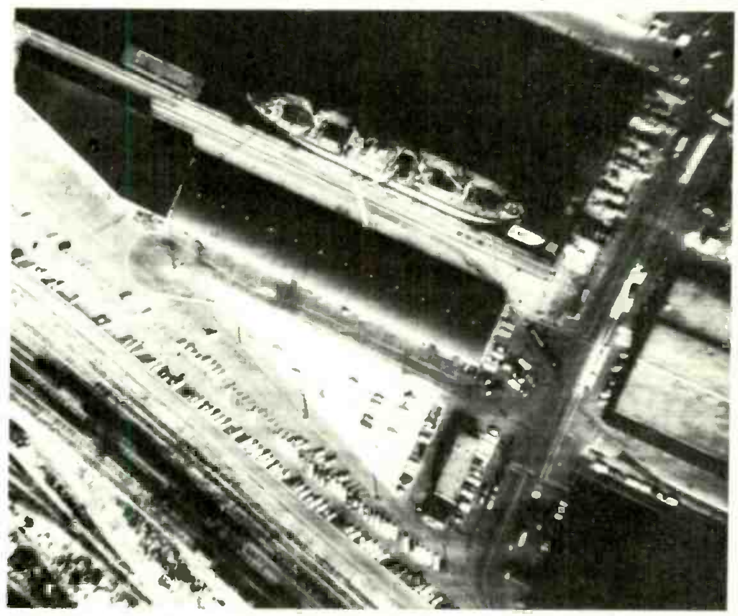


Fig. 1. A photograph of an actual received image, using the "Quick-Look" satellite transmission system. The total transmission path was between Hawaii and Washington, D.C.

needed to insure a transmission path always being available. The geostationary orbit is of course also satisfactory for the regularly scheduled data collection. An equatorial geostationary satellite would be in view of d.c.ps using high gain, directional aerials at latitutudes of up to 70° with elevation angles as low as 5 degrees.

It was suggested that an r.f. bandwidth of 50kHz could be used divided into twenty 2,500Hz channels. The radiated power from a d.c.p. to the satellite would be 5 watts nominal at 149MHz and the interrogating signal from the satellite to the d.c.p. would be 1 watt at 137MHz, which with an aerial gain of 15dB gives an e.r.p. of 31 watts. The carrier-to-noise (s/n) ratio of these signals at a bandwidth of 2,500Hz is estimated to be approximately 15-16dB; or at 250Hz, 26dB.

Integrated circuits in communications

The trend noted last year in the development of linear integrated circuits in communications equipment was seen to be continuing, albeit somewhat conservatively. Consumer electronics designers are taking the logical approach of selecting monolithic replacements for existing component circuitry. S. B. Marshall (Sprague Electric) stated that generally the move to i.cs has provided performance improvements rather than lower costs. Better performance has been realized in i.f. amplifiers for a.m. and f.m., f.m. discriminators, colour demodulators and video processing circuits. It was pointed out, however, that progress in the movement towards greater use of i.cs is slower than might have been expected. This was suggested as being due to the dominant role of the electronic valve in television sets for the past 20 years or so; it is easier to replace valves by transistors than by an integrated circuit.

One portion of the TV set which has been almost completely replaced by an i.c. is the sound channel. Mr. Marshall described a device which included three direct coupled, differential, non-saturating limiting amplifiers providing 60dB of gain, an audio pre-amplifier and an analogue multiplier used as a

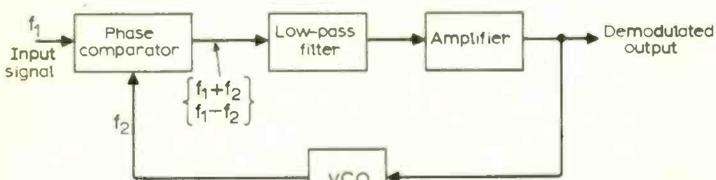


Fig. 2. An integrated circuit phase-locked loop can be employed in f.m. receivers to eliminate L-C networks and conventional detector circuitry.

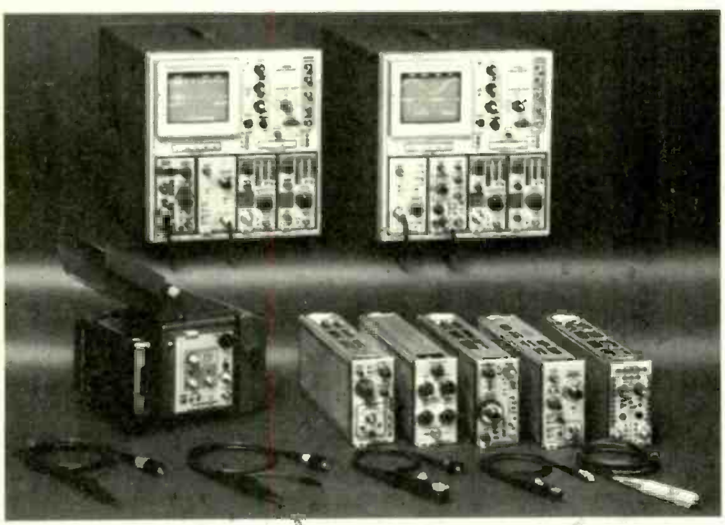


Fig. 3. Tektronix's new generation of plug-in oscilloscopes (the 7000-series) consisting of two mainframes and thirteen plug-in units, including siz amplifiers, four timebase units, and three sampling units.

quadrature discriminator. There is a significant trend amongst many manufacturers towards using this latter technique for intercarrier television sound and also for f.m. receivers.

It has certainly been no secret that in the whole field of integrated circuitry engineering the digital i.c. has enjoyed a far wider range of application and success than the linear device. In part the reason for this is because the monolithic planar process can produce ideally transistors, diodes and low value resistors —the very components used in traditional logic design. However, linear circuitry needs inductors, transformers and large value resistors and capacitors. Further, linear electronics is normally a collection of separate and non-repetitive functions unlike the digital systems where there are large numbers of similarly functioning circuits.

The task of overcoming these problems has been approached, according to H. R. Camenzind (Signetics Corp.), by involving the circuit designer in contiguous disciplines to his own systems design and processing technology.

An example of re-thinking in the systems area was illustrated by the use of a phase-locked loop to eliminate *L-C* networks (Fig. 2). The voltage controlled oscillator (v.c.o.) produces a frequency f_2 proportional to an applied d.c. voltage. This is mixed with f_1 (the input signal) in an analogue multiplier (phase comparator). The sum and difference frequencies are fed to the low-pass filter and an amplifier, the output of which is the control voltage for the v.c.o. If f_1 alone is present, the difference in f_1 and f_2 is large and the entire output is filtered out, there is no control voltage, and the v.c.o. runs at a preset frequency. If $f_1 = f_2$ then the filtered output is a d.c. voltage, its polarity dependent on the phase difference between f_1 and f_2. This d.c. voltage controls the v.c.o. in such a way that if f_2 tends to move away from f_1 the error voltage drives the v.c.o. back to the point where f_2 matches f_1. Where f_2 approaches f_1 then the error voltage pulls the v.c.o. frequency towards that of the input, f_1, rather like the a.f.c. in an f.m. receiver.

Thus, once locked to the input frequency, the v.c.o. follows variations of the input signal; in the case of an f.m. input, the v.c.o. follows the input modulation and as the v.c.o. variations are created by the error voltage this latter represents the demodulated output.

This unique application of a well-used circuit has many advantages: no ratio detector, discriminator, or other detector is required; as the v.c.o. determines received frequency only a single external tuning element is needed; the circuit has high selectivity as, where other frequencies are present at the input, their frequency differences and sums are outside the passband of the low-pass filter.

In the field of processing technology a technique has been evolved providing great flexibility in producing devices needing extreme requirements: high frequency, high voltage, high current, low noise, low power. The process uses anisotropic etching to produce isolation grooves. The advantages are that grooves of precise width and depth can be made economically, components may be placed closer together than with junction isolation, and performance is greatly improved.

This dielectric isolation has application in such circuits as audio amplifiers, c.r.t. drivers, electroluminescent display drivers and video amplifiers. These devices combine high voltage and low voltage needs. By using a field plate over base-collector junctions devices with breakdown in excess of 300V can be made with high yield. For low voltage operation, resistivity can be lowered in some devices by an added diffusion and for fast recovery from saturation gold can be selectively introduced.

Developments in display techniques

The need for displaying large amounts of information on a screen format seems to be increasing rapidly, particularly with the present trend for visual-type displays at computer terminals and also in such situations as aircraft cockpits. In this latter application, the attempt is to do away with the present great mass of indicating instruments and display their readings in numerical or pictorial form on one or two screens.

W. H. Tew (General Electric) described such a device which uses a shadow-mask colour cathode-ray tube. At any one time the screen can display 90 discrete measurands indicating GO, NO-GO or CAUTION for each, 30 analogue measurands, alphanumeric information or a combination of all three. The colour property of the tube is used by the operator as a quick means of determining safe (green), danger (red), or marginal (yellow) conditions. For example, if all the information on the display were green, no immediate action by an operator would be called for; however, the occurrence of a marginal or danger situation would be indicated by the data for that measurand being updated and also its displayed colour changing to yellow or red, drawing attention to the new condition.

It is possible on this device to display trends or past-history plots of data giving a graphical display of the functions; a number of related bar-charts can be displayed adjacent to each other and their relevancy to each other used as criteria for action; digitally produced characters can be used to form legends and the status of the related function indicated by an associated colour spot having the property of appearing in a wide range of colours.

A method developed by Hartman Systems to improve the contrast of a c.r.t. under high ambient illumination levels provides an elegant, if somewhat expensive, solution. The c.r.t. face contains four layers. The electron beam first impinges on a layer of P-16 type phosphor emitting short wavelength energy. This is transmitted through a shortwave optical bandpass filter into a layer of transparent fluorescent glass. Here it is converted to longer wavelength emission. This energy in turn passes through a long-wave bandpass optical filter to the observer. This final filter absorbs those wavelengths which could stimulate the fluorescent layer. Since the two filters have no common bandpass region, no energy can reach the phosphor to be reflected from it.

The tube face appears jet black except where imagery is displayed. It was claimed that with the c.r.t. image at a level of 100 cd/m^2 a useful display is obtained even in the presence of direct sunlight at 34,000 cd/m^2.

Some of the exhibits

Tektronix showed two new oscilloscopes in the 7000-series. The 7504 (d.c. to 90 MHz) and the 7704 (d.c. to 150 MHz) are a new generation of plug-in frames. The main frames are different from the existing types in that they accept up to four plug-in units (Fig. 3). Two each of vertical and horizontal deflection units can be accommodated, and the dual trace switching between channels is accomplished within the frame rather than on the plug-in units.

The screen on the 7000-series frames can show, apart from its regular sweep traces, an automatic scale factor readout. This shows on the screen an alphanumeric display of the time per division, and volts per division settings (Fig. 4). The alphanumeric characters are produced by a built-in character generator and displayed on the screen with the regular traces using a simple time-sharing technique.

Teledyne Corporation showed how far miniaturization can go by combining a s.p.d.t. relay, a relay-driver transistor and an operational amplifier integrated circuit all within a TO-5 transistor can. The op. amp. has a 3M Ω input impedance, maximum bias of 60nA and an offset of 20nA. The device can be used for timers and delay generators by utilizing a small external capacitor; for example, a 30-second delay could be obtained with a 1 μF capacitor.

A new type of phosphor screen for use in multicolour, single gun cathode-ray tubes for display applications has been developed by the ITT Electron Tube Division. This phosphor screen changes colour as the current density is changed, thus avoiding the need for colour masks, multiple electron guns, or beam velocity modulation (previous methods of generating colour displays in cathode-ray tubes).

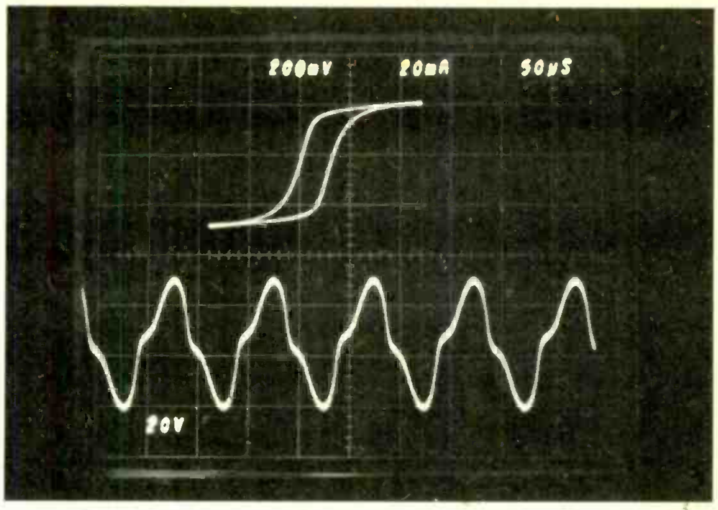


Fig. 4. A polaroid photograph of the screen of the Tektronix 7704 oscilloscope showing the automatic scale factor readout produced by a built-in character generator.

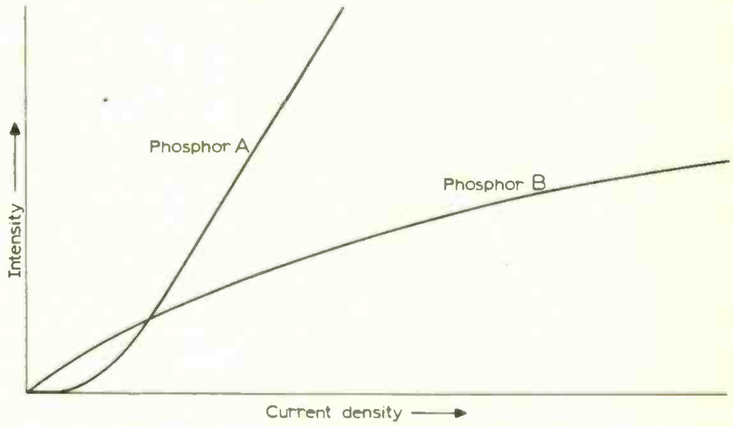


Fig. 5. Current density versus intensity plot of a single gun, dual-phosphor c.r.t. for producing multicoloured displays.

The colour shift is obtained by combining a phosphor having superlinear intensity versus current density behaviour with a phosphor having linear or sublinear behaviour and a different emission colour. This effect is illustrated in Fig. 5 where curve *A* represents a superlinear phosphor. At low current density the emission colour will be that of phosphor *B*, but as the current density is increased, phosphor *A* will contribute more and the colour will shift toward that of *A*. The brightness will increase along with the colour shift, and since *B* continues to contribute, the colour at the higher current density will not be that of *A* but will be intermediate between *A* and *B*. For example: if phosphor *A* is red and phosphor *B* is green, the colour will shift from green to yellow to orange. Similarly, other colour combinations will give other colour shifts.

Current sensitive phosphor screens have been prepared from many different phosphor combinations. The colour shifts obtained include reddish-orange to yellowish-white, reddish-orange to greenish-yellow, and green to orange.

The major advantage of a current-sensitive cathode-ray tube is its relative simplicity in comparison with conventional colour cathode-ray tubes. A display tube of the current-sensitive type can be substituted for a monochrome type to add colour capability. This substitution can be made in existing display systems with little or no modification of the electronic circuitry in order to operate the tube. The main system requirement is that provision must be made for changing current density whenever a colour shift is desired, at a sacrifice in brightness modulation.

High-performance Low-cost "Active Zener" Regulators

by Joachim Preis

Conventional zener diodes, being rather expensive devices, may be replaced by low-cost silicon transistors by making use of the excellent voltage/current characteristic of the base-emitter junction when reverse-biased. The differential zener resistance R_{ZT} of the base-emitter junction of a low-power transistor is at least as low as, or even lower than, the R_{ZD} of a zener diode with the same power rating. Also, V_Z remains essentially constant over a wide current range down to very low current levels which is not necessarily true with V_Z of an ordinary zener[1]. The price ratio, zener diode (200 mW) to n-p-n silicon transistor (TO-18, or similar case, plastic-encapsulated), is of the order of 1:5 to 1:7. With the transistor type BC207 (TO-18, plastic) $-V_{be}$ has been found to be within 8·5–9·5 V (9 V ±5%) for a current of 1 mA. Circuit symbols are shown in Fig. 1.

Now, unfortunately, $-V_{be}$ exhibits a small positive temperature coefficient, but this may be compensated for by connecting a silicon diode (or a forward biased base-emitter junction) in series with the "zener transistor".

A more elegant method is to add an extra transistor connected to operate as an active device with heavy negative feedback, at the same time making use of its negative-temperature-coefficient base-emitter forward voltage to compensate for the positive t.c. of the "zener transistor"[2]. I shall refer to this configuration as the "active zener". Fig. 2, shows the circuit configuration (a) and its equivalent circuit (b).

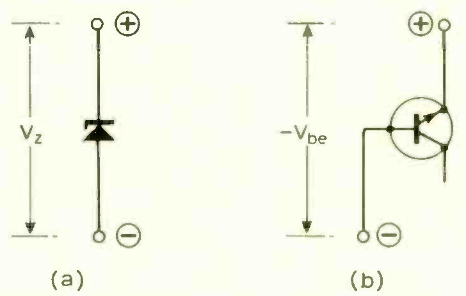


Fig. 1. (a) Ordinary zener diode, and (b) a "zener transistor".

As can be seen from the equivalent circuit Tr_2 acts as a differential amplifier where Tr_1 is connected between the output and the inverted input terminal, thus forming a negative-feedback path. With an ideal differential amplifier the external voltage gain is unity and the current through Tr_1 is zero. With the real amplifier the external voltage gain is close to unity and Tr_1 current equals I_Z/β_2. So Tr_2 acts as a voltage-follower or as a current-multiplier with unity voltage gain. A further advantage of the "active zener" over the conventional zener diode lies in the fact that the small current-induced rise of $-V_{be_1}$ (with increasing I_Z) is largely cancelled out by the decrease of V_{be_2} due to Tr_2 heating up. So V_Z remains essentially constant even at high levels of I_Z. Allowing 180 mW to be dissipated in Tr_2 results in a maximum permissible I_Z of 20 mA at $V_Z = 9$ V.

If the "active zener" is to replace a 1 watt ordinary zener, Tr_2 must be substituted by a transistor in a TO-5 case, the case—air thermal resistance being reduced by a "delta-cooler" heat sink.

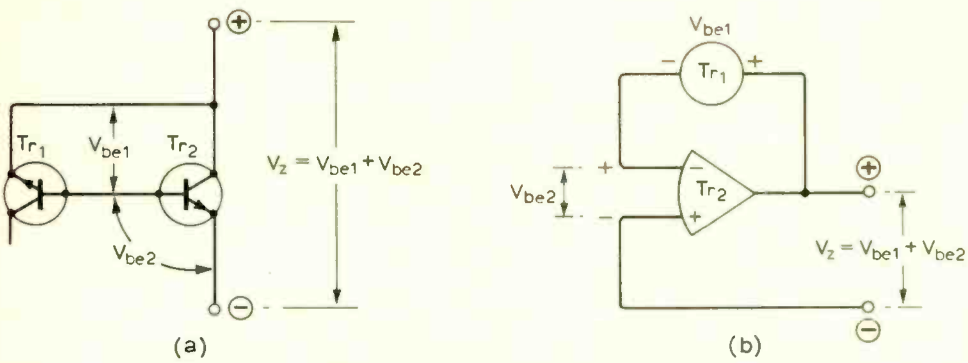


Fig. 2. Circuit configuration of an active zener (a) and its equivalent circuit (b).

Now, a serious drawback inherent to both types of zeners, so far, is the spread of V_Z. This can be easily overcome with the "active zener" by making V_Z variable which is achieved by two resistors, R_1 and R_2 connected as shown in Fig. 3(a). The equivalent circuit in Fig. 3 (b) shows that the original value of V_Z is multiplied by a factor of $1 + R_1/R_2$. Since $-V_{be_1}$ is just below 10 V, a precision 10-V active zener may be set up. When determining the values of R_1 and R_2 it should be kept in mind that the equation $V_Z = (V_{be_1} + V_{be_2})\cdot(1 + R_1/R_2)$ is true only at $I_{b_2} = 0$, otherwise there will be extra current through R_1 tending to increase V_Z. So R_1 should be kept as low as possible. For a tolerated increase in V_Z of, say, 0·5% at $I_Z = 20$ mA and $\beta = 200$, R_1 must be made about 500 ohms resulting in a by-pass current of about 2 mA which is just 10% of the maximum I_Z. R_2 may be found by dividing $V_{be_1} + V_{be_2}$ by $[V_Z - (V_{be_1} + V_{be_2})]/R_1$.

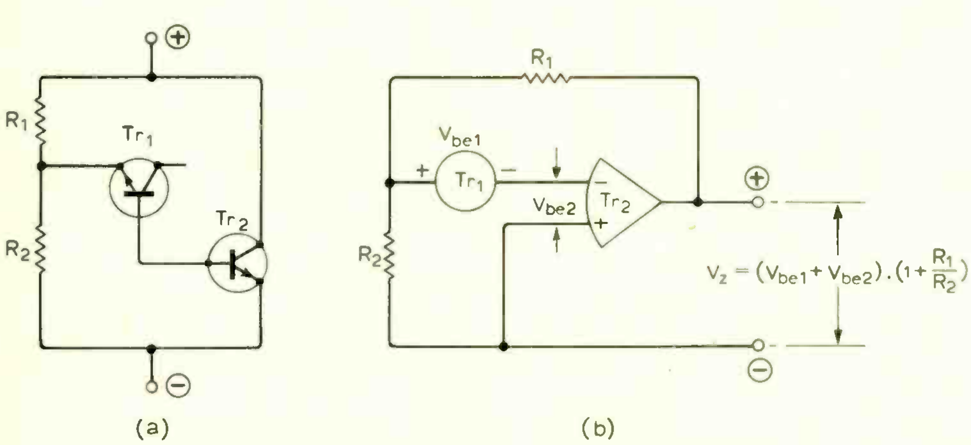


Fig. 3. Active zener with multiplied V_Z and the equivalent circuit (b).

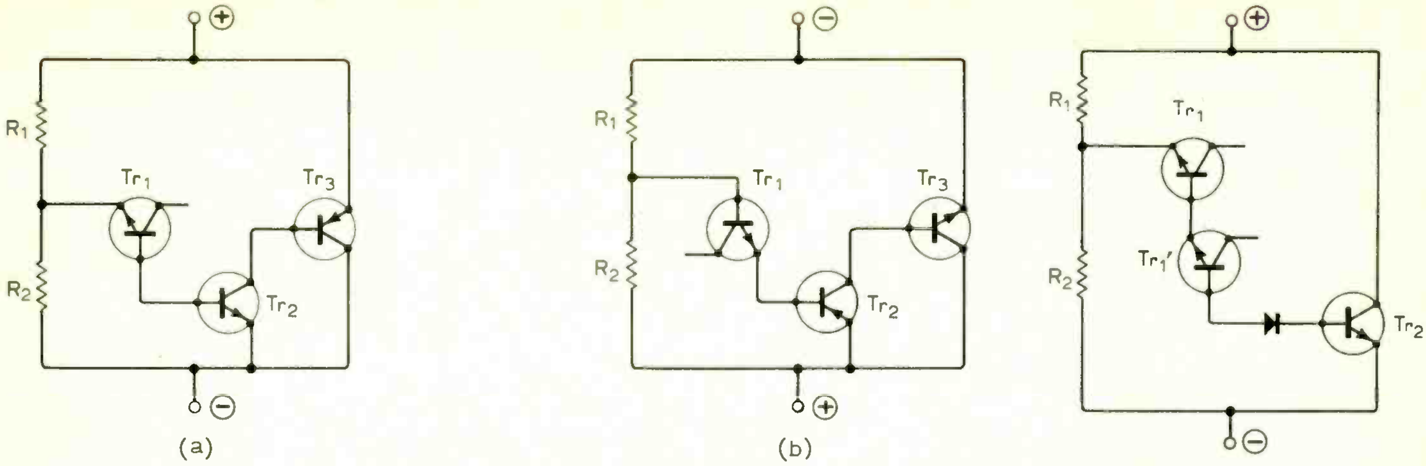


Fig. 4(a and b). Possible alternatives for current boosting without an undue increase in stand-by current.

Fig. 5. Circuit of a 20-V precision zener using two reverse-biased base-emitter junctions.

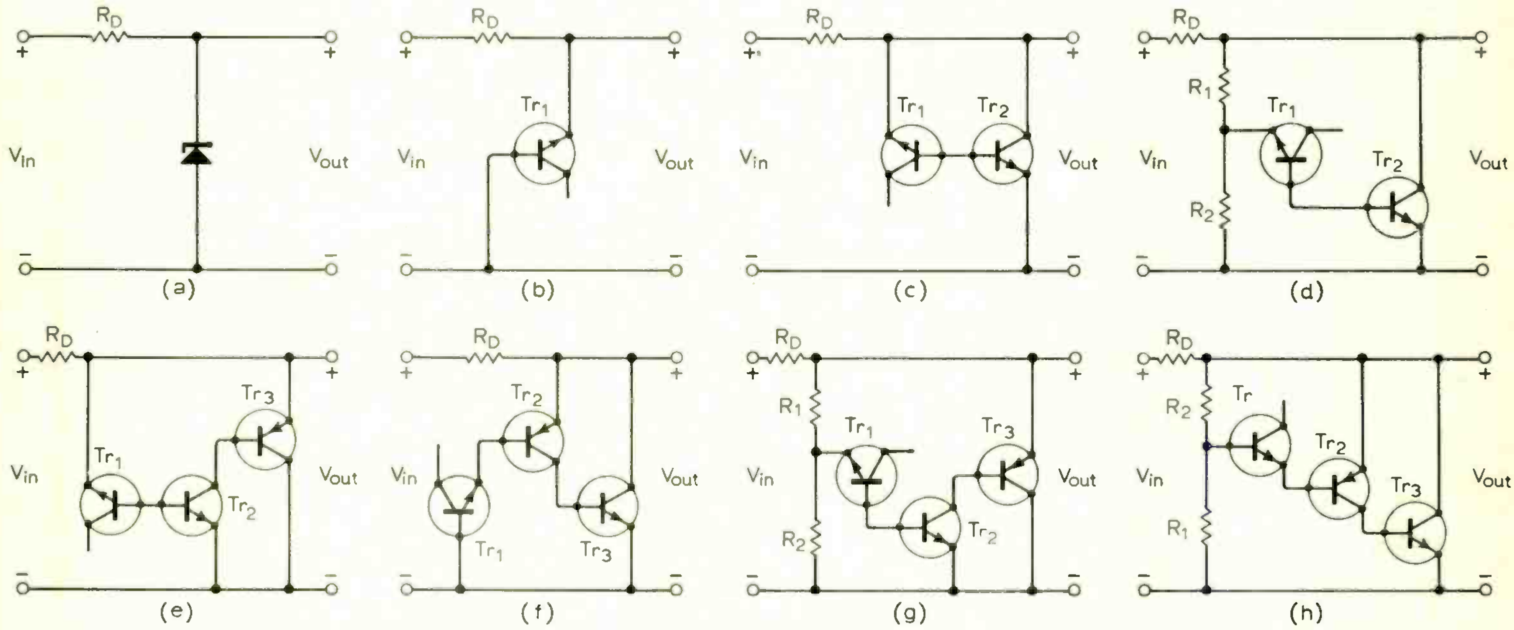


Fig. 6. (a) Zener diode shunt regulator, (b) "zener transistor" shunt regulator, (c) "active zener" shunt regulator, (d) "active variable zener" shunt regulator, (e and f) alternative "active zener" shunt regulators with boosted output current, (g and h) "active variable zener" shunt regulators with boosted output current.

This results in values for R_2 of 4·58 kΩ ($V_{be1} + V_{be2} = 9$ V), 2·88 kΩ ($V_{be1} + V_{be2} = 8{\cdot}5$ V) and 9·5 kΩ ($V_{be1} + V_{be2} = 9{\cdot}5$ V). For practical reasons R_2 is made partly variable by connecting a 10-kΩ trimpot in series with 2·7 kΩ choosing a fixed value of 510 Ω for R_1. For less stringent requirements of changes in V_Z due to I_Z, say 1%, R_1 may be made 1 kΩ, thus halving the by-pass current of the "variable active zener". The larger the current gain of Tr_2 the smaller dV_Z for a given value of R_1. If further current-boosting or greater values of V_Z without sacrificing too much of the useful current-range by stand-by current is required, an extra transistor may be added. Two possible ways are shown in Fig. 4. V_{be3} does not, of course, deteriorate the virtually zero temperature-coefficient of V_Z.

For a 20-V precision zener, two reverse-biased base-emitter junctions may be connected in series, where the increased positive t.c. is compensated for by an extra silicon diode as shown in Fig. 5. However, the author considers the circuit of Fig. 4(b) more attractive for a 20-V precision zener.

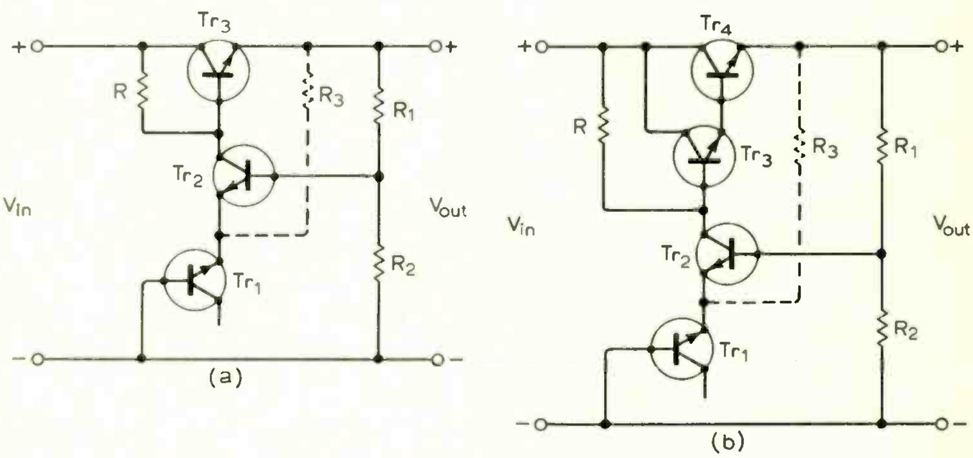
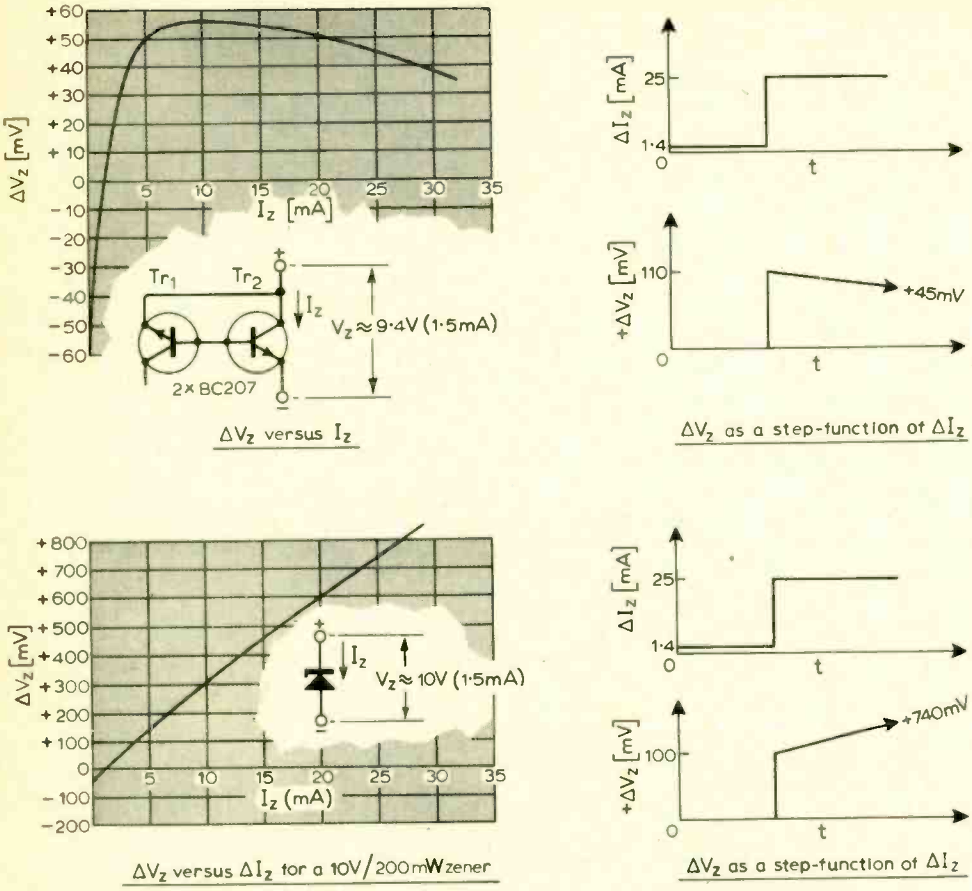


Fig. 7. (a) A simple "zener transistor" (Tr_1) series regulator, and (b) with boosted output current.

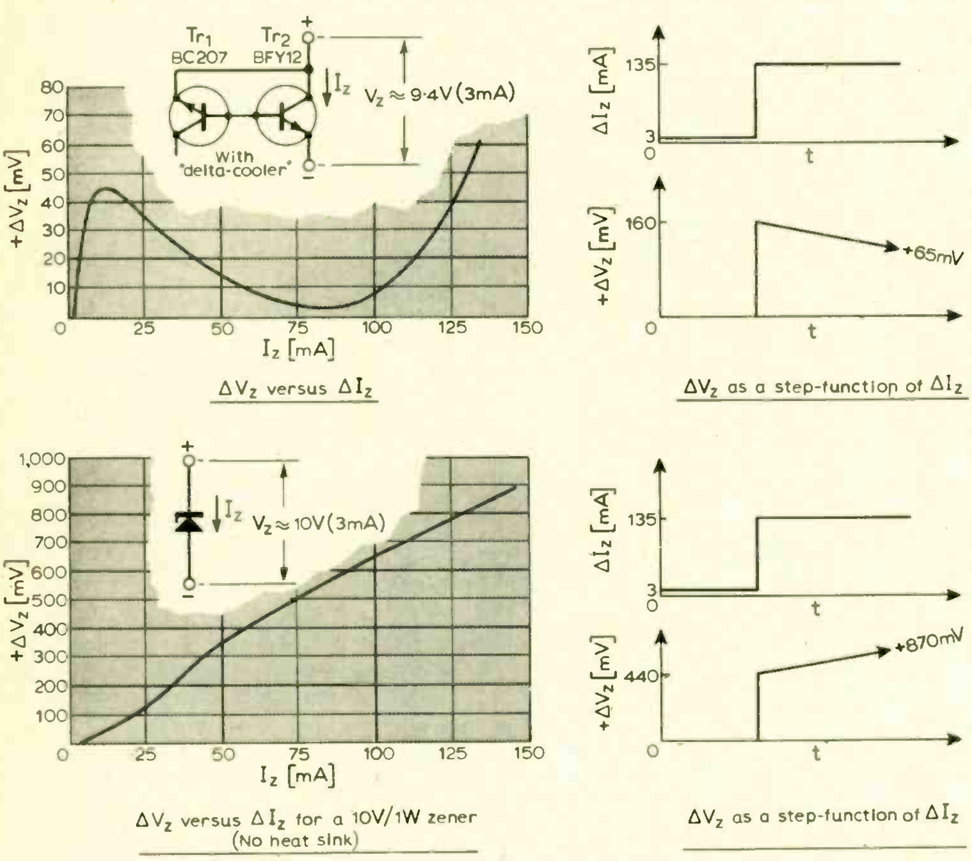
Various examples of shunt and series regulators using "zener transistors", "active zeners" and "variable active zeners" are given in Figs. 6 and 7.

Fig. 6 (f) allows an economic power shunt regulator to be built, with an I_Z of about 2 A, if a 2N3055 (or equivalent plastic version) is used for Tr_3 and a 2N2905 (with "delta-cooler") for Tr_2.

Comparative zener and "active zener" characteristics



Performance characteristics of a 200 mW "active zener" (top) and its ordinary zener counterpart (bottom).



Performance characteristics of a 1W "active zener" (top) and its ordinary zener counterpart (bottom). In both cases ΔV_Z has been allowed sufficient time to settle down to a steady state.

In the case of the series regulators (Fig. 7), the simple "zener transistor" will do, because the zener current requirements are low and the compensation of the positive t.c. of $-V_{be1}$ is performed by the negative t.c. of V_{be2}.

In all circuits shown the lowest possible output voltage is given by $-V_{be1}$ or $V_{be1} + V_{be2}$. In Fig. 7 R_3 serves to fix the current through the "zener transistor" Tr_1.

References
1. "Ring-Of-Two Reference", by P. Williams, *Wireless World*, July 1967.
2. "Constant-Voltage D.C. Supplies", by T. D. Towers, *Wireless World*, Sept. 1968.

Announcements

The following special lectures have been arranged by the Hendon College of Technology, The Burroughs, Hendon, London N.W.4, for the coming session starting in October: **Thyristor applications; Logic algebra** and its application to systems design; and **Electronics for non-electrical engineers.**

Among the courses being offered during the Autumn term at the **Riversdale Technical College**, Liverpool, are full-time, part-time and evening classes covering the new syllabuses for radio, television and electronic technicians and mechanics; full-time marine radar; and evening courses in colour television, industrial electronics and another for radio amateurs

International Computers Ltd, are to hold a series of evening courses in **computer programming** beginning October 14th in London. Details are available from ICL Training Centre (evening classes), Newlands House, 37 Berners Street, London W1P 4AY.

A newly formed electronics company, **Revenue Systems Ltd**, of Luton, Bedfordshire, has announced that it is to receive a substantial development investment from the National Research Development Corporation and Technical Development Capital Ltd. Under the terms of the agreement N.R.D.C. and T.D.C. will jointly finance a two-year research and development programme in exchange for a significant shareholding in the company.

Dynasciences Corporation, of Chatsworth, California, U.S.A., a subsidiary of the Whittaker Corporation, have appcinted Datametrics Ltd, Trout Road, West Drayton, Middlesex, as their exclusive U.K. agents. Dynasciences range of products include pressure transducers, thermocouple reference junctions, acoustic measuring systems, semiconductor strain gauges and temperature sensors.

The **AIM Associates Cambridge Group,** which includes Cambridge Consultants, the research and development company, has established itself in new headquarters at St. Ives, Huntingdonshire. The company was previously based in Bar Hill, Cambridge.

AEI Scientific Apparatus Division, Harlow, has received orders valued at over £40,000 from the U.S.S.R. for two of the new EM8 series of **electrcn microscopes.** Both instruments will be installed in Moscow, one will be used for medical and the other for geological research.

STC's Radio Products Group have been awarded a contract by Aviaexport, Moscow, for the supply and installation of two **instrument landing systems.**

Test Your Knowledge

Series devised by L. Ibbotson* *B.Sc., A.Inst.P., M.I.E.E., M.I.E.R.E.*

17. Quantum electronics

1. An atom or molecule isolated from all others will emit a photon (quantum of electromagnetic radiation):
   (a) only if it is at a high temperature
   (b) only if it is struck by another photon of the same frequency
   (c) only as a result of one of its electrons falling to an orbital of lower energy
   (d) under any circumstance in which its internal energy is reduced.

2. An isolated atom or molecule may absorb a photon by which it is struck:
   (a) in all circumstances—with a probability which depends on the conditions
   (b) only if the photon is at a frequency in the visible region
   (c) only if the temperature is low
   (d) only if the photon energy corresponds to a difference in internal energy states.

3. "Stimulated emission" occurs when an atom or molecule emits a photon as a result of:
   (a) its being struck by another photon of the same frequency
   (b) the application of an electric field
   (c) the application of a magnetic field
   (d) a sudden rise in temperature.

4. Maser or laser action can only occur if the atoms, molecules or ions concerned:
   (a) are all in the lower appropriate energy state
   (b) have more of their number in the lower than in the higher of the two appropriate energy states
   (c) have more of their number in the higher than in the lower of the two appropriate energy states
   (d) are all in the higher appropriate energy state.

5. In the ammonia maser "population inversion" is achieved:
   (a) by "pumping" the gas with infra-red light
   (b) by passing the gas through a non-linear electric field
   (c) by raising the gas to a high temperature
   (d) by a sudden adiabatic expansion.

6. The ammonia maser is not used as a microwave amplifier because:
   (a) it can only operate over a very narrow band of frequencies
   (b) it requires a very large magnetic field to tune it
   (c) it can only operate in pulses, not c.w.
   (d) it can only oscillate, not amplify.

7. The material known as ruby consists of aluminium oxide with a small amount of chromium as impurity. It can be used in either a maser or a laser. Pure aluminium oxide without the chromium:
   (a) would not operate in either capacity
   (b) would operate as maser or laser, but much less efficiently
   (c) would work in a maser but not a laser
   (d) would work in a laser but not a maser.

8. The operating (centre) frequency of a travelling-wave ruby maser amplifier:
   (a) is fixed
   (b) can be changed by altering the cavity resonant frequency
   (c) can be changed by changing the applied magnetic field
   (d) can be changed by changing the applied electric field.

9. In the travelling-wave ruby maser amplifier pumping is achieved:
   (a) by the application of a microwave signal at a frequency higher than the frequency to be amplified
   (b) by illuminating the ruby with light from a discharge tube
   (c) by passing a direct current through the ruby
   (d) by inducing a standing acoustic wave in the ruby.

10. In a ruby laser pumping can be achieved using a broad-band source of light because:
   (a) the chromium-ion electrons are originally pumped into a band of excited states
   (b) the chromium-ion electrons are originally pumped into a metastable state
   (c) the energy is first absorbed by the aluminium atoms in a non-resonant manner, then transferred to the chromium
   (d) enough energy at the single pumping frequency required can be obtained from the broad-band source.

11. Many gases will exhibit laser action. Three of the following methods have been used in different cases to achieve the required energy input—select the "odd man out":
   (a) illumination of the gas by light of an appropriate frequency
   (b) raising the gas to a high temperature
   (c) the passage of a d.c. electric discharge through the gas
   (d) the production of an r.f. discharge in the gas.

12. In the helium-neon laser the laser action occurs:
   (a) in both gases
   (b) in the helium only
   (c) in the neon only
   (d) in molecules which form between the two sorts of atoms under the influence of the electric discharge.

13. The helium-neon laser is capable of operating on at least two frequencies, one in the infra-red and the other in the (visible) red. The frequency at which a given device actually works is determined by:
   (a) the temperature
   (b) the amount of driving power applied
   (c) the construction of the reflecting mirrors
   (d) the diameter of the tube containing the gases.

14. A gallium arsenide p-n junction diode (suitably shaped, with a pair of parallel polished faces perpendicular to the junction) will emit a coherent beam of light if it has applied:
   (a) a small forward current
   (b) a large forward current
   (c) a small reverse voltage
   (d) a large reverse voltage.

15. The light produced by a gallium arsenide injection laser results from:
   (a) recombination of electrons and holes
   (b) energy transitions in the tellurium atoms (donor impurity) only
   (c) energy transitions in the zinc atoms (acceptor impurity) only
   (d) energy transitions in both types of doping atoms.

16. The most nearly perfect monochromatic visible light is:
   (a) a spectral line emitted by a low-pressure gas discharge lamp
   (b) light from a gas laser
   (c) light from a solid-state laser
   (d) light from an injection laser.

17. The travelling-wave ruby maser must be operated at very low temperature (4°K), whereas lasers will work perfectly well at room temperature (some lasers are cooled if very high pumping powers need to be used). The reason for this is:
   (a) the energy levels used in the lasers are much more widely separated than those in the maser
   (b) the energy levels associated with the maser action disappear at higher temperatures
   (c) the maser is an amplifier, whereas the lasers are oscillators
   (d) a very large amount of pump energy is dissipated in the maser crystal.

Answers and comments, page 497

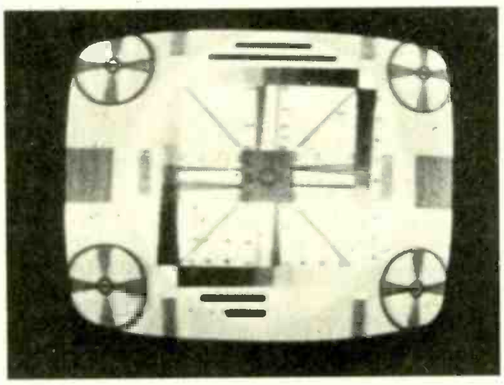
*West Ham College of Technology, London, E.15

Identifying Television Transmissions

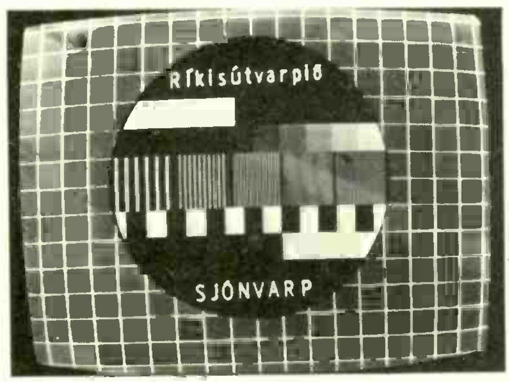
A further selection of test cards

Considerable interest has been created in the reception of Continental television stations as a result of the publication of the Rev. J. E. Scott's letter in the August issue and the selection of test and identification cards included in our last issue. A further selection of test patterns, supplied by M. Dolei of Italy, is given here together with two photographs of pictures received by a reader, Ian A. Beckett, in Buckinghamshire. He was using a four-element wideband (channels 1-5) aerial, horizontally polarized. It was mounted on a rotatable 55-ft telescopic mast which was extended to only 34 ft when the pictures were received.

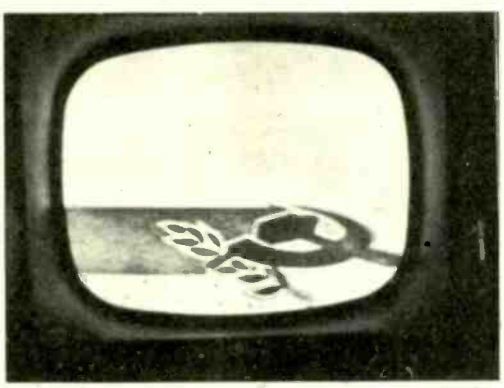
The code letters in parentheses in the heading to each illustration correspond to those in the table listing the parameters of the various television systems given on p. 410 of last month's issue.



Hungarian test card received on a Bush TV115 receiver by Mr. Beckett.

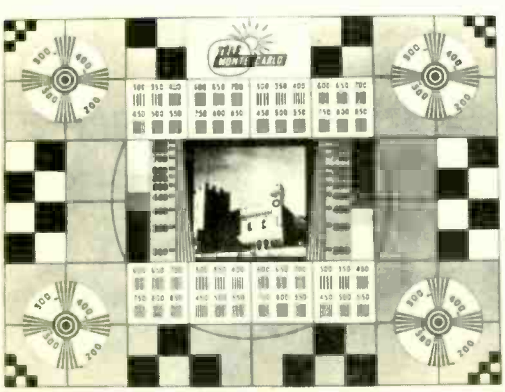


ICELAND (B)
The test card used by the country's few low-power transmitters.



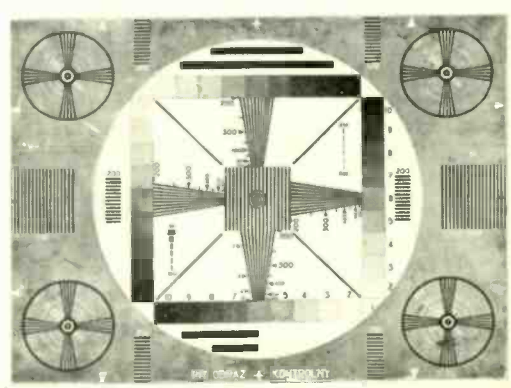
U.S.S.R. caption card as received on a nine - year - old G.E.C. BT311 receiver modified for 625-line negative going pictures.

Caption card used by Iceland's stations.



MONACO (E)
The same test card as employed in France plus the inscription "Tele-Monte Carlo" is used by the principality's station.

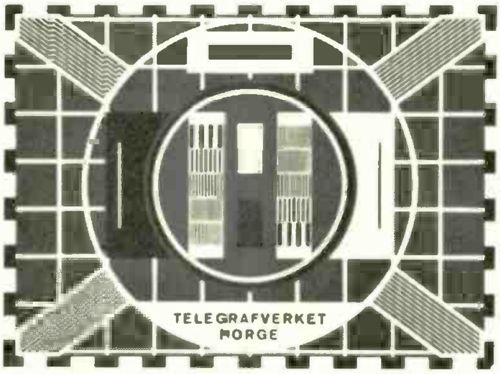
POLAND (B)
No identification is given on this test card.

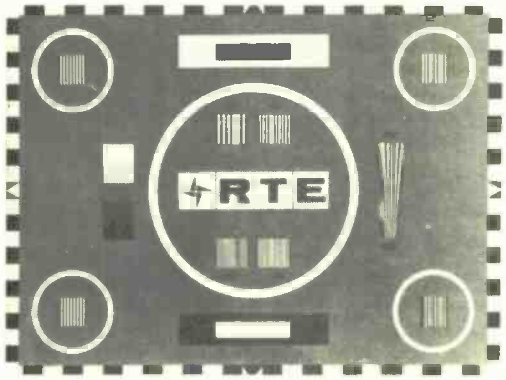


SWEDEN (B)
The country's Band I transmitters use this test card incorporating the name of the station.

YUGOSLAVIA(B)
An easily identifiable caption card used by Jugoslovenska Radio Televizija.

NORWAY (B)
Norway's stations, mostly in Band I, use this test card.

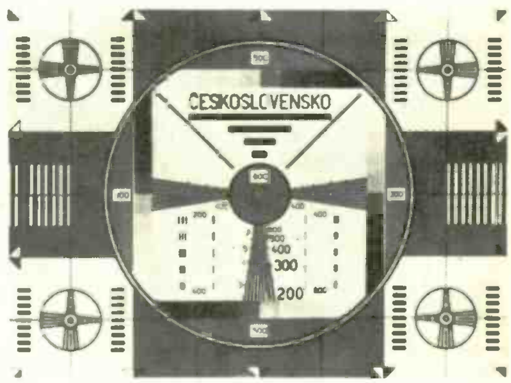




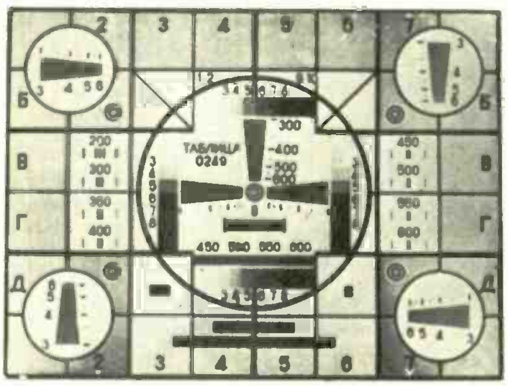
EIRE (A & I)
Reception of television transmissions from Eire can hardly be termed "long-distance", however, here is the test card used.

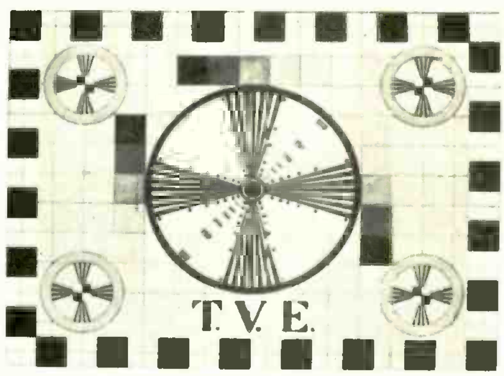
LUXEMBOURG (F)
Identification card of the principality's station

CZECHOSLOVAKIA (D)
The easily recognisable test card used by the Ceskoslovenska Televize.

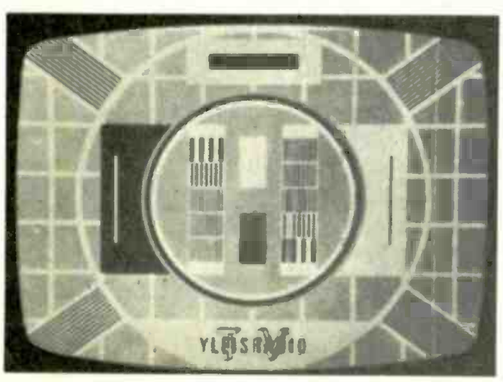


U.S.S.R. (D)
Test card of the stations of the Soviet Union.



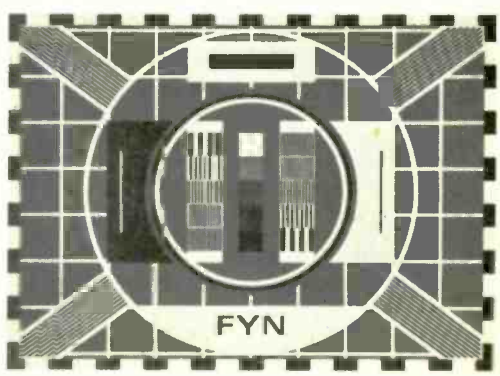


SPAIN (B)
The initials of the Spanish television authority Tele-Vision Espanola appear on the test-card.



FINLAND (B)
Received picture of the Yleisradio test card.

DENMARK (B)
The name of the station appears on the test card.



New Products

Low Light Level TV Camera Tube

The latest addition to the range of TV camera tubes manufactured by English Electric Valve Co. Ltd, combines the low-noise read-out of a 3-in image isocon tube with the additional light amplification of a single-stage image intensifier. The resultant type P8012 tube will give good pictures under overcast starlight conditions. The intensifier stage, P899B, has a curved faceplate for use with a mirror optical system, though with a corrector lens fitted it can also be used with a

refractive optical system. The intensifier output screen and the 3-in image isocon (type P887) photocathode are both fitted with fused fibre optic faceplates, which coupled together provide an efficient transfer of the intensifier output image on to the photocathode of the isocon. Both the P899B and P887 can be supplied separately if required. English Electric Valve Co. Ltd, Chelmsford, Essex.
WW323 for further details

Pocket Radiotelephone

Having no external aerial the Starphone from S.T.C. is claimed to be the smallest two-way radiotelephone produced commercially as a single

unit anywhere in the world. It provides two-way speech at up to 2 or 3 miles from a base station with an aerial 100ft above ground level. The use of u.h.f. ensures a standard of signal penetration into buildings not generally attainable at lower frequencies, together with virtually complete freedom from interference. Where limited coverage is required, e.g. a building construction site, a base station aerial 10ft or 20ft above ground will be adequate. Direct communication between individual Starphone units is feasible without using a central base station, but in this case the range is much more limited and is less predictable. Transmitter power is 150mW and receiver sensitivity 2μV. The new unit is approved by the G.P.O. for 25kHz channel-spacing operation. Price, complete with nickel-cadmium battery, is £125. Standard Telephones & Cables Ltd, 190 Strand, London, W.C.2.
WW309 for further details

Epicyclic Drive

Jackson Brothers have combined their dual ratio ball drive with their adjustable torque ball drive to produce a dual ratio adjustable ball drive —No.5620/DRF. This epicyclic drive gives reduction ratios of 36:1 and 6:1 on one co-axial shaft. A continuous reduction ratio of 36:1 can be supplied on request. The output torque is set at 35 oz.in but the customer can easily adjust this from 20 to as much as 60 oz.in simply by turning four hex head slotted screws. This makes it strong enough to take the place of a gear box in many applications. Jackson Brothers (London) Ltd, Kingsway, Waddon, Croydon CR9 4DG.
WW311 for further details

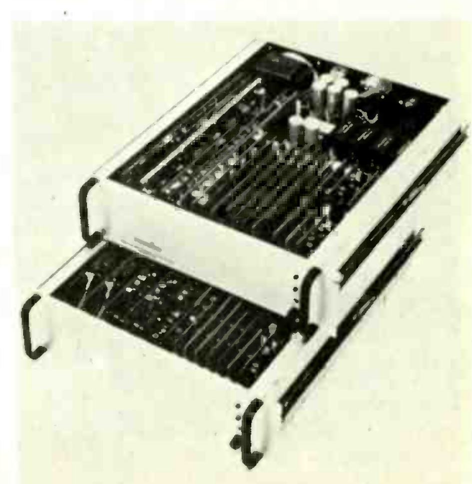
Bandpass Filter Modules

A series of bandpass filters intended for use with the i.f. amplifier section of the company's integrated radio receiver circuit, type TAD100 (and other similar circuits), is being developed by Mullard. The first in the series to be available to setmakers is block filter type LP1175. Designed for use in a.m. radio receivers (see photo showing resonator in situ and others in foreground) it has a centre frequency of 470kHz and a bandwidth, to the -3dB points, of 5kHz; skirt selectivity at -30dB is 18kHz. The filter, which has input and output impedances of 100kΩ, contains two *LC* circuits coupled by a piezoelectric resonator type 540 00105. The filter is enclosed in a metal can measuring approximately 26.5 $\times$ 13 $\times$ 15.5mm, and has six 2.5mm pins that protrude from the base. It can operate at an ambient temperature of 60°C and thermal drift does not exceed 10Hz/°C. The selectivity of the filter module is governed mainly by the piezoelectric resonator, which is equivalent to a capacitor in parallel with a series *LCR* circuit. The type used in the LP1175 has a resonant frequency of 470-

kHz at which it has a *Q*-factor greater than 800, a typical value being 1000, which is far more than that of a conventional capacitor-and-coil arrangement. In addition to high *Q*-factors, the resonators have the advantage of needing no alignment nor screening because they produce no magnetic field. A resonator for use in bandpass filters for f.m. receivers is type 540 04501. At its resonant frequency of 10.7MHz $\pm 0.5\%$, it has a *Q*-factor of more than 350. Each piezoelectric resonator consists of a disc of extremely pure and stable modified lead-zirconate held between gold-plated springs that extend to form printed-wiring tags on a 5.08mm (0.2in) pitch. At its resonant frequency, the disc presents a minimum impedance to an alternating voltage between the gold electrodes; at anti-resonance, the disc presents a maximum impedance. Mullard Ltd, Mullard House, Torrington Place, London W.C.1.
WW318 for further details

Programmable Pulse System

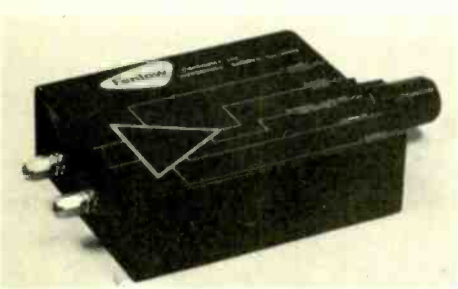
The new Systron Donner 140 System generates repetition rates up to 100MHz, pulse widths to 5nS, and independently variable rise/fall times from 2nS. Applications include testing of high speed integrated circuits, logic modules, cards, and components. In the 140 System, the user's programme sets the upper and lower levels of the output waveform to any values between +10V and -10V. Pulse amplitudes (difference between levels) from 50mV to 5V into a 50Ω load are attainable. Accuracy is typically $\pm 2\%$ for all programmed parameters, including repetition rate, delay, width, and transition times. Programming may be accomplished from punched paper tape, magnetic tape, cards, or other logic sources. All pulse parameters are controlled by BCD inputs which are compatible with DTL logic levels. System components include the model 141 Timing Unit, the model 145 Dual Timing Unit, and the model 142 Output Unit. Both timing units offer



synchronous and asynchronous gating, double pulse operation, square wave modes, and external trigger. The dual timing unit is offered for applications requiring two independently controlled pulses, both from a common clock source. It contains a single repetition rate circuit, two delay circuits and two width circuits, with two independent outputs. One model 145 may be combined with two model 142s to provide a complete dual pulse system. Aveley Electric Ltd, Arisdale Avenue, South Ockendon, Essex, RM15 5SR.
WW310 for further details

High-impedance Data Amplifier

The Fenlow high-impedance data amplifier has been designed to meet those applications in physics, engineering, and medicine, where operational differential amplifiers are unsuitable. The gain of the AD55 is set (by a single resistor) to lie in the range from 2 to 1000. The input impedance is greater than 20,000MΩ being *increased* by the feedback arrangement and not reduced as with



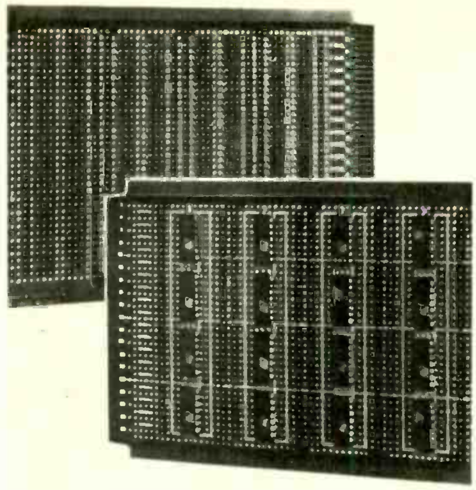
operational amplifiers. The maximum common mode voltage is ± 8V. The noise, referred to the input, is 5μV and the drift from 10μV to 40μV per °C according to the selection on test. The input current is 2 to 20 pA, again by selection on test. The price of the amplifier is from £30 to £60 according to this selection. Fenlow Electronics Ltd, Whittet's Eyot, Jessamy Road, Weybridge, Surrey.
WW301 for further details

Radio Link

Pye introduce a solid-state radio link to provide radiotelephone users and in particular the Home Office with an improved method of point-to-point communication. The radio link, known as the L150, operates in the frequency band 146-174MHz and can be used for the relaying of telephone, radiotelephone and telemetry information to remote premises. The use of field-effect transistors in the r.f. and mixer stages gives the required very good linearity over a wide range of input signals, to provide good inter-modulation and blocking performance. Audio response characteristics are governed by a single module filter and there is a choice of 3.4kHz, 6kHz or 9.5kHz. The transmitter has a power output of 7 watts (minimum) at 174MHz with higher output at lower operating frequencies. The L150 is frequency-modulated and there is a choice of 25kHz or 50kHz channel spacing. Pye Telecommunications Ltd, St. Andrew's Road, Cambridge, CB4 1DP.
WW316 for further details

Circuit Boards for I.Cs

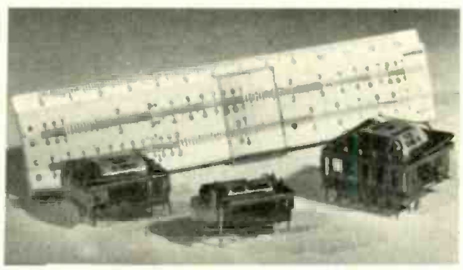
Vero have introduced a new circuit board which permits the mounting of dual-in-line packages of any number of terminations at 0.1 in. centres as well as allowing the user to determine the number of i.cs he wishes to accommodate. Power rails are provided on both sides adjacent to the d.i.p. pads. Test point pads are also included. Plain



holes or local copper pads will take Vero terminal pins for inter-connections. Location patterns can be screen printed on the component side. The new design permits cooling by natural convection as the dual-in-line packages are mounted in the vertical plane and so allows maximum airflow between rows. These boards are available on epoxy glass or s.r.b.p. base material. Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Hampshire.
WW321 for further details

Two-changeover Relay

The range of ITT's PZ style relays for printed circuit boards has been augmented by a two-changeover version, the type PZ-2, shown between the four- and six-changeover types in the photograph. Overall dimensions of this miniature relay are only 29 × 16 × 14mm. The connections are for direct soldering on to printed circuit boards. The two-changeover contacts are of the twin type with a choice of silver/palladium or gold/silver contact alloy. Maximum switched power per



contact is 12VA (1A at 100V a.c. or d.c.). The relay is for d.c. operation. ITT Components Group Europe, Standard Telephones and Cables Ltd, Electro-Mechanical Product Division, West Road, Harlow, Essex.
WW324 for further details

Split screen storage 'scope

The Tektronix model 564B is really two oscilloscopes in one and both can be used at the same time. For display purposes the screen is divided horizontally into an upper and a lower section. Each of these two sections can be switched independently to operate as a conventional oscilloscope or as a storage oscilloscope. This gives four possibilities: (1) Whole screen being used as a conventional display; (2) Whole screen being used in the storage mode; (3) Upper half of screen storing information while lower half operates normally; and (4) Same as (3) with the storage and conventional areas reversed. It is impossible to describe the performance of the Y amplifier and timebase because this depends on which of the 25 available plug-ins you decide to use. Plug-ins will provide dual and four trace facilities and can be sub-divided as follows: d.c. to 14GHz, 25ps sampling; d.c. to 10MHz, 35ns; d.c. to 1MHz, 10μV/div. differential; and 10Hz to 36MHz spectrum analysers: time base units go up to 0.1ns/div. with a ×10 magnifier. the 8×10cm display area split screen storage c.r.t. employs a 3.5kV accelerating voltage and will store for 1 hour, can be erased in 0.25s and has a writing speed of 500cm/ms. A built-in calibration unit provides the following facilities: voltage — 4, 40, 400mV, 4 and 40V $\pm 1.5\%$ ground-to-peak square wave at 1 kHz $\pm 1\%$; current: 10mA d.c. or 10mA ground-to-peak square wave $\pm 1.5\%$. A rear connector allows either the lower or the upper display area to be erased remotely. An Auto erase version is also available. Tektronix U.K. Ltd, Beaverton House, Harpenden, Herts.
WW327 for further details

Dual Channel Coaxial Joint

A new addition to the Radiall range of microwave accessories is a dual channel coaxial rotary joint. Both channels have 50Ω characteristic impedance and the insertion loss for one channel is specified as low as 0.15dB for up to 1000kHz with a maximum v.s.w.r. of 1.15. Effective use up to 4000MHz is claimed with only slight deterioration of the electrical specification. The device will operate in a temperature range from −40°C to +100°C at a maximum turning speed of 100 r.p.m. and a specified life of 500,000 revolutions minimum. Models fitted with b.n.c. receptacles are now in production but other coaxial outlets can be fitted on request. Radiall Microwave Components Ltd, Station Approach, Grove Park Road, Chiswick, London, W.4.
WW302 for further details

Television Camera

A transistor television camera, using a standard one-inch vidicon pick-up tube and having no external controls other than for mechanical focusing is announced by K.G.M. Vidiaids. All the circuitry necessary for the operation of the camera—model 113—including the tube, is housed in a single unit which, after initial setting-up, may be left for long periods without any adjustment being necessary. The camera uses a low wattage integral or separate mesh vidicon. The use of plug-in boards and plug-in transistors greatly eases servicing, and the construction is such that inexperienced personnel can easily change a circuit board. A constant output signal for a wide range of vidicon target illumination is maintained by an automatic sensitivity circuit which can tolerate a range of 2000:1. The camera provides a composite video signal output of 0.7V p-p and has a horizontal resolution in the order of 800 lines, with the vertical better than 400 lines. The standard camera can be operated from external synchronizing pulses which may be random interlace or 2:1 interlace. Alternatively, with the addition of a K.G.M. Vidiaids model 113/18 sync-generator and video processing board, external or internal synchronization is obtainable. This additional unit also extends the facilities of the camera to provide a composite video output with black level clamp. A simple change converts the camera to line and field drive operation with composite or non-composite video output. The camera operates from a 100-125V or 200-250V a.c. power source at 17VA, and connections at the rear of the unit provide for operation from a −16V d.c. supply. Prices for the camera, without the lens and vidicon tube, range from £250 for the standard unit to £312.15.0d.

for a unit fitted with a synchronizing generator and video processing board, optical focus driving motor and the additional facility of operation from line and field drive. K.G.M. Vidiaids Ltd, Clock Tower Road, Isleworth, Middlesex.
WW 317 for further details

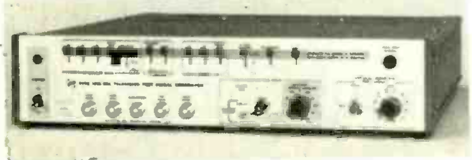
Surge Indicating Meter

The John Howard Industrial Electronics surge indicating meter is believed to be the first of its kind. By simply placing two clip leads from the meter across the supply to be monitored any harmful surges which occur on the line of microsecond duration or longer are instantly displayed on the large mirror-scale meter. The reading is automatically held for approximately 30 sec. Reset is accomplished by means of a press

button on the panel. The battery, which is a standard PP3 or equivalent, has check facilities built into the unit. Two stock models are available which are 0-200 volts and 0-2kV f.s.d. Other ranges can be ordered. Price: £20. John Howard Industrial Electronics Ltd., 32 Oaks Road, Great Glen, Leicester LE8 0EG.
WW305 for further details

TV Test Signal Generator

Tektronix announces a television test signal generator (type 141A). Designed to provide test signals for 625-line, 50-cycle field PAL colour TV systems its three operating modes provide colour bars, a 5-step staircase with fixed average picture level (a.p.l.), and the same staircase with variable a.p.l. Colour bars can be produced with



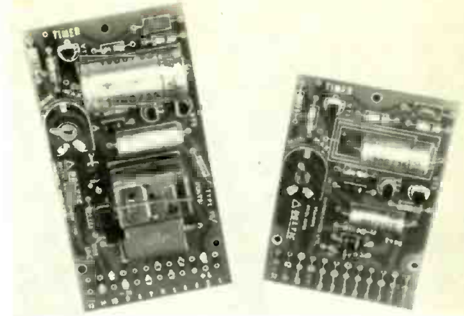
the following alternatives: 75% or 100% amplitude; 75% or 100% white reference; and 0% or 25% setup. The ability to select these various parameters of the colour bar signal affords output of three colour-bar signal arrangements used as standards in various countries using the PAL system—E.B.U. bars, B.B.C. 95% bars and 100% bars. A PAL pulse output is selectable, either a 1-V squarewave of a 4-V pulse, to afford locking of any PAL synchronization system at present in use to the type 141A test signal generator. The staircase signal is keyed on during a selected line of the vertical blanking interval (line 11-22 on field 1, or line 324-335 on field 2) and is particularly useful with a Tektronix type 520 PAL vectorscope to measure differential phase, differential gain, and luminance channel linearity. The last step (at white level) is double width for viewing with and without subcarrier to detect clipping in the white direction. Normal PAL colour burst is provided on the stair-step and colour bar signals. The complex 4-field burst blanking sequence during vertical interval is provided and may be switched off if desired. A 1-MHz reference signal which is frequency locked to the 4.43361876-MHz PAL subcarrier oscillator is provided at the rear of the instrument. The type 141A is available in either rackmount (R141A) or cabinet styles (141A) for £858 plus £183 17s duty. Tektronix U.K. Ltd, Beaverton House, Harpenden, Herts.
WW319 for further details

Signal Buffer Store

Frederick Electronics Corp. announces an economical solid-state buffer store for 5-unit code teleprinter signals with a storage capacity of up to 9900 characters. It is particularly suitable for operation with ARQ automatic error correction equipment, for speed conversion purposes and, in general, for replacing mechanical perforated tape storage systems. Storage of teleprinter signals is effected by plug-in delay line modules. The stored signals keep circulating in a delay line loop at 2MHz until it is their turn to be released to the output. A parallel output, stepped by an external pulse, or a stepped or free running start-stop serial output are available. The rate at the output can be as high as 120 characters per second. A meter on the front panel indicates how full the store is. Various outputs are available for auxiliary functions. Also provided is an input for remote clearing of the store. The model 1330 buffer store is designed for mounting in standard 19-in. cabinets. Frederick Electronics Corporation, P.O. Box 502, Frederick, Maryland 21701, U.S.A.
WW307 for further details

Timer Modules

Three basic modules are offered, by Deltic Automation, to provide timed delay or timed interval control and covering times of 0.1 sec to 10 minutes in four overlapping time ranges. Typical repeat timing accuracy is within 2%. Series TD and TS modules provide single pole change-over relay output switching rated up to 1 amp at 250V a.c. and the series SD modules single make solid-state output, rated at 0.5 amp at 150V d.c. with time delay operation. Standard supply voltages for series TD and TS modules are: 12V, 24V and 48V d.c., or 100/125V and 200/250V a.c. (50/60 Hz). For the series SD, 10-50V d.c. Time setting and adjustment are carried out by means of a self locking preset potentiometer mounted on the module. Facility for the time setting to be remote controlled using an externally mounted potentiometer is also provided. The modules are said to show good stability over wide changes of ambient temperature and supply voltage fluctuation. A further range of timer modules series RDD and ROS have also been introduced, designed specifi-



cally for driving external relays, reed switches or thyristors. Connection of all types is either by permanently wired solder tags or, to provide easy interchangeability, by means of a 12-way plug-in edge connector. Screw fixing holes are also provided so that the module may be rigidly attached to a suitable mounting face if desired. Deltic Automation Ltd, Tillys Lane, Staines, Middlesex.
WW315 for further details

Miniature Coaxial Mixers

Available from Interplanetric is a range of miniature coaxial balanced mixers, in octave bands from 0.5 to 12.4GHz. All of these mixers exhibit a noise figure of approximately 7dB, and are fitted with OSM connectors or solder pins. Local oscillator power requirement on all devices is 2mW, and i.f. ranges vary to suit customer requirements. Two easily replaceable Schottky barrier diodes are used in these mixers. Interplanetric, 39–49 Cowleaze Road, Kingston upon Thames, Surrey.
WW322 for further details

Microwave Isolator and Circulator

Two miniature, strip-line components are introduced by The Marconi Company—an isolator and a three-port circulator—which are considerably smaller and lighter than the standard designs available. Both devices cater for a very wide band of frequencies, from 7.5 to 12.5GHz, and have the same basic design. The isolator is derived from the circulator, but with one of the three ports replaced by a miniature coaxial load. The reliability of these ruggedly made devices, combined with their light weight and small size (approx. 38 × 13 × 25mm), makes them particularly suitable for use in miniaturized equipment, such as man-pack and airborne communications systems, which have to operate in severe conditions. The isolator and the three-port circulator will form the foundation of a new range. Marconi Company Ltd, Chelmsford, Essex.
WW304 for further details

Wide-range Oscillator

A wide-range oscillator—the SG67A—providing sine or square wave output over the frequency range 1Hz to 1MHz, has been added to the signal generators available from Advance Instruments.

An 'Augat' component is its own salesman. Apply one and you'll buy another (Electrosil's repeat orders prove that daily).

'Augat's' supreme reliability in use and re-use is consistent throughout a complete range of semi-conductor hardware.

It is unvarying in integrated circuits.

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or to Electrosil distributors:

WEL Components Limited, 5 Love Rock Road, Reading, Berks. Tel: Reading 40616-9.

Electrautom, 8 Clarence Road, Windsor, Berks. Tel: 64258.

SDS (Portsmouth) Limited, Hillsea Industrial Estate, Portsmouth, Hants. Tel: 62332

Illustrated: The new 24 lead dual-in-line low-profile i.c. socket accepts packages with round or flat leads, has large contoured entry holes for cosy, damage free i.c. insertion. Also available: 14, 16, and 40 pin i.c. sockets for soldering, p.c. mounting and wire-wrapping. We have over 35 i.c. socket types available immediately.

See the 'Augat' range of components at
**ELECTROSIL'S STAND NO. 304
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OCTOBER 14, 15 AND 16**

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WW297 for further details

can you spare three minutes?

That's all it will take you to read this and as long as it will take you to put any mobile radio transmitter on tune—without demounting it.

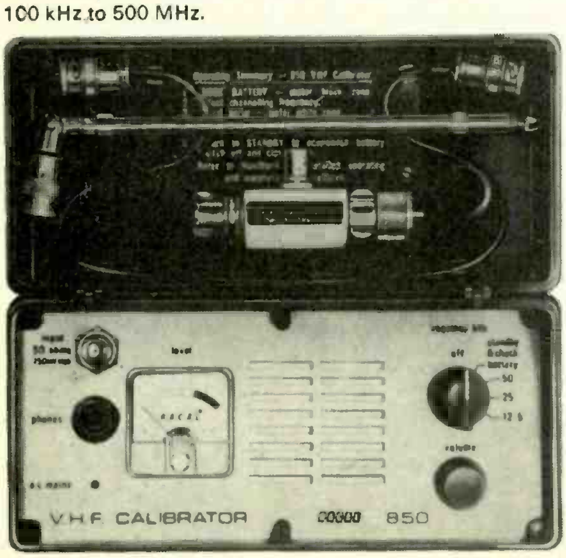
On-site mobile transmitter re-calibration to one part in one million accuracy—with the 850 in one hand and a screwdriver in the other—you've done it!

The Racal Type 850 VHF/UHF Calibrator

Unique state-of-the-art instrument embodying a major Racal innovation in mobile radiotelephone calibration. Checks and sets single and multi-channel transmitters "on frequency" accurately and rapidly.

Frequency accuracy of mobile and marine transmitters must by law be within very close limits. GPO requirements stipulate a frequency accuracy of ± 2.5 kHz on the u.h.f. band. This is an accuracy of 1 part in 100,000. Inevitably frequencies drift—BUT the 850 calibrator enables transmitters to be calibrated 'in situ'—no need to demount and return to the Lab.

☐ PORTABLE BATTERY/MAINS ☐ FAST WARM-UP ☐ 1 PART IN 1 MILLION ACCURACY ☐ ALL SOLID STATE ☐ SIMPLE TO OPERATE ☐ HIGH STABILITY ☐ ELIMINATES THE NEED FOR COSTLY TEST EQUIPMENT ☐ FREQUENCY COVERAGE 100 kHz to 500 MHz.



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WW—108 FOR FURTHER DETAILS

Noise is low. Battery operation of the SG67A provides maximum portability; it further minimizes noise due to ground loops and hum, and enables the instrument to be "floated" at potentials above ground without damage. A battery check position is provided on the front panel. For continuous laboratory operation not requiring power-line isolation, an a.c. power supply BEI may be specified as an optional extra. Both sine and square wave outputs are thermistor stabilized to within ±1dB at constant temperature for frequencies up to 200kHz. Output level is fully variable from 250mV to 2.5V r.m.s. into 600Ω by means of a fine level control and a four position 60dB attenuator. Square wave rise time is typically 50ns at all frequencies. Price £42. Advance Instruments, Roebuck Road, Hainault, Essex.
WW320 for further details

Radiotelephone Fixed Station

Pye Telecommunications offer a v.h.f. radiotelephone fixed station, known as the F100FM, designed to meet the requirements for a 100-watt control station in a mobile radiotelephone scheme. This export unit is available for both simplex and duplex operation on one of four bands in the frequency range 29.7 to 174MHz. The standard unit is for single channel operation, but up to six-channel versions are available with a choice of 12.5kHz, 20/25/30kHz or 40/50/60kHz channel spacing. The transmitter (upper unit in photo)

has a power output of 100 watts for simplex operation and of 60 watts for duplex. Silicon transistors are used throughout the equipment except in the drive and output stages of the transmitter. All components are selected for reliable operation over a wide range of temperature to make the equipment suitable for use in all climates. Both local and remote control facilities are available and these and other functions can be built into the receiver itself, thus requiring no extra rack or cabinet space. The equipment is designed for standard 19-in rack mounting. Pye Telecommunications Ltd, St. Andrew's Road, Cambridge, CB4 1DP.
WW325 for further details

Wide-band Power Splitters

Interplanetric offer a range of wide-band power splitters, series PS. These provide a power split from one input to a number of outputs or a power combination of a number of inputs to one output with low loss and high isolation. They may be used to add or subtract signals, providing a single output proportional to the sum of all inputs, or the difference between two signals with high isolation between sources. For example, two or more i.f. signals may be combined in a receiver diversity combiner circuit. These devices may be used to split input power from 2-128 ways and, are said to give good port matching, high isolation and good amplitude, with excellent phase balance. These devices cover frequency ranges from 80kHz to 400MHz with a nominal impedance on all parts of 50Ω. Other impedance values are available on request. All units exhibit a v.s.w.r. of 1.2-1 at frequencies up to 100MHz and 1.3-1 for frequencies up to 400MHz. Insertion loss is typically 0.5dB. Maximum power on all units 5 watts. All units come in either pin package or connector package. Operation is possible between −65°C and +105°C and in strong electro-magnetic fields. All units meet military specifications 202C for vibration and shock. Interplanetric, 39-49 Cowleaze Road, Kingston upon Thames, Surrey.
WW326 for further details

Photo-Thyristors

A family of photo-thyristors (light sensitive s.c.rs) from Transitron Electronic features high sensitivity, high transient immunity and wide-angle sensing. Anode voltage ratings include 15, 30, 60, 100 and 200V for light sensitivities of 1500 and 1000 lux at either 25 to 100°C or 25 to 125°C. The same voltages are available for 500 lux at either −55°C to 100°C or −55°C to 125°C. Operating and storage temperatures are −65°C to 100°C and other absolute maximum ratings include: continuous d.c. forward current (50°C case) 300mA; surge current (8ms) 5A; peak gate current 250mA; average gate current 25mA; reverse gate voltage 5V. Transitron's photo-thyristor range is packaged in a TO-18 can. Transitron Electronic Ltd, Gardner Road, Maidenhead, Berks.
WW312 for further details

Stylus and Turntable Cleaning Kit

The playing of only one side of an l.p. record involves a journey for the stylus of ½ mile, which inevitably means that the stylus picks up foreign matter during tracking. The deposits can impair the quality of reproduction, and damage the record. A stylus and turntable cleaning kit has been produced by the Bib Division of Multicore. The size B kit comprises: a 30 c.c. bottle of Bib anti-static; stylus and turntable cleaner; a cleaning brush with a suction pad; and also an absorbent, washable cleaning cloth. This is provided to wipe the brush free from dirt picked up from the stylus, and also to apply and remove the Bib cleaner to the turntable in order to render it clean and anti-static, thereby keeping it free from dust. The Bib cleaner is non-flammable. The recommended retail price for the kit is 6s 10d. Bib Division, Multicore Solders Ltd, Hemel Hempstead, Herts.
WW313 for further details

Reed Relay Modules

An extensive and versatile series of both open and totally sealed Clareed modules for p.c.b. mounting is now available from Clare Electronics. All models switch 10VA–200 volts d.c. max and 0.75 amp max. With a switching time of 1 millisecond they are versatile transistor interface units driven by d.t.l. or t.t.l. The standard series has an operate sensitivity of 80mW while the sensitive range can operate with less than 35mW. The drive to switch isolation on the open type MRMC module (shown left in photo) is tested at 500V while the

sealed epoxy moulded module MRME (shown right) is tested at 2kV to safeguard circuit isolation. There is also type MRMD metal cased (shown centre). Selected relay modules can have a thermal voltage of 35μV across the open contacts. Standard contact resistance plotted against life, indicates that full resistive load (24V d.c., 420mA) contact resistance can be lower than 100mΩ throughout a life of 10^7 operations. C. P. Clare Electronics Ltd, Stonefield Way, Ruislip, Middlesex.
WW303 for further details

TO-3 Cover

The Jermyn A22/2003 cover has been designed to fit snugly over the high profile range of TO-3 size semiconductors currently being marketed to insulate the exposed surfaces from adjacent components and other objects such as screw-

drivers, fingers etc. The use of these covers is recommended particularly where the transistor is not at earth potential. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW314 for further details

Signal Averaging Gate

Brookdeal Electronics have introduced a linear gate, type 415, to sample and average repetitive information. The 415 is the latest addition to the Brookdeal "400" series instrumentation, specifically designed to recover low-level signals buried in noise. Brookdeal claim that the 415 is also

ideally suitable as a signal recovery phase-sensitive detector up to 30MHz. The main section of the 415 is a sample-and-hold circuit which is given very high linearity by the application of overall negative feedback. The samples of the signal and noise are then processed by an averaging circuit whose time constant may be altered to suit individual experimental conditions. The sampling system must be triggered by an external reference voltage of +1V into 50Ω. A Schmitt trigger incorporated in the reference channel ensures that the rise and fall times of the sampling operation are virtually independent of the rise and fall times of the reference pulse. Gate time is set by the reference pulse, minimum 10nS. 100mV peak input gives 10V output from 10kΩ. Price £240 (U.K.). Brookdeal Electronics Ltd, 2 Myron Place, Lewisham, London, S.E.13.
WW308 for further details

Personalities

Harvey F. Schwarz, B.Sc., managing director of the Decca Navigator Company, is president elect of the Institution of Electronic and Radio Engineers for 1969/70 in succession to **Major-General Sir Leonard Atkinson,** K.B.E., president for the past two years. Mr. Schwarz, who was born in 1905 in Edwardsville, Ill., graduated at Washington University, St. Louis, and then joined the General Electric Company, Schenectady. In 1928 he became the assistant chief engineer of the Brunswick Radio Corporation. He was in England on business with Warner Brunswick Ltd when that company was acquired by the Decca Record Company and he was made chief engineer of Brunswick Ltd on its formation. When Decca Radio and Television Ltd was formed in 1938 Mr. Schwarz became technical director. When his friend **William O'Brien** invented a c.w. hyperbolic navigational system in 1939 it was taken up by Decca. After the war the Decca Navigator Company was formed and in 1950 Mr. Schwarz became managing director.

Donald H. Randall, who is 31, has been appointed manager of the Service Divison of Pye Unicam Ltd. He joined Philips Electrical Ltd as a medical X-ray service engineer in 1955 and two years later joined the company's Research and Control Instrument Division. With the formation of M.E.L. in 1964 Mr. Randall became technical services manager. In July last year he became responsible for the Philips branded products as one of three technical services managers when Pye Unicam Ltd was formed.

Peter Mikutta recently joined the Bonn branch of Racal-Milgo Ltd, as sales manager, Federal Republic of Germany. Prior to joining the Racal Group, he was with Collins Radio in Frankfurt where he was in charge of their data systems. He has also worked for Siemens AG as a development and field engineer in Munich and Frankfurt.

Derek Ashby has joined Lyons Instruments Ltd, of Hoddesdon, Herts, as field sales manager. He was formerly with Marconi Instruments, first as a sales engineer and latterly as manager, factored products, and was at one time sales manager at Furzehill Laboratories. The company also announces the appointment of **Bill Hooper** as manager, quality assurance. Prior to spending a year with Lyons Instruments as a sales engineer, he had held senior quality control positions in the Royal Navy and with Sperry Gyroscope.

J. F. Dukes, appointed U.K. marketing manager of Racal-Milgo Ltd, joined Racal in 1963 as a communications sales engineer. He became liaison engineer between Racal and the Tele-Signal Corporation and was instrumental in the establishment last year of a joint company between Racal and the Milgo Corporation of Miami. Prior to joining Racal, Mr. Dukes, who is 34, worked with Cable and Wireless Ltd, from 1955 for four years, and from 1959 until joining Racal was with the Marconi Company as a communications sales engineer.

Ian Dewar, aged 33, has been appointed sales manager of ITT Electronic Services, Harlow, Essex. He moves from the capacitor division of ITT Components Group Europe at Paignton, Devon, where he has been in charge of the sales office. He joined the capacitor division in 1962.

Francis Hall, for the past two years chief engineer of the telecommunications division of CEDENCO (C. Denis & Co.), has been appointed technical director. Mr. Hall, who is 46, was in the R.A.F. from 1938 until 1946 when he joined the Post Office as a telecommunications engineer. 1956 saw him in East Africa as assistant engineer in the East African Post and Telegraph Administration. He returned to England in 1962, subsequently joining the Telephone Manufacturing Co. as systems application engineer.

F. Hall

John Woods has been appointed marketing manager by Computer Technology Ltd. Mr. Woods (37) joins C.T.L. from the Univac Division of Sperry Rand, where he became director of marketing (U.K.). His nine years at Univac included a spell with the company's Federal Systems Divison in the U.S.A. Previously, he had been with E.M.I. Electronics and Powers Samas.

Data Recognition Ltd. of Reading, manufacturers of optical document readers, announce the appointment of **J. R. B. Cooper** as managing director. Mr. Cooper was previously managing director of Mohawk Data Sciences (Great Britain) Ltd and prior to that was a director of Automatic Input Systems Ltd.

N. V. Nichols has joined Leevers-Rich Equipment Ltd as sales engineer. Mr. Nichols was formerly with Radford Electronics Ltd, Bristol, and the E.M.I. Group. The company also announces the appointment as general manager of **Peter Richards,** who recently joined the board. He has been with the company since 1959 and was latterly works manager.

W. F. Hawes, aged 48, has been appointed overseas marketing manager for Pye Telecommunications Ltd. Mr Hawes was for two years commercial services manager, having previously had five years' experience in export sales as the Far East area manager.

The electronic research and industrial activities of Electric & Musical Industries Ltd have been formed into one unit termed Electronics and Industrial Operations. **J. M. Kuipers** (EMI board director) has been appointed chief executive and **P. A. Allaway** (EMI board director, and previously managing director of EMI Electronics Ltd) has been appointed chairman of EMI Electronics Ltd. **Air Vice Marshal W. E. Oulton** is appointed director, publicity & sales promotion. The Unit has been divided into four divisions each under its own managing director: Television Equipment, **P. A. D. Duffell;** Systems & Weapons, **D. J. George;** Radar & Equipment, **F. H. Panter;** and Electron Tube & Microelectronics **J. Sharpe.**

Michael K. Woy, who joined Bryans Ltd in 1963 as sales engineer, has become sales manager in succession to **L. Crowhurst** who has left the company. Mr. Woy served for eleven years in the Royal Navy in communications and a further eight years in industry.

Dr. Robert C. G. Williams, O.B.E., chief engineer of Philips Electronic and Associated Industries Ltd, has been elected president of the Institution of Electrical and Electronics Engineers for 1969/70 in succession to **Sir Harold Bishop,** C.B.E. Dr. Williams, who was elected chairman of the Council of I.E.E.T.E. in 1967, has been with Philips since 1947.

Electrotech Instruments, a division of Coutant Electronics, announce the appointment of **Roy S. Bibby** as a senior sales engineer. Prior to joining Electrotech Instruments, Mr. Bibby was with Advance Industrial Electronics from 1963 as an area sales engineer.

John Woodley, aged 32 years, has been appointed senior sales engineer in the Power Supply Division of Coutant Electronics Ltd of Reading. He served his apprenticeship with G.E.C., and joined the company in 1959 as a group test development engineer. He was later seconded to Rolls-Royce & Associates. From 1968 until joining Coutant Electronics, he was with Wayne Kerr Co. Ltd.

OBITUARY

Henry Franklin Smith, editor of *Wireless World* from 1941 until his retirement in 1957, died on August 25th aged 77. Known affectionately in the radio and electronics industry as "High Frequency" he joined the staff of *W.W.* in 1925. Born in New Zealand and educated in Switzerland he joined the Marconi Company as an installation engineer in 1911 and installed the first direction finders in India. When broadcasting started he went into the domestic radio industry which he left to join *W.W.* When replying to the many tributes from leaders in industry at the time of his retirement he used the phrase "a journal is essentially a team and any success we have achieved is mainly due to the very capable team which I have had the privilege of leading". Those who were members of that team know the value of such a mentor.

Professor Frederick Joseph Hyde, D.Sc., F.I.E.R.E., died recently as a result of an accident in the swimming pool at the Royal Military College of Science, Shrivenham, where he had been professor of electrical and electronic engineering for the past year. Professor Hyde, who was 45, graduated at Birmingham University in 1943. After service in the R.A.F. he returned to the University in 1947 and took his masters' degree. He was awarded a doctorate in 1963. In 1949 Dr. Hyde joined the staff of the Radio Research Station at Slough. In 1958 he left to become a lecturer in the Department of Electronic Engineering and School of Engineering Science at the University College of N. Wales at Bangor, where he became professor of physical electronics in 1965.

World of Amateur Radio

Amateurs under new P. & T. Ministry

Responsibility for the issue and control of British amateur radio and model control licences passes on October 1st to the new Ministry of Posts and Telecommunications. All licences issued after this date are expected to be in a slightly different form, but the clauses will remain unchanged, and licences already in force will not need to be replaced. So after almost 65 years—the first British licences "to use Wireless Telegraphy for experimental purposes" were issued in 1905—the control of amateur licences will no longer rest with the Post Office. From October 1st, all correspondence in respect of amateur and model control licences should be addressed to: Ministry of Posts and Telecommunications, Telecommunications and Radio Regulatory Department, Radio Regulatory Division, Amateur and Special Licensing Branch, Waterloo Bridge House, Waterloo Road, London S.E.1.*

* What an opportunity for a coded address!—Ed.

V.H.F. and moon-bounce records

A recent A.R.R.L. listing of v.h.f. two-way records shows that currently all band records other than for 50MHz are claimed by American amateurs, although Peter Blair, G3LTF, of Chelmsford, is credited with two of the special "moon bounce" records. The present records are given as: 50MHz, 12,000 miles, LU3EX and JA6FR (1956); 144 and 220MHz, 2540 miles, W6NLZ and KH6UK (1957 and 1959); 420MHz, 1150 miles, W5LUU and WA4KFW (1965); 1215MHz, 400 miles, W6DQJ and K6AXN (1959); 2300MHz, 225 miles, W2BVU and K1DRB (1968); 3300 MHz, 190 miles, W6IFE and W6VIX (1956); 5650 MHz, 179 miles, WA6KKK and WB6JZY (1966); 10GHz, 265 miles, W7JIP and W7LHL (1960); 21GHz, 27 miles, W2UKL and WA2VWI (1964); above 30GHz, 2.3 miles, W6FUV and W6ICJ (1969). Two-way earth-moon-earth records are: 144MHz, 11,055 miles, SM7BAE and ZL1AZR (1969); 420-MHz, 5730 miles, WA6LET and G3LTF (1965); 1215MHz, 5492 miles, WB6IOM and G3LTF (1969). First moon-bounce reception reports on 2.3GHz amateur signals show that transmissions from W3GKP, Maryland, have been heard at W4HHK near Memphis. The transmitter had an output power of 275 watts and a 28-ft dish aerial. Reception was achieved on an 18-ft dish aerial using a parametric amplifier with a 9.6GHz klystron pump. The stations hope to establish two-way contact soon.

Beginner's Licence—future uncertain

Considerable interest is still being shown in the "beginner's licence" announced in March 1968 by the then P.M.G., Mr. Edward Short. Most informed amateurs, however, are convinced that the original proposals are unlikely to be implemented by the new Ministry, although it is possible that some alternative scheme may eventually be introduced. The 1968 statement ran into considerable opposition, not least because the announcement was made by the P.M.G. without the customary full consultation between the Post Office and the Radio Society of Great Britain. Many amateurs, while they would welcome a carefully thought out scheme to encourage genuinely interested newcomers, fear that a beginner's licence could easily act as a further disincentive to enthusiasts who would otherwise persevere in obtaining full facilities, resulting in fewer applications for the traditional forms of licence. Such a trend has already become apparent since the Class B (v.h.f./telephony only) licences were extended to include 144MHz; these licences require applicants to pass the Radio Amateurs' Examination, but not a morse test.

Australian 1970 bi-centenary

Next year is an important year for Australia, since it was in 1770 that Captain Cook first landed there. It will also mark the diamond jubilee of the Wireless Institute of Australia, formed in 1909-10, and believed to be the oldest radio society in the world. Among the special activities, it has been announced that Australian amateurs will be able to use the prefix "AX" instead of "VK". The Australian Tourist Commission is to make available 100,000 special QSL cards. The W.I.A. is to issue a "Captain Cook Bi-Centenary Award"; the qualification, for amateurs outside Australia, will be to work 50 stations using the AX prefix. To claim the award, QSL cards need not be sent but full details of the contacts listed and a certificate signed by two other amateurs who have seen the log entries. Address is "Cook Award", Awards Manager, W.I.A., PO Box 67, East Melbourne, Victoria, Australia 3002.

Cheshire Homes amateurs

A new fund CHARN (Cheshire Homes Amateur Radio Network Fund) has been launched with the object of equipping Cheshire Homes with communications receivers suitable for amateur operation. At present, of the 57 Homes, three have licensed amateur stations, and four (soon to be joined by a fifth) have receivers, partly as a result of a recent Memorial Fund to the late Douglas Clague, G2BSA. The launching of the Fund coincides with the 21st anniversary of the Cheshire Foundation. Donations to CHARN should be sent to W. M. Clarke, G3VUC, Fillace Park, Horrabridge, Yelverton, Devon (to minimise charges on the Fund, acknowledgements will be sent only on request).

Amateur Radio Show

The International Radio Engineering and Communications Exhibition—the formal title of what is more usually known as the R.S.G.B. Amateur Radio Show—opens this year on Wednesday, October 1st, until Saturday, October 4th (daily 10 a.m. to 9 p.m.) at the Royal Horticultural Society's New Hall, Greycoat Street, London S.W.1.

In Brief: A two-day convention in Cambridge on July 25th-26th, 1970, is being arranged in connection with the 21st anniversary of the British Amateur Television Club . . . Scottish Mobile Rally on October 5th at Beach Ballroom, Aberdeen . . . Peterborough Mobile Rally on October 12th at Walton County School, Mountsteven Avenue . . . Anglian Mobile Rally on October 26th at Suffolk Show Ground, Ipswich . . . The F.C.C. has turned down requests from American Citizen Band operators for additional frequencies including portions of the 28-MHz amateur band . . . Ken Smith, G3JIX (82 Granville Road, London E.17) is trying to re-establish the Wanstead and Woodford Radio Society . . . Stewart Perry, W1BB is appealing to American amateurs to leave the segment 1825 to 1830kHz free for amateurs outside the United States during periods of "Top Band" long-distance operation . . . A new morse code course on twelve 6.5-in gramophone records has been prepared recently by Alfred Mueller, DL1FL, and is available from the German Amateur Radio Society: DARC, 10 Beselerallee, D-23 Kiel, German Federal Republic (price 25 DM plus postage). . . . The International Amateur Radio Club, which operates the station 4U1ITU at the headquarters of the International Telecommunication Union, Geneva, reports that during 1968 the station was operated by 95 operators representing 31 countries . . . Interest in the collection and restoration of early radio equipment has been growing recently, and one of the local societies now hunting for old crystal sets, bright-emitter valves, horn loudspeakers and the like is the Peterborough Radio and Scientific Society. (Hon. secretary is Douglas Byrne, G3KPO, Jersey House, Eye, Peterborough.)

PAT HAWKER, G3VA

October Meetings

'ickets are required for some meetings: readers are advised, therefore, ɔ communicate with the society concerned

LONDON

2nd. S.E.R.T.—"High fidelity reproduction of music in large churches" by D. M. Chave at 19.30 at St. Martin in the Fields, Trafalgar Sq., W.C.2.

6th. I.E.E.T.E.—"Training of technician engineers" by F. Metcalfe at 18.00 at the I.E.E., Savoy Pl., W.C.2.

7th. I.E.E.—Discussion on "Frequency synthesis" at 17.30 at Savoy Pl., W.C.2.

8th. I.E.E.—Discussion on "The new rules 127 (for H.N.C. and H.N.D. in electrical and electronic engineering)" at 17.30 at Savoy Pl., W.C.2.

8th. I.E.R.E.—"Image intensifiers for night vision and their application to television at low light levels" by D. G. Taylor at 18.00 at 9 Bedford Sq., W.C.1.

8th. Soc. Environmental Engrs.—"An absolute method of piezo electric accelerometer calibration" by H. Gregory at 18.00 at Imperial College, Mech. Eng. Dept., Exhibition Rd., S.W.7.

9th. I.E.E.—"Electrical manufacture, today and tomorrow" presidential address by D. Edmundson at 17.30 at Savoy Pl., W.C.2.

9th. I.E.R.E./I.E.E.—"Physiology for engineers" at 18.00 at St. Bartholomew's Hospital Medical College, E.C.1.

9th. R.T.S.—"Test methods for television receivers that employ micro-circuits" by B. J. Rogers at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.

14th. I.E.E.—"The human necessity for automation" by P. L. Taylor (chairman, Control & Automation Division) at 17.30 at Savoy Pl., W.C.2.

14th. Radar & Electronics Assoc.—"Microwave radio stations—aerial systems and propagation problems" by H. Cole at 19.00 at the Northern Polytechnic, Holloway Rd., N.7.

15th. I.E.E.—"Radio and weather" by Dr. J. A. Saxton (chairman Electronics Division) at 17.30 at Savoy Pl., W.C.2.

16th. R.T.S.—Symposium on "Diversity & integration—a study of educational TV in Glasgow" at 17.00 at the I.T.A., 70 Brompton Rd., S.W.3.

16th. I.E.E.—"The links between education and training" by E. R. L. Lewis at 17.30 at Savoy Pl., W.C.2.

16th. I.E.R.E.—"A review of Soviet Space Programmes" by Sqdn. Ldr. R. C. Travis at 18.00 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

17th. Brit. Acoustical Soc.—Symposium on "Underwater acoustic propagation" at 11.00 at the Institution of Mechanical Engineers, 1 Birdcage Walk, S.W.1.

20th. I.E.E.—"Submerged repeater systems—past, present and future" by F. Scowen at 17.30 at Savoy Pl., W.C.2.

21st. I.E.E.—Discussion on "Multilayer printed circuits and their allied active processes" at 17.30 at Savoy Pl., W.C.2.

22nd. I.E.R.E.—Presidential address of Harvey F. Schwarz at 19.00 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

23rd. I.E.E./Inst. Meas. Control—Discussion on "Mechanical design of electromechanical components" at 17.30 at Savoy Pl., W.C.2.

27th. I.E.E.—"A basis for a mathematical theory of direction-defining radio beacons" by C. W. Earp at 17.30 at Savoy Pl., W.C.2.

27th. I.E.E./Inst. Meas. Control—"The application of digital computers to aircraft navigation and control" by Dr. G. E. Roberts at 17.30 at Savoy Pl., W.C.2.

28th. I.E.E./I.E.R.E.—Colloquium on "Constructional practice for computer equipment" at 17.30 at Savoy Pl., W.C.2.

28th. I.E.E.—Discussion on "Recent advances in solid-state infra-red detectors" at 17.30 at Savoy Pl., W.C.2.

29th. I.E.R.E./I.E.E.—Discussion on "The Haslegrave Report on technician courses and examinations" at 18.00 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

30th. R.T.S.—"International aspects of television broadcasting" by E. L. E. Pawley at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.

CARDIFF

10th. S.E.R.T.—"The IVC colour video tape recorder" by R. A. Calaz at 19.30 at the Llandaff Technical College, Western Ave.

CHATHAM

30th. I.E.R.E.—"Electronics in the ship-to-shore interface on the Kent coast" by Lt. Cdr. R. B. Richardson and J. E. Rees at 19.00 at the Medway College of Technology.

CHELMSFORD

6th. I.E.R.E./I.E.E.—"The trend of future world communication" by Prof. E. C. Cherry at 18.30 at the Lion and Lamb Hotel, Duke Street.

DONCASTER

16th. I.E.E.T.E.—"Mechanised teaching methods in education" by K. Holling at 19.00 at the Technical College, Waterdale.

LLANDAFF

9th. R.T.S.—"The field store converter" by E. R. Rout at 19.00 at the B.B.C.

READING

29th. I.E.E./I.E.R.E.—"Computer aided design of closed-loop systems" by P. Atkinson, R. L. Davey and V. S. Dalvi at 19.30 at the J. J. Thomson Laboratory, The University.

LATE SEPTEMBER MEETINGS

LONDON

25th. R.T.S.—"Colour television receiver development—Phase 2" by J. W. Bussell, R. Gray and S. C. Jones at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.

29th. I.E.E.T.E.—"Education and qualifications for technician engineers and technicians' by Dr H. L. Haslegrave at 18.00 at the I.E.E., Savoy Pl., W.C.2.

LOUGHBOROUGH

25th. I.E.E.T.E.—"The developing role of the technician engineer" by Dr. R. C. G. Williams at 19.30 at the Technical College.

Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Oct. 1–4 R. Horticultural New Hall
R.S.G.B. Radio Engineering & Communications Show
(P. A. Thorogood, 35 Gibbs Green, Edgware, Middlx)

Oct. 7 & 8 St. Ermin's Hotel
Ultrasonics for Industry Conference
(Ultrasonics Conference and Exhibition, Dorset House, Stamford Street, London S.E.1)

Oct. 16–22
Audio Fair
(C. Rex Hassan, 42 Manchester St., London W.1)

Oct. 30 & 31 Inst. Mechanical Engineers
Numerically Controlled Machines Conference
(I.Mech.E., 1 Birdcage Walk, London S.W.1)

BRIGHTON

Oct. 14–16 Hotel Metropole
INTER/NEPCON '69
(INTER/NEPCON '69, 21 Victoria Rd., Surbiton, Surrey)

NEWCASTLE-ON-TYNE

Oct. 28–30 Exhibition Centre
Northern Engineering Exhibition
(Engineering Industries Association, 15 Walker Terrace, Prince Consort Rd., Gateshead-on-Tyne 8)

OVERSEAS

Oct. 6–8 Toronto
Electronics Conference
(Dr. Rudi de Buda, International Electronics Conference, 1819 Yonge St., Toronto 7, Canada)

Oct. 7–12 Ljubljana
Modern Electronics Exhibition
(Gospodarsko razstavisce, Ljubljana, Titova No.50, Yugoslavia)

Oct. 7–16 Utrecht
Het Instrument
(Cooperatieve Vereniging "Het Instrument" u.a., Sparrenlaan 2, Soest, Netherlands)

Oct. 9 & 10 Montreal
Engineering Management Conference
(I.E.E.E., 345 E. 47th St., New York, N.Y.10017)

Oct. 15–17 Waterloo, Ont.
Switching and Automata Theory Symposium
(Prof. J. A. Brzozowski, Dept. of Applied Analysis and Computer Science, University of Waterloo, Ontario, Canada)

Oct. 18–26 Genoa
International Communications Fair
(Fiera di Genova, Casella Postale 1834, 16100 Genova, Italy)

Oct. 26–30 Anaheim, Cal.
Mathematics and Computer Aided Design
(J. F. Traub, Computing Science Research Center, Bell Telephone Lab., Murray Hill, New Jersey 07974)

Oct. 27–29 Washington
Electronics and Aerospace Systems Convention
(H. P. Gates, EASCON '69, P.O. Box 2347, Falls Church, Virginia 22042)

Answers to "Test Your Knowledge" – 17

Questions on page 487

1. (*d*) The change of energy may be due to an electron changing to an orbital of lower energy, a change in electron-spin alignment or a change in molecular configuration (it is assumed that the atom(s) is not radioactive; nuclear disintegrations are not considered).

2. (*d*) For this reason gases, in which the atoms can be regarded as isolated from each other except when they collide, exhibit "resonant absorption".

3. (*a*) The emitted photon is in phase with, and travels in the same direction as, the stimulating photon.

4. (*c*) This is known as a "population inversion"; it can never occur naturally (in thermodynamic equilibrium) however high the temperature.

5. (*b*) The two energy levels concerned are associated with different molecular configurations; a non-linear electric field has a different effect on molecules in the two configurations.

6. (*a*) The ammonia maser cannot be tuned; it can only operate over a band of frequencies 10 kHz wide at a nominal frequency of 24 GHz.

7. (*a*) Electrons associated with the chromium ions make the transitions which cause both the maser and laser actions. The energy levels concerned in the two cases are, of course, quite different.

8. (*c*) The two energy levels associated with the emission depend on different electron-spin alignments with an applied magnetic field. The energies of the two levels change if the field strength is changed. Note that the ruby is mounted in a slow-wave structure, not a resonant cavity, and there is no applied electric field.

9. (*a*) The pumping signal raises the electrons to a higher energy level from which they quickly fall into the desired upper level (which is metastable).

10. (*a*) Chromium-ion electrons are pumped into energy bands associated with the normal ruby absorption in the green and blue, from which they quickly fall into a metastable level, the upper level for the laser action.

11. (*b*) Population inversion cannot be achieved directly or indirectly by the application of heat.

12. (*c*) Helium atoms raised to excited states by the applied discharge transfer their energy to neon atoms with which they collide. This causes a population inversion between various levels in the neon.

13. (*c*) In the initial build-up of oscillations the gain in traversing the gas must be greater than the loss at reflection. Mirrors are used which reflect energy efficiently at the desired frequency but not at the other.

14. (*b*) Laser action occurs when the current exceeds a certain threshold value.

15. (*a*).

16. (*b*) It is the very high Q of the optical cavity used in the gas laser which gives the light its very high degree of coherence.

17. (*a*) The upper energy level associated with the maser action has significant occupancy at room temperature. From this we infer that at room temperature a great deal of random emission will take place, thus introducing noise and making population inversion difficult. The upper energy levels associated with laser action, on the other hand, all have negligible occupancy in equilibrium at room temperature.

Literature Received

For further information on any item include the appropriate WW number on the reader reply card

SEMICONDUCTORS

We have received the following information from Ferranti Ltd, Gem Mill, Chadderton, Oldham, Lancs.

35. Micro-E transistors, thermal ratings and mounting techniques **WW401**
36. A photo darlington pair **WW402**
37. A low-power high-efficiency output stage using ZT3866 transistors **WW403**
38. A low-Q bandpass amplifier design using ZT3866 transistors **WW404**
39. A v.h.f. ring divider **WW405**

Ferranti Semiconductor catalogue June '69 . . . . **WW406**
E-Line transistor applications **WW407**

The latest catalogue of LST Electronic Components Ltd, 7, Coptfold Rd, Brentwood, Essex, is now available. It lists a wide range of semiconductor and passive components **WW408**

A 60-A logic triac is the subject of bulletin EN-2538 from International Rectifier, Hurst Green, Oxted, Surrey **WW409**

E.C.S. (Windsor) Ltd, Thames Ave, Windsor, Berks, include a large selection of semiconductors and other components (including a.f. amplifier kits) in their latest catalogue **WW410**

"National semiconductor op amp guide" is a leaflet available from Athena Semiconductor Marketing Co. Ltd, 140 High St, Egham, Surrey **WW411**

PASSIVE COMPONENTS

Two new leaflets available from Electrosil Ltd, P.O. Box 37, Pallion, Sunderland, Co. Durham, are:

Micro-R, dual-in-line resistor module **WW412**
Dual-in-line pick-a-back connector **WW413**

The Aug/Nov 1969 Radiospares catalogue is now available from Radiospares, P.O. Box 427, 13-17 Epworth St, London E.C.2. . . . . . **WW414**

The catalogue of Associated Automation Ltd, 70 Dudden Hill Lane, London N.W.10, lists a variety of reed, mercury and conventional relays . **WW415**

Precision rotating components are described in a catalogue from Muirhead Ltd, Beckenham, Kent. Included are synchros, resolvers, tachos, motors etc. **WW416**

Engineering bulletin ATB published by Sprague and available from W.E.L. Components Ltd, 5 Loverock Rd, Reading, Berks, describes polarized aluminium electrolytic capacitors **WW417**

A leaflet from the Dynalco Corp., 4107 N.E. 6th Ave, Ft. Lauderdale, Florida 33308, describes relay tachometers **WW418**

EQUIPMENT

An all-semiconductor 19-inch PAL colour video monitor (RHE19) is the subject of a leaflet from the Marconi Co. Ltd, Chelmsford . . . **WW419**

Microspot cathode ray tubes and coils, electronic display equipment, industrial valves and photon devices are briefly described in an abridged catalogue from the Electronic Display Department of Ferranti Ltd, Gem Mill, Chadderton, Oldham, Lancs. **WW420**

A booklet on the current range of Unicam spectrophotometers is available from Pye Unicam Ltd, York St, Cambridge CB1 2PX **WW421**

The first member of the CC.1200 series of cassette recorders (for analogue and digital data) made by the Avionics Division of A. & M. Fell Ltd, F.G.A. Works, Denton, Newhaven is described in a leaflet available on application **WW422**

Application Note 93 "Statistical Analysis of Waveforms & Digital Timer-Waveform Measurements" is a comprehensive 60 page survey of measurements that can be made with Hewlett-Packard multichannel analysers. Copies are available from Hewlett-Packard Ltd, 224 Bath Road, Slough, Bucks. **WW423**

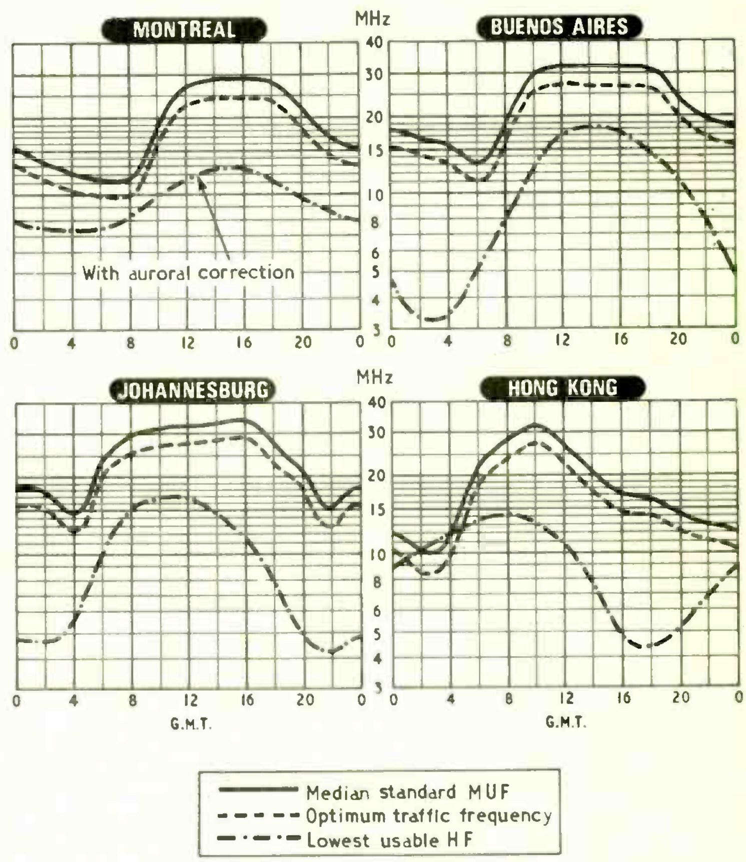
GENERAL INFORMATION

Two new publications from the British Standards Institution, British Standards House, 2 Park St, London, W1Y 4AA are:—

BS 9002, Qualified parts list for electronic parts of assessed quality, price 10s.
BS 9070, Specification for fixed capacitors of assessed quality: generic data & methods of test, price 30s.

A course to be held at Hendon College of Technology, The Burroughs, Hendon, London, N.W.4, on computer programming (Fortran) is described in a leaflet.

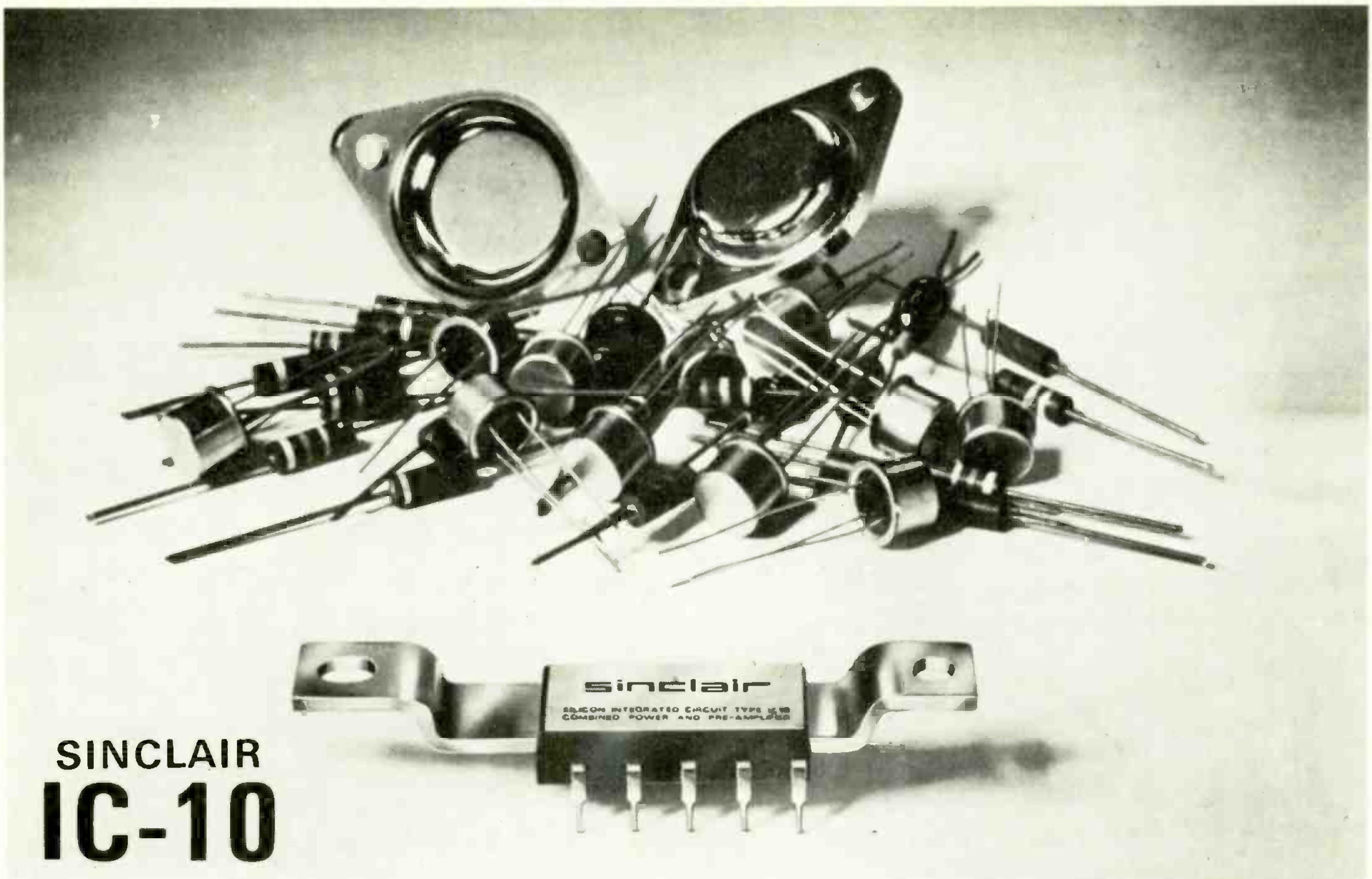
H. F. Predictions—October



The prediction curves show the median standard MUF, optimum traffic frequency and lowest usable frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, and type of modulation. The LUF curves shown are those drawn by Cable & Wireless Ltd, for commercial telegraphy and assume the use of transmitter power of several kilowatts and rhombic aerials.

The effects of sporadic-E ionization are becoming less significant as winter conditions set in, and this month it is unlikely that sporadic-E will permit operation above the MUF. Day-to-day variations in height and density of the ionospheric layers give a standard deviation of 12 to 20% of the MUF shown on the charts. Greatest variance occurs at equinox periods during sunspot maximum as at present.

WW—109 FOR FURTHER DETAILS



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, which has an output power of 10 Watts, is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick. This tiny chip contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, all of which are 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.

Monolithic I.C's. were originally developed for use in computer and space applications where their extraordinary toughness and reliability were even more important than their minute size. These same advantages make them ideal for linear applications such as audio amplifiers, but hitherto they have been confined to low power applications. The IC-10 thus represents a very exciting advance. Not only is it far 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 the usual tone and volume controls and a battery or mains power supply. However, the IC-10 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.

The photographic masks required for producing monolithic I.C's. are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. So we are able to sell the IC-10 at a price far below that of the components for a conventional amplifier of comparable power. At the same time, we give a 5 year guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

AT THE INTERNATIONAL AUDIO & PHOTO-CINE FAIRS, OLYMPIA, OCTOBER 16th-22nd, STAND 95, SECTION C

sinclair

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD, CAMBRIDGE Telephone: 0223 52731

WW—110 FOR FURTHER DETAILS

10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

■ Specifications

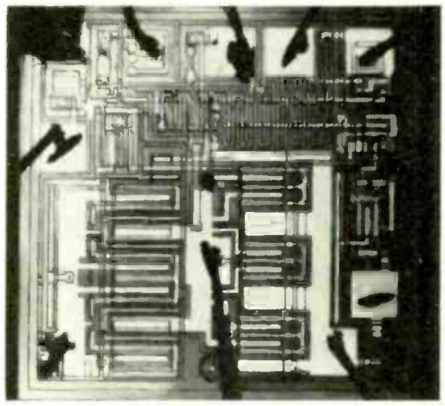
Power Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 Hz ±1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5 M ohms for above sensitivity.

The tiny black square on the right which is the smallest we could print without its getting lost is fractionally larger than the IC-10 before encapsulation.

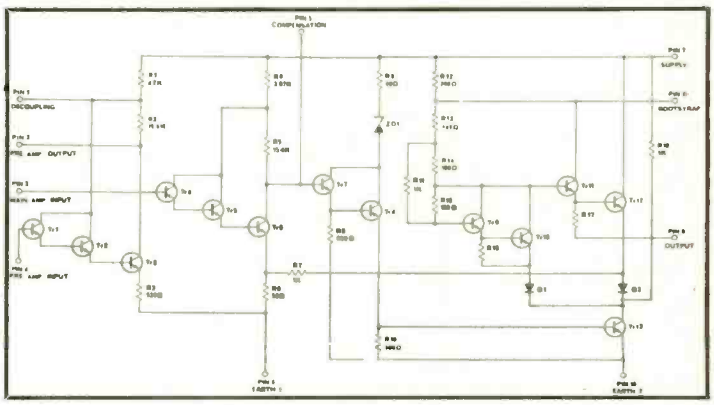
■

■ Circuit Description

The circuit diagram of the IC-10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.



Photograph shows the IC-10 magnified about 1,200 times. Below is shown the 13 transistor circuit of the Sinclair IC-10.



■ Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

■ 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 uses. These include public address, loud-hailers, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers. The transistors in the IC-10 have cut off frequencies greater than 500 MHz so the pre-amp section can be used as an R.F. or I.F. amplifier making it possible to build complete radio receivers without any additional transistors.

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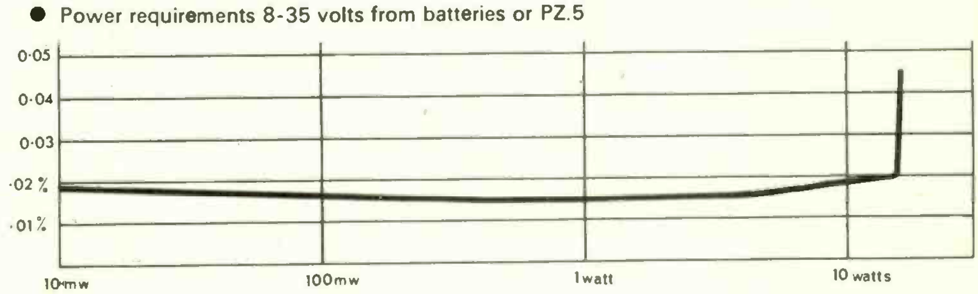
- Input Sensitivity—250 mV into 100 Kohms
- Signal to noise ratio—better than 70dB unweighted
- Class AB output
- Power requirements 8-35 volts from batteries or PZ.5



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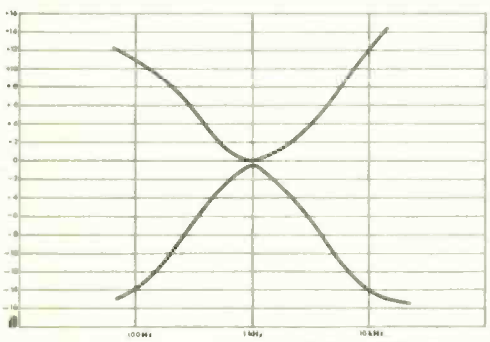

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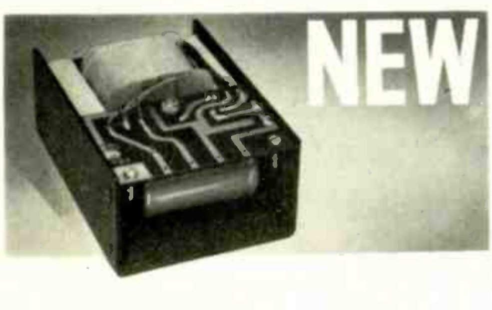
Inputs:	Radio, pick-up (magnetic, ceramic or crystal), Auxiliary.
Overload factor:	> 20dB per channel on all inputs.
Distortion:	0.03%.
Signal to noise ratio:	Better than 70dB unweighted.
Controls:	Press buttons for on-off, P.U., radio and aux. Treble +15dB to —15dB at 10kHz. Bass +15dB to —15dB at 100Hz. Volume. Stereo Balance.
Size:	$8\frac{1}{4}'' \times 1\frac{1}{2}'' \times 4''$ from front to back, plus knobs.
Finish:	Brushed aluminium with black titling, knobs and press buttons.



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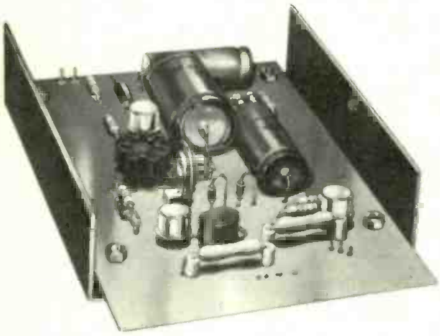

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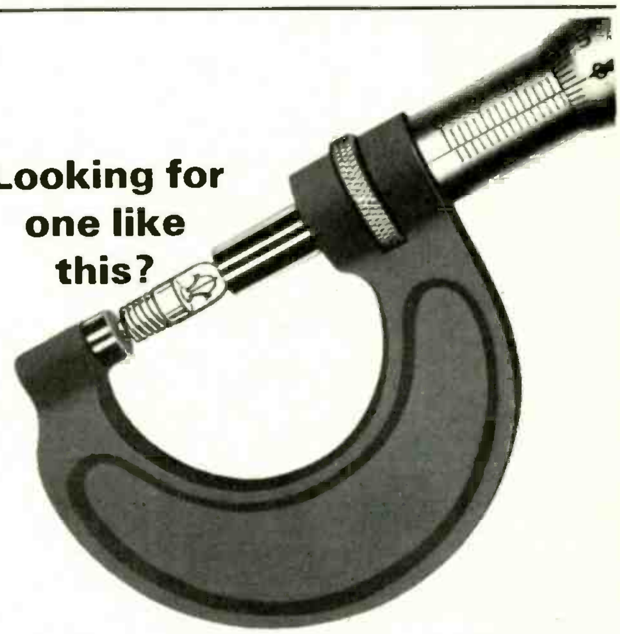

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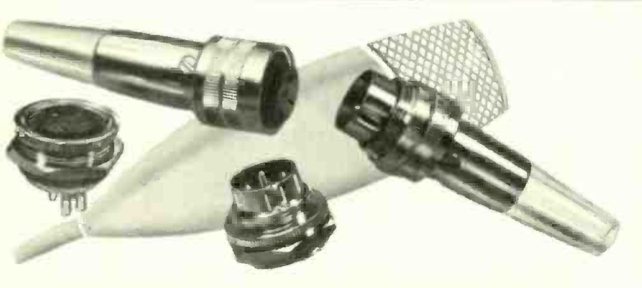

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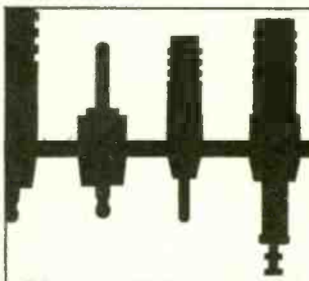

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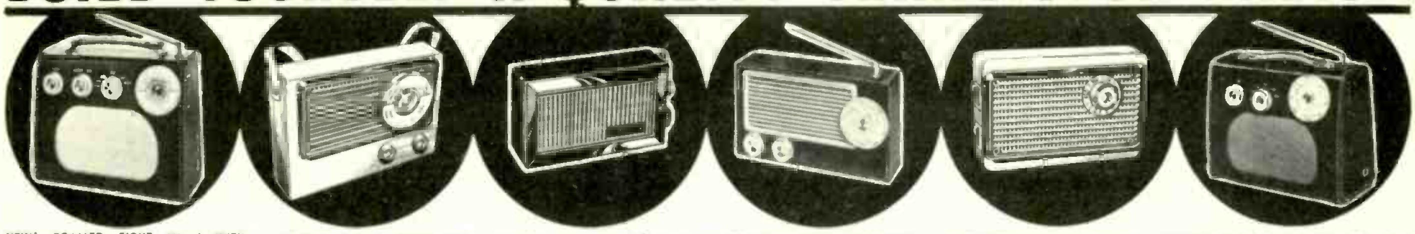

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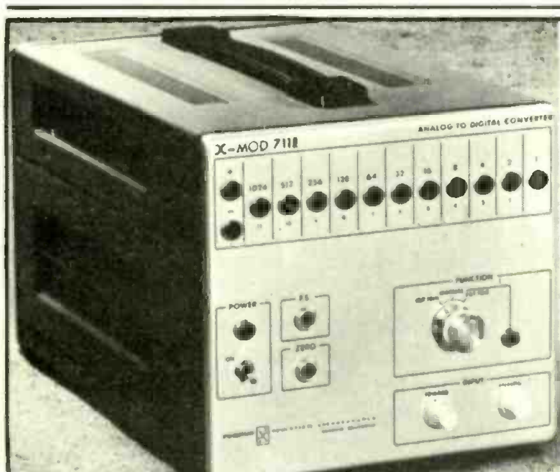

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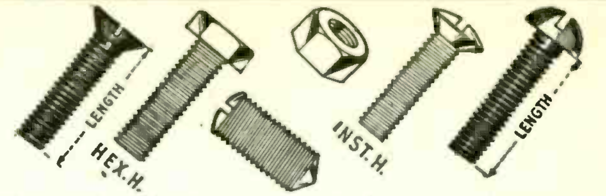

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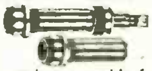

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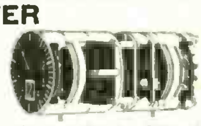
RADIO ALTIMETER



This precision Instrument is based on a 24 v. D.C. LOW INERTIA (Integrating) Motor. The Motor drives two precision pots through close tolerance gear-trains, including slipping clutch. Offered at fraction of manufacturer's price: 32/6, plus 6/- P. & P.

LATEST TYPE SELENIUM BRIDGE RECTIFIERS
30 volt 3 amp., 11/-, plus 2/6 P. & P.
30 volt 5 amp., 16/-, plus 2/6 P. & P.

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.

COPPER LAMINATE PRINTED CIRCUIT BOARD. Large sheet 15½ × 5½in. 3 for 10/- post paid. (3 minimum order).

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY

7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2¼lb. £4/12/6 post paid.

***NEW MODEL* HIGH FREQUENCY TRANSISTORISED MORSE OSCILLATOR**
Adjustable tone control. Fitted with moving coil speaker, also earpiece for personal monitoring. Complete with morse key. 45/- plus 3/6d. p. & p.

NICKEL CADMIUM BATTERY

1.2 v. 35 AH. Size 8¾ high × 3 × 1¾. 30/- each, plus 4/- P. & P.
Sintered Cadmium Type 1.2 v. 7AH. Size: height 3½in., width 2¾in. × 1$\frac{7}{16}$in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6, P. & P. 2/6.

DRY REED SWITCHES

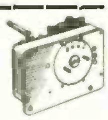
2 × lamp Dry Reeds (makes contacts) mounted in 870 ohm 9-18v coil. Size 3in. × 3½in. × ½in. New. Price 8/6 per pair. Post Paid.
6 of the above mentioned units (12 Reeds, 6 coils) fitted in metal box. Size 4in. × 3½in. × 1½in. Mfg. by Elliott Bros. New 45/- each. Post Paid.

Telephone Dials (New) 14'6d. Post Paid.

250 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.

PRECISION INTERVAL TIMER



From 0-30 seconds (repetitive). Jewelled balanced movement. Lever re-set. Operates 230 v. A.C. 5 amp. c/o micro-switch. Ex. equipment tested. 17/6, plus 2/6 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/-

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., 1,000 ohm 280mA., 1,500 ohm 230mA., 2,500 ohm .2a.** Diameter 3½in. Shaft length ¾in. dia. ¼in., **27/6.** P. & P. 1/6.
50 WATT 1/5/10/25/50/100/250/500/1,000/1,500/2,500 ohm, All at **21/-**, P. & P. 1/6.
25 WATT 10/25/50/100/250/500/1,000/1,500/2,500 ohm, All at **14/6**, P. & P. 1/6.
Black Silver Skirted knob calibrated in Nos. 1-9. 1½ in. dia. brass bush. Ideal for above Rheostats, 3/6 each.

STROBE! STROBE! STROBE!

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.

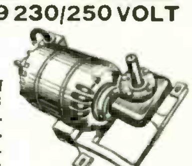
EXPERIMENTERS "ECONOMY" KIT
1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube + instructions £5.5.0 plus 5/- P. & P.

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.

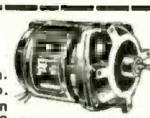
7-INCH POLISHED REFLECTOR. Ideally suited for above Strobe Kits. Price 10/6 & 2/6 p. & p. or post paid with kits.

PARVALUX TYPE SD19 230/250 VOLT AC REVERSIBLE GEARED MOTORS



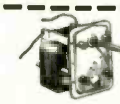
30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. **6 gns.** P. & P. 10/-.

BODINE TYPE N.C.1 GEARED MOTOR



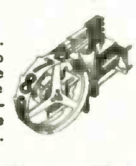
(Type 1) 71 r.p.m. torque 10 lb. in. Reversible 1/70th h.p. 50 cycle .38 amp.
(Type 2) 28 r.p.m. torque 20 lb. in reversible 1/80th h.p. 50 cycle .28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v A.C. Supplied complete with transformer for 230/240v A.C. input
Price, either type £2.17.6 plus 6/6 P. & P. or less transformer £2.2.6 plus 4/6d. P. & P.
These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines etc.

230 v. GEARED MOTOR



(as illustrated)
6 R.P.M. or 10 R.P.M.
230 v. A.C. non-reversible, approx. 1.7lb.in. Price 45/-, plus 3/6 P. & P.

LARGE DIGIT 12 v. D.C. MAGNETIC COUNTER



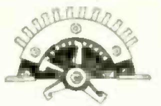
4in. drum, calibrated 1-9. Figures 1¼in. high ¾in. wide. Set of 1m, 1b, 1c/o contacts operated by drum cam. The units can be used in pairs and are ideally suited for batch or lap recording or for the many purposes where large easily read numerals are required. Price 18/6, P. & P. 2/6.

VEEDER ROOT COUNTER

230 v. A.C. 50 cycle 5 figure counter (non resetable). 18/6, P. & P. 1/6.

Latest American. New. Plastic THYRISTOR 400 P.I.V. 8 amp. Data sheet. 19/6 post paid.

MINIATURE UNISELECTOR

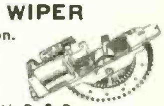


3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. **22/6**, plus 2/6 P. & P.

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.

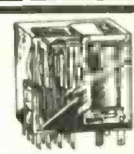
6 BANK 25 WAY FULL WIPER



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



BULK PURCHASE ENABLES US TO OFFER THE FOLLOWING *NEW* **SIEMENS PLESSEY**, etc. MINIATURE PLUG IN RELAYS COMPLETE WITH BASE, AT A HIGHLY COMPETITIVE PRICE

COIL Ω	WORKING VOLTAGE	CONTACTS	PRICE
280	6—12	2 c/o	14/6
280	9—18	4 c/o	15/6
700	12—24	2 c/o	12/6
700	16—24	4 c/o	15/6
700	16—24	4M 2B	12/6
1250	20—40	2 c/o Heavy Duty	12/6
2500	30—50	2 c/o Heavy Duty	12/6
9000	40—70	2 c/o	10/-

POST PAID

230 VOLT AC RELAYS

230 volt AC Coil. Three c/o 5 amp. contacts, 17/6 Post Paid.
LONDEX four c/o 3 amp contacts. 18/6, Incl. base. Post Paid.

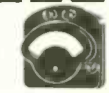
MINIATURE RELAYS

30-36 v. D.C. operation. 2 c/o 500 M.A. contacts. 3.200 ohm coil. Size only 1 × $\frac{7}{16}$ × 1$\frac{1}{16}$in. 8/6 post paid.

INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New 17/- per doz. P. & P. 2/-.

SANGAMO WESTON



Dual range voltmeter. 0-5 and 0-100 v. D.C. FSD 1 mA. In carrying case with tests prods and leads. 32/6. P. & P. 3/6.

A.C. AMMETERS 0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at 21/- each.
A.C. VOLTMETERS 0-25 v., 0-50 v., 0-150 v. M.I 2½in. Flush round all at 21/- each. P. & P. extra.
0-300 v. A.C. Rect. M-Coil 2½in. 29/–
0-300 v. A.C. Rect. M-Coil 3½in. Type W23 ...... 55/-

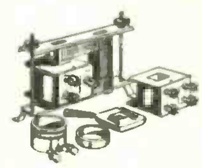
'AVO' MODEL 47A

Ex-Admiralty in first class condition, complete with instructions, leads and case. £9/19/6, P. & P. 10/-.

'AVO' MODEL 48A

Ex-Admiralty in good condition with instructions, leads, plus D.C. Shunts for 120 Amp and 480 Amp. A.C. Transformer for 60 Amp. and 240 Amp. Multiplier for 3600 volt. Complete outfit in fitted case. £15/0/0, P. & P. 10/-.

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	30, 32, 34, 36 v. at 5 amps.	£4 5 0	6/–
2	30, 40, 50 v. at 5 amps.	£6 5 0	6/6
3	10, 17, 18 v. at 10 amps.	£4 10 0	4/6
4	6, 12 v. at 20 amps.	£5 17 6	6/6
5	17, 18, 20 v. at 20 amps.	£6 12 6	6/6
6	6, 12, 20 v. at 20 amps.	£6 5 0	7/6
7	24 v. at 10 amps.	£4 15 0	5/6
8	4, 6, 24, 32 v. at 12 amps.	£6 10 0	6/6

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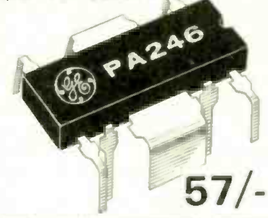
Kinver for Integrated Circuits

CHOOSE! the audio power amplifier i.c. to suit your requirements. With the introduction of the PA246 5 WATT amplifier by General Electric, Kinver now offer you the choice of 1, 2 or 5 Watts output from the tiny dual-in-line packages, illustrated below. These three amplifiers require external resistors and capacitors (for bias, feedback etc.). They DO NOT require transformers. A single supply line is required for each amplifier, thereby holding down the costs of power units. Full technical data sheets are available if required (see below).

PA246. 5 WATTS CONTINUOUS 10 WATT PEAK POWER INTO 16 OHMS

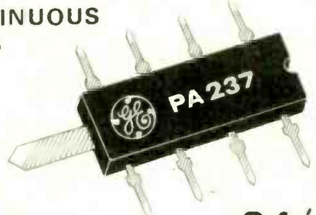
This high efficiency amplifier will deliver 5 WATTS output into 16 ohms with a typical input voltage of 12mV. If feedback is employed to reduce gain the input rises to maximum of 200mV. The noise output relative. to 5 Watts output. is typically −70 dB. and quiescent current requirement is 20mA (max.).



57/-

PA237. 2 WATTS CONTINUOUS POWER INTO 16 OHMS

This amplifier requires a typical input voltage of 8mV (or 120mV with feedback) for 2 Watts continuous power output. A single power supply of between 9 and 27 Volts will provide useful power out.



34/-

PA234. 1 WATT CONTINUOUS POWER INTO 16 OHMS

OUTLINE AS PA237

This very popular amplifier offers a full one watt output for a very modest cost. It is mounted in a similar package to the PA237. illustrated above.

24/-

PA230. THE IDEAL PRE-AMP FOR ANY OF THE ABOVE POWER AMPLIFIERS

21/-

A low noise. low level audio pre-amplifier. the PA230 is ideal for use with audio power amplifiers. It is mounted in a dual-in-line package similar to the PA237 but without the heat transfer tab. A minimum voltage gain of 4.000 times is featured together with an output voltage swing of 9V pk to pk. (minimum). In closed loop applications. with a gain of 200. the distortion is typically 0.05% and the input noise voltage is 2μV.

LINEAR I.C.S. FOR ALL YOUR REQUIREMENTS

RCA type CA3000 DC amplifier	54/9
RCA type CA3001 Video amplifier	79/6
RCA type CA3011 Wide-band amplifier	20/–
RCA type CA3020 ½ Watt Wide-band amplifier	32/–
RCA type CA3028A Differential/cascode amp. (120MHz)	20/–
RCA type CA3029 Operational amplifier	55/2
RCA type CA3035 Ultra high gain amplifier	30/–
Mullard type TAA231 Video amplifier	56/8
Mullard type TAA263 A.F. amplifier	15/9
Mullard type TAA293 General purpose amplifier	21/8
Mullard type TAA310 Record/playback pre-amplifier	32/-
Mullard type TAA320 MOS L.F. amplifier	13/5
G.E. type 2N5306 Darlington pair	11/6
G.E. type D13TI Programmable UJT	10/8

Full technical data sheets are available for all the devices listed above at 1/– each when purchased with i.c. These data sheets may be purchased separately at 1/6d each post free.

DIODES & TRANSISTORS IN STOCK

Diodes											
AA119	3/-	IS44	1/8	ACY44	8/-	BC214L	4/-	2N696	4/9	2N2925	5/3
AAY11	2/6	IS134	5/3	ASY26	6/2	BCY70	5/4	2N697	5/-	2N2926	3/-
AAZ15	3/3	IS940	1/-	ASY27	8/-	BCY71	10/4	2N706	3/3	2N3053	6/8
BAY38	3/9	Transistors		ASY28	6/2	BCY72	4/6	2N1132	10/9	2N3055	19/6
OA47	2/-					BD121	18/-	2N1302	3/11	2N3702	3/6
		ACY17	8/8	ASY29	8/-	BF184	7/6	2N1303	3/11	2N3703	3/3
OA91	1/3	ACY18	4/5	BC107	3/3	BFY50	5/-	2N1304	5/-	2N3704	3/9
OA202	2/-	ACY19	5/3	BC108	3/-	BFY51	4/6	2N1305	5/-	2N3705	3/4
IN34A	4/-	ACY20	4/6	BC109	3/3	BFY52	5/-	2N1306	6/5	2N3707	4/-
IN60	4/-	ACY 21	4/11	BC182L	3/2			2N1307	6/5	2N3708	2/5
IN64	4/-	ACY22	2/10	BC183L	2/5	BSY95A	3/11	2N1308	9/6	2N3819	9/-
IN82A	9/6	ACY39	18/-	BC184L	3/2	TIS44	1/9	2N1309	9/6	2N3820	18/9
IN87A	4/6	ACY40	3/6	BC212L	3/9	TIS49	2/6	2N2906	13/-	2N4058	4/6
IN914	2/-	ACY41	4/4	BC213L	3/9	TIS50	3/9	2N2924	4/4	2N4059	3/5

Send **NOW** for our Components Catalogue at only 2/- post free. This catalogue is packed with information on a host of up to the minute components by leading manufacturers. Included are Integrated Circuits. Silicon and Germanium Transistors. Diodes, Rectifiers. Resistors. Capacitors. Plugs and Sockets. etc. Please note that all goods supplied by us are brand new and guaranteed to fully conform to the manufacturer's published specifications. **DISCOUNTS:** Order value over £5—10 per cent. Order value over £10—15 per cent. Cash with order please. Post and packing 1/6 per order.

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This unconventional triple conversion design is for single sideband and double sideband reception. It incorporates advanced techniques including "up conversion" and covers the frequency range 2MHz to 28MHz. A built-in crystal comparator ensures accurate alignment. Optional arrangements for local oscillator and other unusual features add to the versatility of this forward-looking design.

AUDIO GENERATOR

an indispensable accessory for audio enthusiasts. Neat modern styling makes this unit a most suitable companion for the Hi-fi equipment in the lounge, or an impressive addition to the workshop test gear. It is a self-contained battery-operated instrument covering frequencies from 15Hz to 200kHz, with low distortion sine or square wave output through a calibrated attenuator.

FREE! CIR-KIT

for use in building one of the two modules making up the audio generator

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HAS SENSING FOR REMOTE CONTROL OPERATION STOP
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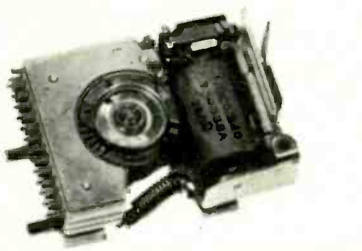
ADVANCE CONSTANT POTENTIAL POWER SUPPLY—TYPE DC6

Input 200–245 ±15%. Output 24 v. D.C. at 5 amps. Supplied brand new complete with front panel, neon indicator, fuse protected, mains input plug, etc. Normal price over £35. We supply with guarantee for **£17/0/0.** Post/packing 15/-.

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.



0-600 v. 0-500 mA A.E.I. STABILISED P.S.U. R2130

Outputs D.C. 0–600 v. Adjustable in one continuous range + Unstabilised D.C. voltage of VO + 120 to VO + 220 v. + two independent 6.3 v. A.C., centre tapped outputs 5 amp each. Brand new. Boxed. **£45.**

A.E.I. HIGHLY STABILISED P.S.U.

Illustrated below is the well-known R2141 transistorised variable power supply. 3–53 v. D.C. at 1 amp. These units are offered brand new. Boxed at **£22/0/0** plus post/packing 20/-.

BRADLEY D.C. CALIBRATOR—TYPE 126

This instrument is essential for the accurate calibration of meters/oscilloscopes and provides accurate voltages up to 2,500 v. D.C. For lab. use at 2 mA. Ripple 0.05%. Accuracy ±0.5%. Range 0–2,500 v. in 50 v. steps. Polarity positive or negative with respect to earth. Percentage deviation ±5% of output voltage (calibrated control). Supplied in perfect condition at **£60.**

LEVELL TRANSISTOR A.C. VOLTMETERS TYPE TM2

These small portable meters will measure down to 50 microvolts to 500 v. at frequencies up to 30 KHz. Input impedance 1.8 megohms. These very popular meters have many applications in the field of electronics, may be used as voltage amplifier/microvolt indicator, etc. Powered by 9 v. battery. Offered in good condition, little used, at **£18/10/0,** post/packing inclusive.

POLYSKOP TYPE SWOB I. 0.5–400 MHz.
POLYSKOP TYPE SWOB II. 0.5–1,200 MHz.
Both instruments are offered in excellent condition. Please write for further details.

DIGITAL VOLTMETERS!

Digimeter Type B.I.E. 2123 is a fully transistorised multi-range instrument possessing the following distinctive features:

Electrical characteristics:

D.C. Ranges: 10 mv to 400 volts in four ranges (1,000 volts for positive voltages).
Accuracy: the greater of ±0.1% of ±1 digit.
A.C. Ranges: 100 Mv to 250 volts RMS in three ranges.
Brand new with handbook **£92/10/0.**

	Price
Marconi TF913 AM/FM signal generator	£35
Marconi TF894 audio tester 10 c/s–12 KHz	£15
Marconi TF899 A.C. millivoltmeter	£12
Marconi TF195 BFO range 0–40 KHz	£20
Marconi TF1400 double pulse generator	£90
Marconi TF723A crystal calibrator	£45
Marconi TF762C UHF signal generator 200–400 MHz	£45
Marconi TF340 output power meter	£15
Marconi TF1102 amplitude modulator	£25
Marconi TF1104 television sweep generator	£65
Marconi TF675B pulse generator	£40
Marconi TF455E wave analyser	£125
Marconi TF886A circuit magnification meter	£75
Marconi TF329G/1 circuit magnification meter	£70
Marconi TF1345/2 digital frequency meter with 2 plug-ins. Range continuous to 220 MHz. As new	£325
Marconi TF890A/4 RF X band signal generator	£275
Marconi Type 6456 dual trace plug-in for TF2200 oscilloscope	£38
Marconi TF144G signal generator 85 KHz–25 MHX	£40

HIGH VOLTAGE TRANSFORMER

A.1 grade. Input 240 v. tapped down to 200 v. Output 0–2,560 and 2,820 v. at 1 amp. Offered at only **£15.** Weight 75 lb. Post/packing 25/-.

MULLARD HIGH SPEED VALVE TESTER

Complete with over 500 cards in excellent condition, ready to work. Our price **£45,** post/packing 25/-.

MARCONI VHF FM TELEPHONE TRANSMITTER

Complete with matching receiver these items are offered brand new with control unit and speaker. Ideal for marine use. Write for further details.

Advance Counter Timer TC1A **£75**
Dawe Stroboflash. Calibrated in RPM to 12,000. Excellent condition.. .. .. **£30**

RF ATTENUATORS—ADVANCE 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.

SPECIAL EQUIPMENT COOLING BLOWERS

Manufactured by Woods of Colchester. Totally-enclosed type with good airflow makes these blowers suitable for cooling T/X valves and equipment. For 115 v. A.C. operation. Supplied new and boxed. Price **60/-,** post/packing 5/-.

PORTABLE NON-SPILLABLE 12 VOLT 4 AMP/HOUR LEAD ACID BATTERIES

These are a very modern type battery fully sealed but not dry charged. They are terminated with screw terminals. Brand new and guaranteed, with full instructions. The size is about the same as the Perdio portable TV type batteries and you know how much they were. Our price is **45/-.** If you are still guessing, the size is roughly 4 in. square. Post/packing 2/6.

EDDYSTONE DIE-CAST BOXES

Contains sensitive amplifier originally intended for amplification of P.E. cells. C/W input socket, fuse signal lamp P.S.U. (mains) amplifier, fully transistorised. Brand new **32/6.** Post/packing 2/6.

BECKMAN HELIPOTS

Type A 30K ohms. Ten Turn ¼ spindles supplied. New, boxed. Price only **47/6** each.

BURNDEPT RF PLUGS

These difficult-to-obtain plugs, suitable for the Londex aerial c/o relay and many other types of equipment, are offered new, ex. equipment at **4/6** each. Post/packing 6d.

AT LAST—Surplus to Requirements

Pairs of 4×250 series valve-bases. The bases are of the forced-air type, heavily silver plated. Insulation is P.T.F.E. Supplied as new, fitted to base plate. Price **69/6** per pair. Post/packing 3/6.

SIGNAL GENERATORS

Marconi CT 218. Marconi TF 867A.
We stock a wide range of R.F. Signal Generator. Let us know your requirements.

DIRECT CURRENT AMPLIFIER

Contains "Brown Convertor", for continuous balance system and associated circuit. Complete less valves (5). Brand new. **50/-.** Post/packing 4/6.

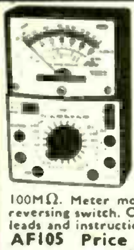
HR

QUALITY COMPONENTS AND EQUIPMENT

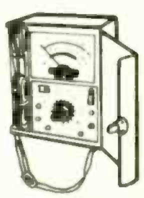
NEW RANGES FOR THE AMATEUR AND PROFESSIONAL USER

* QUALITY PANEL METERS

38 Series. Face size 42 x 42mm (1¾in x 1¾in). 50µA, 37/6; 100µA, 35/–; 200µA, 32/6; 500µA, 27/6; 1mA, 5mA, 10mA, 50mA, 100mA, 500mA, 25/– each; 10V, 20V, 50V, 100V, 300V and 500V, 25/– each; 1A and 5A, 25/– each. "S" meter, 1mA, 29/6. VU meter, 37/6.
65 Series. Face size 86 x 78mm (3½ x 3¼in). 50µA, 62/6; 100µA, 52/6; 200µA, 47/6; 500µA, 45/–; 1mA, 5mA, 10mA, 500mA, 37/6 each. "S" meter. 1mA. 42/6.
Other ranges and sizes available. List on request with full details.



* 50,000 OHMS PER VOLT MULTIMETER

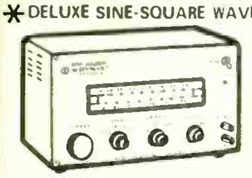


Recommended quality instrument with mirror scale and overload protection. 0/0·3/3/12/60/120/300/600/1200V d.c. (50Kµ/V); 0/6/30/120/300/600/1200V a.c. (10Kµ/V); 0/30µA/6/60/300mA, 0/12A: resistance 0/10kΩ/1/10/100MΩ. Meter movement 20µA. Polarity reversing switch. Complete with batteries, leads and instructions.
AF105 Price £8.10.0 p.p. 2/6
Leather case 28/6

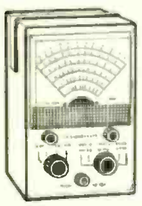
* SINE/SQUARE WAVE AUDIO GENERATOR

Provides audio output on 4 bands. Sine wave 20c/s to 200kc/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.

* DELUXE SINE-SQUARE WAVE RC AUDIO GENERATOR



Weinbridge RC Audio oscillator featuring four overlapping scales covering 18c/s to 200 Kc/s. Output waveforms are sine, square and complex. Mirrored scale with smooth geared tuning control. Output 5 volts RMS or 10 volts P-P. Sinewave response ± ½dB. Distortion under 1% at 1Kc/s. Stability ± 1%. Accuracy ± 2%. O/P Impedance under 3Kohms. Variable Attenuator. Mains operated. With Handbook.
ORC 27A Price £28 10 0 pp.10/-

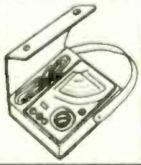


* VACUUM TUBE VOLTMETER

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.
MODEL TE65
£17.10.0 p.p. 7/6
HV Probe 50/–
R.F. Probe 42/6

* 20,000 OHMS PER VOLT MULTIMETER

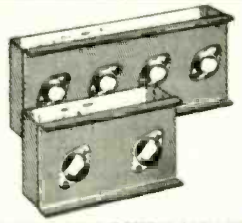
Popular model but with extra scale range. 20,000 ohms per volt. 0/5/25/50/250/500/2500V d.c., 0/10/50/100/500/1000V a.c., 0/50µA, 0/2½/250mA. Resistance 0–6kΩ and 6MΩ. Also dB scales or capacitance.



Model 200H 77/6
(Leather case, Price 15/- pp.2/-)

* PORTABLE OSCILLOSCOPE

Features 3in clear view tube, easy to use controls and good stability. 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. 220/240V. A.C. Supplied brand new with handbook.
TO3 Price £35 p.p. 10/–



* TRANSISTOR POWER AMPLIFIERS

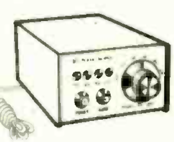
12 watt 3 ohm 100mV Input 24 volt supply. Model MPA 12/3 £4.10 p.p. 3/–
12 watt 12-16 ohm 100mV Input 40 volts supply. Model MPA 12/15 £5.5 p.p. 13/–
25 watt 8-16 ohm 180mV Input 50/60 volt supply. Model MPA 25 £7.10 p.p. 4/6
Power Supplies 24-40 volt 90/ p.p. 3/6
50–60 volt 97/6 p.p. 4/6
Model PA7. 7 watt Amplifier 3 ohms O/P. 7mV Input, operates 12–18 volts D.C. Price 72/6 p.p. 2/6

* 100 WATT AMPLIFIER—details on request.

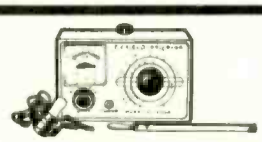
* GRID DIP METER

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
Price .. £11.10.0
pp.3/6

* DC STABILISED POWER SUPPLY



Switched DC Stabilised Outputs UP TO 1AMP. 3-6-9 & 12 VOLTS. Indicator lamp for each voltage. Fully fused mains operated. Negligible ripple. Regulation 1%.
SE101A Price £8 15 0



* FIELD STRENGTH METER

5–Ranges 1 – 250 mc/s. Fitted 200µA meter. Earphone output. Calibrated tuning scales.
FL30HA Price 72/6 pp.2/-
Also non-calibrated type peaking F/S meter.. FSI Price 45/- pp.2/6

POCKET DOSIMETER

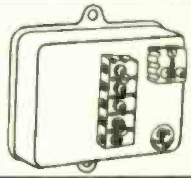
Small size Radiation Detector with bright easy to read scale. Fitted Pocket Clip. Range 0–50r. Brand new, quantity available. Price 12/- each

* SIGNAL INJECTOR

New model for checking all audio and RF up to VHF. Simple to use. Battery operated. Output approx. 1kc/s, 1·4V pp. Harmonics up to VHF.
SE250B Price 35/– p.p. 1/6
* MATCHING SIGNAL TRACER
SE 500 Price 27/6 p.p. 1/6

* EXPERIMENTER'S MODULE

Terrific offer of brand new STC time delay electronic units. Adjustable 3-15 secs. 9–12V operated. Supplied complete with suggested uses & circuits.
STC Module Price 35/– p.p. 2/6



MEC, BORG PRECISION PRESETS

Complete Range in stock of these Precision W/W Presets.

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Well below usual Prices—See Catalogue for Types in Stock

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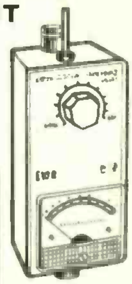
* MULTIMETER

Return of a popular model. 2000 ohms/V. 0/10/50/500/1000V a.c./d.c. 0/50µA. 0/10/250µA d.c. 0/10/100kΩ/1MΩ resistance. dB and capacitance scales. Size 5in. x 3½in x 1¾in. Robust and easy to use. Complete with leads, batteries and instructions.
THL 33A 82/6 p.p. 2/6
Leather case Price 22/6

* SWR ALIGNMENT METER

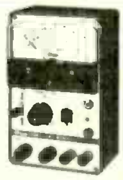


Ideal for all transmitter alignment. Built-in field strength meter 100µA. Complete. Ready to use. SWR 1:1 to 1:3.
SWR 3 .. Price 69/6
p.p. 2/6

WELLER SOLDERING IRONS

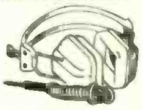
8200 Gun & Iron	59/6
8200D PK Gun Kit ..	79/6
ANTEX CN Iron	29/6
ANTEX Iron Kit	42/6

* TRANSISTOR CHECKER



Complete capacity for checking all transistors *npn* and *pnp* for alpha, beta and leakage. Also diodes. Complete with leads and instructions.
ZQM 2 .. Price £5.19.6
p.p. 3/6

STEREO HEADPHONES



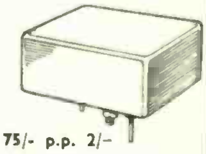
Featuring soft Padded Headsets, wide frequency response. Adjustable Headbands. Fitted Jack plugs.

DHO 2/S Recommended 25C/S-15KC/S .. £2.19.6
SE28 Built in Tweeters and Volume Controls £9.19.6
KOSS, KO727 £16.10.0. PRO-4A .. £23. 0.0
SP-3KC £11.15.0
Above are mon/stereo suitable for 8-16 ohm systems.
Mono Switched 8/16 ohms and 4K ohms Price £4.4.0

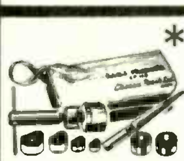
Stereo Headphone Amplifiers
Inputs for PU/Tuner, Battery Model Mains Operated High Quality
Eagle HA10 .. .. £8.19.6
Shure SA2/E £18.18.0

* STC CRYSTAL FILTER

10·7Mc/s Crystal Filter Type 445 / LQU / 904A. Band Pass 10·7 6dB is ± 20 Kc/s, Insertion loss 5dB. Parallel terminations 2·7K. 25K. Normal Price £18.



BRAND NEW SPECIAL OFFER 75/- p.p. 2/–



* CHASSIS PUNCH KIT

Complete kit with punches ½in, ⅝in, ¾in, 1in, 1⅛in for metal, plastics, etc., up to 16 gauge.
Price 50/-

* ALL ITEMS OFFERED ARE BRAND NEW STOCK — ALWAYS IN STOCK *

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'309' Test Gear/High Fidelity etc. 01-723 6963

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OPEN ALL DAY SATURDAY.

CURRENT RANGE OF BRAND NEW L.T. TRANSFORMERS. FULLY SHROUDED (*excepted) TERMINAL BLOCK CONNECTIONS. ALL PRIMARIES 220/240v.

No.	SEC. TAPS	AMPS	PRICE	CARR.
1A	25-33-40-50	15	£9 10 0	10/6
1B	25-33-40-50	10	£6 19 6	8/6
1C	25-33-40-50	6	£5 19 6	8/6
1D	25-33-40-50	3	£3 12 6	7/6
2A	4-16-24-32	12	£6 10 0	7/6
2B	4-16-24-32	8	£4 17 6	7/6
2C	4-16-24-32	4	£3 5 0	6/–
2D	4-16-24-32	2	£2 2 6	5/–
3A*	25-30-35	40	£14 17 6	15/–
3B*	25-30-35	20	£9 7 6	9/6
3C	25-30-35	10	£6 10 0	7/6
3D	25-30-35	5	£3 15 0	6/6
3E	25-30-35	2	£2 15 0	6/6
4A*	12-20-24	30	£11 15 0	10/–
4B	12-20-24	20	£7 10 0	8/6
4C	12-20-24	10	£4 15 0	7/6
4D	12-20-24	5	£3 5 0	6/6
5A	3-12-18	30	£8 15 0	7/6
5B	3-12-18	20	£6 10 0	7/6
5C	3-12-18	10	£3 17 6	6/6
5D	3-12-18	5	£2 12 6	6/6
6A	48-56-60	2	£3 5 0	5/6
6B	48-56-60	1	£2 7 6	5/6
7A*	6-12	50	£9 7 6	9/6
7B	6-12	20	£5 10 0	7/6
7C	6-12	10	£3 10 0	6/6
7D	6-12	5	£2 10 0	5/6
8A	12-24	1	£1 9 6	5/6
9A	17-32	8	£5 12 6	5/6
10A*	9-15	2	£1 5 0	5/6
11A	6·3	15	£2 5 0	5/6
12A	30-25-0-25-30	2	£3 5 0	5/6

Note: By using the intermediate taps many other voltages can be obtained.

Example: No. 1. 7-8-10-15-17-25-33-40-50V.
„ 2. 4-8-12-16-20-24-32V.
„ 5. 3-6-9-12-15-18V.

AUTO TRANSFORMERS

240v.-110v. or 100v. Completely Shrouded fitted with Two-pin American Sockets or terminal blocks. Please state which type required.

Type	*Watts*	*Approx. Weight*	*Price*	*Carr.*
1	80	2½ lb	£1 17 6	4 6
2	150	4 lb	£2 7 6	5 0
3	300	6½ lb	£3 7 6	6 0
4	500	8½ lb	£4 15 0	6 6
5	1000	15 lb	£6 12 6	7 6
6*	1750	25 lb	£13 10 0	10 6
7*	2250	30 lb	£16 10 0	12 6

*Completely enclosed in beautifully finished metal case fitted with two 2-pin American sockets, neon indicator, on/off switch, and carrying handle.

Samson's

(ELECTRONICS) LTD.

9 & 10 CHAPEL ST., LONDON, N.W.1

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HIGH GRADE POTTED CHOKES BY FAMOUS MAKERS. NEW. GUARANTEED

20 H. 200 m/a. 30/-. P. & P. 7/6. 20 H. 180 m/a. 27/6. P. & P. 7/6. 15 H. 180 m/a. 25/-. P. & P. 7/6. 12 H. 200 m/a 25/-. P. & P. 7/6. 10 H. 180 m/a. 22/6. P. & P. 7/6. 5 H. 300 m/a. 15/-. P. & P. 6/6. 30 H. 50 m/a. 25/-. P. & P. 7/6. 10 H. 75 m/a. 10/6. P. & P. 2/6. 50 H. 25 m/a. 8/6. P. & P. 2/-. 10 H. 120 m/a. 12/6. P. & P. 3/6. 15 H. 75 m/a. 12/6. P. & P. 3/6. 5 H. 100 m/a. 6/6. P. & P. 2/-. 0·75 H. 450 m/a. 15/-. P. & P. 4/6.

PARMEKO NEPTUNE SERIES
EHT TRANSFORMERS

Pri Tapped 200-250v. Sec. 3 kV 58 m/a. 4v. 1·1 A. 10 kV r.m.s. test and 4v. 0·5 A. 75/-. P. & P. 10/-.

GRESHAM POTTED TRANSFORMERS

Pri Tapped 200-250v. Sec. 475-0-475v. 160 m/a. 215-0-215v. 60 m/a. 6·3v. 8·2 A. 6·3v. 5 A. 6·3v. 0·75 A. 5v. 3 A. 85/-. P. & P. 10/-.
Pri Tapped 200-250v. Sec. 415-0-415v. 160 m/a. 165v. 155 m/a. 6·3v. 3 A. 6·3v. 1·6 A. 6·3v. 1·6 A. 5v. 2·8 A. 75/-. P. & P. 10/-.
Pri Tapped 200-250v. Sec. 6·3v. 2·5 A. twice, 6·3v. 1·5 A. 6·3v. 1 A. 6·3v. 0·5 A. 17/6. P. & P. 4/6.
Pri Tapped 200-250v. Sec. 27-0-27v. 0·3 A. 28-27-26-0-26-27-28v. 0·3 A. 6·3v. 1 A. 6·3v. 0·3 A. 6·3v. 0·6 A. 30/-. P. & P. 4/6.
Pri Tapped 200-250v. Sec. 350-0-350v. 25 m/a. 6·3v. 1 A. 15/-. P. & P. 4/-.
Pri Tapped 205-245v. Sec. 300v. 37 m/a. twice. 4v. 1 A. 4v. 0·3 A. 27/6. P. & P. 5/-.
Pri Tapped 200-250v. Sec. Tapped 370-390-410v. 6 m/a. 10/-. P. & P. 3/-.
Pri Tapped 200-245v. Sec. 300-0-300v. 66 m/a. 6·3v. 4A. 17/6. P. & P. 5/-.
Pri Tapped Sec. 125v. 265 m/a. twice. 35/-. P. & P. 5/-.
Pri Tapped 200-250v. Sec. 130v. 185 m/a. twice. 200v. 350 m/a. twice. 57/6. P. & P. 8/6.
Pri Tapped 200-240v. Sec. 130v. 450 m/a. three times. 79/6. P. & P. 10/6.
Pri Tapped 200-240v. Sec. 400v. 290 m/a. 75/-. P. & P. 10/6.
Pri Tapped 200-250v. Sec. 45v. 25 m/a. 1v. 0·5 A. 12/6. P. & P. 4/6.
Pri Tapped 200-240v. Sec. Tapped 760-700-40-20v. 50 m/a. 6·3v. 1·5 A. 25/-. P. & P. 5/-.

ONE ONLY DAVENSET TRANSFORMER

Pri 400-415-440v. Sec. 270v. 1,500 watts. £12/10/-. Carr. 15/-.

NEW GUARANTEED OIL-FILLED BLOCK CAPACITORS. ALL BY FAMOUS MAKERS

8 mfd. 2,500v. D.C. wkg. 70°C. 37/6. P. & P. 7/6. 8 mfd. 1,500v. D.C. wkg. 70°C. 22/6. P. & P. 5/-. 8 mfd. 750v. D.C. wkg. 60°C. 10/6. P. & P. 3/6. 8 mfd. 400v. D.C. wkg. 60°C. 7/6. P. & P. 3/6. 4 mfd. 400v. D.C. wkg. 70°C sub chassis mtg. 6/6. P. & P. 3/-. 2 mfd. 1,500v. D.C. wkg. 70°C. 10/6. P. & P. 3/6. 2 mfd. 1,000v. D.C. wkg. 70°C. 6/6. P. & P. 2/6. 0·5 mfd. 2,000v. wkg. 60°C. 5/6. P. & P. 2/-. 2 mfd. 2,000v. D.C. wkg. 60°c. 8/6. P. & P. 3/6. 8 mfd. 250v. wkg. 71°C. 4/-. P. & P. 2/-. 2 mfd. 500v. D.C. wkg. 60°C. 3/6. P. & P. 1/6. 1 mfd. 600y. D.C. wkg. 70°C. 0·1 mfd. 7,500 v. D.C. wkg. 70°C. 15/-. P. & P. 3/6. 0·1 mfd. 5,000v. D.C. wkg. 70°C. 7/6. P. & P. 1/6. 0·01 mfd. 8kV. D.C. wkg. 70°C, tubular. 3/9. P. & P. 1/6.

AMERICAN TYPES

8 mfd. 600v. wkg. 7/6. P. & P. 3/6. 8 mfd. 1,000v. wkg. 12/6. P. & P. 3/6. 4 mfd. 600v, tubular S.H. fixing. 6/6. P. & P. 2/6.

A.C. WKG. BLOCK CAPACITORS

60 mfd. 275v. wkg. 45/-. P. & P. 7/6. 25 mfd. 300v. wkg. 25/-. P. & P. 5/-. 25 mfd. 275v. wkg. 22/6. P. & P. 5/-. 18 mfd. 300v. wkg. 17/6. P. & P. 3/6. 12 mfd. 400v. wkg. 15/-. P. & P. 5/-. 7·19 mfd. 400v. wkg. 3 ph Delta connection. 45/-. P. & P. 8/6.

A.E.I. LIGHTING CAPACITORS

12 mfd. 250v. A.C. wkg. 5/-. P. & P. 2/6. 13 mfd. 250v. A.C. wkg. 2·85 mf. 440v. wkg, tubular. 5/-. P. & P. 2/-.
T.C.C. Type 1C52. 0·01 mfd. 15 amps max. 2kV rms max. 20 kVA max. 10 kV P.K. (A.C. + D.C.). 27/6. P. & P. 7/6.
HIVOTRONIC LTD. 40 mfd. 3kV. Rapid discharge capacitors. Size 12×9×7in. 75/-. Carr. 12-6.

SMITHS SYNCHRONOUS MOTORS

A.C. 200-240v. 4 r.p.m. 3in. dia. Length of spindle ¾in. 22/6. P. & P. 2/6. As above. 1 r.p.m. 22/6. P. & P. 2/6.

AMERICAN SYNCHRONOUS MOTORS

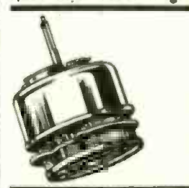
A.C. 230v. 50 cycles, 6 r.p.h. 2½in. dia. cog spindle. 12/6. P. & P. 2/6.

VENNER SYNCHRONOUS MOTOR

A.C. 240v. 50 cycles, 40 r.p.m. 2½in. dia. Length of spindle ¾in. 12/6. P. & P. 2/6.

HIGH CAPACITY TUBULAR ELECTROLYTICS

25,000 mfd. 12v. wkg. 12/6. P. & P. 2/-. 3,500 mfd. 55v. wkg. 1,250 mfd. 180v. wkg. 8/6. P. & P. 2/-.



WESTERSTRAND CLOCKWORK TIMERS

Switch contacts, 15 amps., 250 volts A.C. Control knob can be set between 30 secs. and 6 mins. Brand new 17/6. P. & P. 2/6.

AMERICAN WILLARD, miniature accumulators 6v. 1·2 A.H. size ⅞×1½×4in. wt. 4oz. 7/6+1/6.

SCOTCH MAGNETIC TAPE. Type 3M 459. ½in. 3,600 feet. Suitable for video. Brand new in maker's sealed cartons. List Price £18/10/-. Our Price £3/19/6. P. & P. 5/-.

LATEST RELEASE OF

RCA COMMUNICATION RECEIVERS AR88

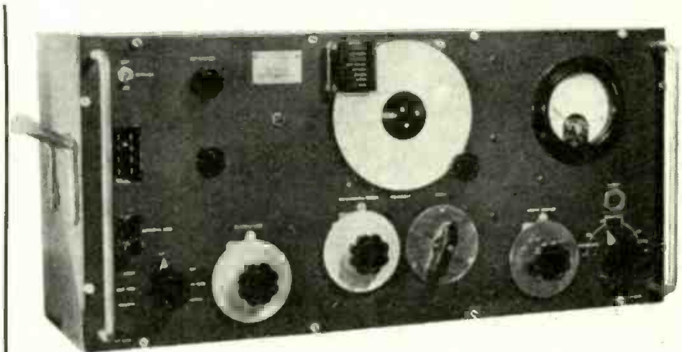
BRAND NEW and in original cases—A.C. mains input. 110V or 250V. Freq. in 6 bands 535 Kc/s-32 Mc/s. Output impedance 2.5-600 ohms. Complete with crystal filter, noise limiter, B.F.O., H.F. tone control, R.F. & A.F. variable controls. Price £87/10/- each, carr. £2.

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.*



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.

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Phone: Tottenham 9213

HRO RECEIVER. Model 5T. This is a famous American High Frequency superhet, suitable for CW, and MCW, reception crystal filter, with phasing control. AVC and signal strength meter. Freq. range 50 kc/s. to 30 mc/s., with set of nine coils. Complete HRO 5T SET (Receiver, Coils and Power Unit) for £30, plus 30/- carr.

COMMAND RECEIVERS; Model 6-9 Mc/s., as new, price £5/10/- each, post 5/-.

COMMAND TRANSMITTERS, BC-458: 5.3-7 Mc/s., approx. 25W output, directly calibrated. Valves 2 × 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: RA. 17 Outer Metal case for receiver available, as new, **£10** each, carr. £1. Frequency Meter type SA20: **£35** each, carr. £1. Frequency Counter type SA21: **£65** each, carr. 30/-. Diversity Switching Unit type MA. 168: **£35** each, post 10/-. Receiver Converter SA.80: 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, 32,000 v, **£7/10/-** each, carr. 15/-. 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.

AVO MULTIRANGE No. 1 ELECTRONIC TEST SET: **£25** each, carr. £1.

OSCILLOSCOPE Type 13A, 100/250 v. A.C. Time base 2 c/s.-750 Kc/s. Bandwidth up to 5 Mc/s. Calibration markers 100 Kc/s. and 1 Mc/s. Double Beam tube. Reliable general purpose scope, £22/10/- each, 30/- carr.
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.

Actuator Type SR-43: 28 v. D.C. 2,000 r.p.m., output 26 watts, 5 inch screw thrust, reversible, torque approx. 25 lbs., rating intermittent, price **£3** each, post 5/-.

SYNCHROS: and other special purpose motors available. British and American ex stock. List available 6d.

TCS MODULATION TRANSFORMERS, 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price 25/-, post 5/-.

AUTOMATIC PILOT UNIT Mk. 2. This complex unit of diodes and valves, relays, magnetic clutches, motors and plug-in amplifiers, with many other items, price £7/10/-, £1 carriage.

FOR EXPORT ONLY: B.44 Trans-ceiver Mk. III. Crystal control, 60-95 Mc/s. **AMERICAN EQUIPMENT:** BC-640 Transmitter, 100-156 Mc/s., 50 watt output. For 110 or 230 v. operation. ARC 27 trans-ceivers, 28 v. D.C. input. Also have associated equipment. BC-375 Transmitter. BC-778 Dinghy transmitter. SCR-522 trans-ceiver. Power supply, PP893/GRC 32A; Filter D.C. Power Supply F-170/GRC 32A: Cabinet Electrical CY 1288/GRC 32A; Antenna Box Base and Cables CY 728/GRC; Mast Erection Kits, 1186/GRC; Directional Antenna CRD.6; Comparator Unit, CM.23; Directional Control CRD.6, 567/CRD and 568/CRD; Azimuth Control Units, 260/CRD. Test Set URM.44, complete with Signal Generator TS.622/U.

SOLENOID UNIT: 230 v. A.C. input, 2 pole, 15 amp contacts, **£2/10/-** each post 6/-.

CONTROL PANEL: 230 v. A.C., 24 v. D.C. @ 2 amps., **£2/10/-** each, carr. 12/6.

AUTO TRANSFORMER: 230-115 v.; 1,000 w. **£5** each, carr. 12/6. 230-115 v.; 300VA, £3 each, carr. 10/-.

OHMITE VARIABLE RESISTOR: 5 ohms, 5½ amps; or 2.6 ohms at 4 amps. Price (either type) £2 each, 4/6 post each.

POWER SUPPLY UNIT PN-12B: 230 v. A.C. input, 395-0-395 v. output @ 300 mA. Complete with two × 9H chokes and 10 mfd. oil filled capacitors. Mounted in 19in. panel, £6/10/- each, £1 carr.

TX DRIVER UNIT: Freq. 100-156 Mc/s. Valves 3 × 3C24's; complete with filament transformer 230 v. A.C. Mounted in 19in. panel, £4/10/- each, 15/- carr.

POWER UNIT: 110 v. or 230 v. input switched; 28 v. @ 45 amps. D.C. output. Wt. approx. 100 lbs., **£17/10/-** each, 30/- carr. **SMOOTHING UNITS** suitable for above **£7/10/-** each, 15/- carr.

DE-ICER CONTROLLER MK. III: Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O. (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20-30 v., 12 r.p.m.; geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay etc., sealed in steel case (4 × 5 × 7 ins.) **£3** each, post 7/6.

MODULATOR UNIT: 50 watt, part of BC-640, complete with 2 × 811 valves, microphone and modulator transformers etc. **£7/10/-** each, 15/- carr.

ADVANCE TEST EQUIPMENT: VM78 A.C. Millivoltmeter (transistorised) **£55** each; TT1S Transistor Tester (CT472) **£37/10/-** each; VM77C Valve Voltmeter **£40** each. Carr. 10/- extra per item.

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/-.

UNISELECTORS (ex equipment): 5 Bank, 50 Way, 75 ohm Coil, alternate wipe, **£2/5/-** each, post 4/-.

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. TS323/UR, 20-450 Mc/s., **£75** each, carr. 15/-. FR-67/U: This instrument is direct reading and the results are presented directly in digital form. Counting rate: 20-100,000 events per sec. Time Base Crystal Freq.: 100 Kc/s. per sec. Power supply: 115 v., 50/60 c/s., **£100** each, carr. £1.

CT.49 ABSORPTION AUDIO FREQUENCY METER: freq. range 450 c/s-22 Kc/s., directly calibrated. Power supply 1.5 v.-22 v. D.C. **£12/10/-** each, carr. 15/-.

CATHODE RAY TUBE UNIT: With 3in. tube, colour green, medium persistence complete with nu-metal screen, **£3/10/-** each, post 7/6.

APNI ALTIMETER TRANS./REC., suitable for conversion 420 Mc/s., complete with all valves 28 v. D.C. 3 relays, 11 valves, price **£3** each, carr. 10/-.

TEST EQUIPMENT

MARCONI	TF-142F	Distortion Factor Meter	**£85 each**
	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-868	Universal Bridge	**£75 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**
POLARAD	Type MSG-1	Microwave Signal Generator, 950-2400 Mc/s	**£100 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.** Used condition working order **£25.** Carr. on both types £2/10/-. Transmitter only **£7/10/-** (few only) Carr. 15/-. Power Unit for Rec., new **£3/5/-.** Used power units in working order **£2/5/-.** Carr 10/-.

AVOMETERS: Model 47A, **£10** each, 10/- post. Excellent secondhand cond. (meters only).

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/-.

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PCL85	9/3
PCL86	9/3
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PY33	10/9
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PY82	4/9
PY83	7/-
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QS1209	7/3
QVO3-12	12/-
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QV05-25	9/-
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S130	40/-
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SP41	5/6
SP61	5/-
STV280/40	25/-
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T41	17/6
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VLS631	30/-
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VR105/30	6/6
VR150/30	6/-
W81M	12/6
XH8/100	300/-
XR13/200	120/-
Z66	15/-
Z319	25/-
Z759	23/-
Z800	20/-
Z801	30/-
Z803U	15/-
OA2	6/3
OB2	6/-
OZ4	4/6
1CP31	120/-
1B3GT	7/3
1Z2	25/-
2D21	6/6
2C39A	140/-
2C43	70/-
2E26	20/-
2K25	160/-
3A/167M	80/-
3A5	20/-
3B24	70/-
3B240M	110/-
3B241M	110/-
3B28	40/-
3C24	60/-
3C45	65/-
3D21A	35/-
3E29	15/-
4C35	300/-
4CX250B	240/-
4X150A	95/-
4X150D	200/-
4X250B	180/-
5B/254M	37/-
5B/255M	37/6
5C22	320/-
5R4GY	10/6
5U4G	5/6
5V4G	8/-
5Y3GT	6/-
5Z4G	7/-
6/30L2	15/-
6AK5	5/-
6AK6	12/6
6AL5	3/-
6AM6	3/6
6AN8	10/-
6AQ4	4/-
6AQ5	6/3
6AS6	6/-
6AS7	15/-
6AT6	4/9
6AU5GT	20/-
6B4G	20/-
6BA6	5/-
6BE6	5/-
6BH6	9/-
6BJ6	9/-
6BK4	21/6
6BN6	7/6
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6BR7	17/-
6BR8	12/6
6BS7	25/-
6BW6	14/6
6BW7	13/-
6C4	5/-
6CB6	5/-
6CD6G	24/-
6CH6	7/6
6CL6	8/6
6CW4	12/-
6D4	15/-
6DK6	9/-
6F23	16/-
6F32	2/9
6F33	19/6
6J5G	4/-
6J6	3/6
6J7G	6/-
6K7	1/9
6K7G	2/-
6K8	2/9
6K8G	3/-
6L6G	7/9
6L6WGB	17/6
6SQ7M	7/6
6Q7G	6/-
6SG7	6/-
6SJ7M	7/-
6SL7GT	6/-
6SN7GT	5/6
6V6G	4/6
6X4	4/6
6X5G	4/6
7B7	7/6
7C5	22/6
7C6	15/-
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7S7	45/-
7Y4	8/6
10F1	14/9
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12AE6	9/6
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12AT7	6/-
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12BA6	6/-
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25Z4	6/3
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30C15	15/-
30C17	18/-
30F5	17/-
30FL1	16/-
30L15	17/-
30L17	17/-
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35Z4GT	8/6
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85A1	25/-
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88L	160/-
90AG	45/-
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150B2	11/6
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807	9/-
811	35/-
813	75/-
813USA	120/-
705A	10/-
723A/B	160/-
725A	240/-
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833A	360/-
837	17/6
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931A	72/6
954	5/3
955	3/-
2050	15/-
5644	40/-
5651	7/3
5654	8/-
5672	7/-
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5963	10/-
6057	10/-
6058	10/-
6059	18/-
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ACY19	6/6
ACY20	5/-
ACY21	6/-
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AF115	7/-
AF116	7/-
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NKT228	6/-
NKT404	12/6
NKT675	6/-
NKT677	5/-
NKT713	7/6
OC16	20/-
OC19	17/6
OC20	15/-
OC24	15/-
OC25	11/-
OC26	7/6
OC28	16/-
OC29	15/-
OC35	11/6
OC44	4/6
OC45	4/-
OC71	4/6
OC72	6/-
OC74	6/-
OC75	6/-
OC76	6/-
OC77	8/-
OC78	6/-
OC81	4/-
OC81D	4/-
OC81M	5/6
OC81DM	6/-
OC82	6/-
OC82D	6/-
OC83	6/-
OC169	5/-
OC170	7/-
OC171	8/-
OC200	7/6
SX642	3/6
XA101	3/6
XA111	3/6
XA112	4/6
XA125	5/-
XA141	7/-
XA142	8/-
XA143	8/-
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1CP31	120/-
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5BP1	80/-
5CP1	55/-
5FP7	35/-
88L	80/-
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CV1526	40/-
CV1587	50/-
CV1588	35/-
DH3/91	120/-
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ECR30	35/-
ECR35	50/-
MW6-2	60/-
09D	80/-
09G	80/-
09L	80/-
VCR97	35/-
VCR138	50/-
VCR138A	50/-
VCR139A	35/-
VCR516	80/-
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Valves tested and released to A.R.B. specification if required.

Express postage 9d. per valve.
Ordinary postage 6d. per valve.
Over £5 postage free.
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Monday to Saturday
9 a.m.—5.30 p.m.
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Complete range of TV Tubes available from £4.5.0.

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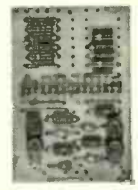
DIODES. Ex eqpt., Silicon. 150 PIV. 10 amp. 4 for 10/-. 150 PIV. 20 amp. 4 for £1.

MICRO SWITCHES. Miniature button type. 10/- doz. P. & P. 1/6.

THERMOSTATS. 1" × ½" × 1½", O.C. above 120°F. 1½a. 250v. 5/- ea.

New 750μH inductors 5/- doz.

COMPUTER PANELS (as shown) 2in. × 4in. 10 for 10/- + 1/6 p. & p. Guaranteed min. 35 transistors; 25 for £1 p. & p. 3/6 min. 85 transistors; 100 for 65/-. p. & p. 6/6, min. 350 transistors; 1,000 for £30 + carr.



GIANT PANELS 5½" × 4" min. 20 transistors 9 × 56 μH. Inductors, resistors, capacitors etc. 3 for £1 + 2/- p. & p.
As above, only 21 transistors, 70 diodes, 62 min. 1/10thW resistors, 3 for 25/-. P. & P. 2/-.

LARGE CAPACITY ELECTROLYTICS. 4½in, 2in diam. Screw terminals.
4,000μF 72V d.c. wkg. 7/6
10,000μF 25V d.c. wkg. 7/6
25,000μF 12V d.c. wkg. 7/6
16,000μF 12V d.c. wkg. 7/6
1½" × 4½" screw terminals—2500μF 55V d.c. wkg. 6/- ea.

NEW PLESSEY CAPS. 1½" × 4½" 5000μF 55V d.c. wkg. 8/- ea.
1" × 3" 2000μF 25V d.c. wkg. 6/- ea.

NEW SPRAGUE CAPACITORS. 0.22μF 250V 5/- doz. P. & P. 1/-.
4μF 150V, 5/- doz. P. & P. 1/-.
Tantalum—2.2μF 50V non-polar. 10/- doz. P. & P. 1/-.

POWER TRANSISTORS sim. to 2N174 ex. eqpt. on Finned Heat Sink, £1 for 4 + 5/- p. & p.

PANELS with 2 power transistors sim. to OC28 on each board + components. 2 boards (4 × OC28) 10/-, p. & p. 2/-.

MINIATURE GLASS NEONS. 12/6 doz.

TRIMMER POTS on 2" × 4" bds. + Ta. caps. and other components. 100 Ω, 500 Ω, 15K, 20K. Please state requirements. 5 for 10/- + 2/- p. & p.

OVERLOAD CUT OUTS. Panel mounting in the following values 5/- each: 2, 3, 4 amp.

EXTRACTOR/BLOWER FANS (PAPST) 100 C.F.M. 4½ × 4½ × 2in. 2800 R.P.M. 200/250 volt A.C.

Very clean, smooth running fans, guaranteed working. 50/- ea. post free.

DESK TELEPHONES
Complete with dial, magneto, cradle, line, connection block, receiver etc.

Not new but workable. Suitable for all applications. Only 19/6 each. p. & p. 5/-. Two for 39/6 post free. Four for 70/- post free.

KEYTRONICS
52 Earls Court Road, London, W.8.
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F.A.L. 'PHASE 50'
Public Address Amplifier

A superb solid state A.C. Mains unit for vocal and instrumental groups and General Public Address use

29 GNS.
Recommended Retail price

★ 50 Watts Output (Peak Rating)
★ High Sensitivity
★ Output matching for speakers from 3-30 ohms
★ 3 separately controlled inputs
★ Separate Bass and Treble Controls
★ Frequency Response 22 c.p.s. to 30 Kcs.

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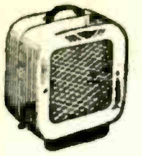


2½kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater (2½kW), switch down for half heat (1¼kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto control and safety cut-out. Complete kit **£3.15.0.** Post and ins. 7/6.

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. **19/6.** 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.

BECKASTAT

This is an instant thermostat simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season. **19/6.** Post and ins. 2/9

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature. 1in. long × approximately ⅛in. 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 ⅛in. 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 **1/3** each. **12/-** dozen.

60 r.p.m. Geared Motor. This is a powerful unit, driven by a mains motor of similar type to, but rather larger than the average Tape Deck or Record Player motor The gear boxes may be detached. It is, in fact, a unit measuring approximately 3½ × 2½ × 1½in. thick. The final drive shaft is ¼in. wide, 1in. long. **35/-.**

A Micro Meter bargain. Limited quantity only, centre zero 50-0-50 micro amps. This is a Weston Meter enclosed in clear Perspex case for flush mounting. Dial size approximately 2½in. wide. The scale is not engraved but has a red part in the centre and a green part to the left of centre. Scale could be cleaned off and re-written to suit your particular requirements. Regular price probably over £5 each, our price **29/6** each.

Battery Record Player. Made by Collaro. This is made up on a unit plate with speed selector and pick-up. The turntable is a heavy one and measures approximately 9½in. Pick-up is fitted with the famous "Studio cartridge. Price **69/6.** Post and ins. 6/6.

E.H.T. Condenser. 28Kv. 0.0011 mfd. Suitable for transmitting test conditions 6A at 300k/c. Bakelite case. **18/6** 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.

Press to Make Switch. Double pole, 5A contacts or can be used as single pole, 10A, contacts 250 volt working. Single hole fixing. **2/6** each. **24/-** dozen.

Door Switch. Contacts open when plunger is depressed. Prevents lights being left on. 15A contacts, 230 volt working. Made by Arrow. **3/6** each. **36/-** per dozen.

Rotary Appliance Switch. 16A, 230 volt on moulded ceramic base. Operated by pointer knob (not supplied). **2/-** each. **18/-** per dozen.

1/40th h.p. Motor. Made by the French (Cassor) Company. This is an excellent totally enclosed motor, powerful enough to operate small lathe, drilling machine, washing machine, etc. Its speed is 1,450 r.p.m. Made for normal 50 cycle; 230/250 volts mains, totally enclosed, size 2½ × 3½in. dia. with 1in. of ¼in. spindle. Price **19/6** plus 4/6 post and ins.

Burglar Alarm Kit. Protect your home and family by frightening away the intruder. With our circuit a mains operated bell rings loudly directly the door or window is opened. Kit comprises 12 reed switches, 12 magnets, relay, mains transformer and bell with circuit. Price **49/6.**

FLEX BARGAINS

Screened 3 Core Flex. Each core 14/0076 Copper PVC insulated and coloured, the 3 cores laid together and metal braided overall. Price **£3.15.0** per 100 yds. coil

15A 3 Core Non-kink Flex. 70/0076 insulated coloured cores, protected by tough rubber sheath, then black cotton braided with white tracer. A normal domestic flex as fitted to 3kW fires. Regular price 3/6 per yd. 50 yd. coil **£4.10.0.** or cut to your length 2/6 per yard.

10A 3 Core Non-kink Flex. As above but cores are 28/0076 Copper. Normal price 2/6 per yd. 100 yd. coil **£7.10.0.** or cut to your length **1/9** yd.

6A 2 Core Flex. As above, but 2 cores each 23/0076 as used for Vacuum Cleaners, Electric Blankets, etc. **39/6** 100 yd. coil.

3-CORE WATERPROOF FLEX

6A, 23/0076 circular PVC covered as fitted to electric drills and most portable appliances, ideal extension lead. Regular price 1/6 per yard, our price **79/6** for 100 yard coil. Post 6/6.

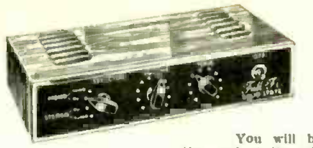
Elliot Sealed Contact Reed Relay. Three circuits closed by 3 volt or 100MA. **9/6** each.

Slim Tubular Microphone. For hand holding or frontal suspension—lever switch—high impedance with lead and plugs for cassette tape recorder but suitable for most amps. **19/6.**

500MA Moving Coil Meter. 2in. flush mounting round meter ex-Government but unused and perfect. **17/6.**

Thermal Cutout. A miniature device ⅜in. dia. on one screw fixing mount—can be used for motor overload protection, fire alarm. Soldering iron switch-off, etc., etc. 15A contacts open with flame—radiant or conducted heat. **1/6** each. **15/-** doz. **£5.0.0** 100.

5,000mfd. 12 volt Condenser. Tubular size 3in. × 1in. dia. made by Plessey. **4/9** each. **48/-** doz.



THE FULL-FI STEREO SIX

The amplifier sensation of the year

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled and teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut," "balance" and separate mains on/off switch. Price is **£9.9,** plus 7/6 post & insurance. Speakers (with tweeters) in oiled teak finish cabinets to match amplifier. **£8.8** pair.

BUY TIME SLOT METERS

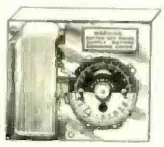
If you hire out equipment such as TV sets by the hour then these slot meters are what you require. We have 3 types, 8d. an hour, 1/- an hour and 1/6 an hour. Brand new. Made by the famous Weston Company. Price **£3.19.6,** post and ins. 6/6

HORSTMANN 'TIME & SET' SWITCH

(A 30 Amp Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **29/6.** Post and ins. **4/6.**

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. Supplied complete with 6 feet of heavy cable and 13 amp plug. Similar panels advertised at £5. Our price **39/6,** plus 3/6 post and insurance.

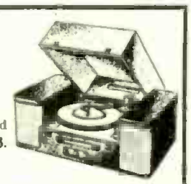


ELECTRIC TIME SWITCH

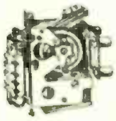
Made by Smiths these are AC mains operated, NOT CLOCKWORK ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours. 5A changeover contacts will switch circuit on or off during these periods. **59/6,** post and ins. 4/6. Additional time contacts. 10/- pair.

THIS MONTH'S SNIP

STEREO CABINET



Size 25in. × 14in. × 9½in. deep—speaker compartment each end. Centre portion with hinged lid and removable bottom has platform for autochanger and room for amplifier. Two tone (red and grey) rexine covered but loud speaker ends need metal grilles. With handle and clips, **22/6.** Carriage and packing 15/-.

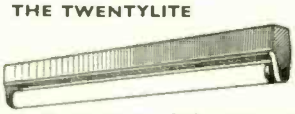


SELECTOR DRIVE

At each impulse the electro magnet ratchets the toothed drive wheel round one notch—a switch wafer is coupled to this and the contacts are such that it is on for 10 pulses and off for 15—an auxiliary contact switches on and off once every 25 pulses. New and unused, **25/-** each.

ATLAS SLIMLINE FLUORESCENTS

THE TWENTYLITE

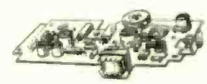


A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses ¼ unit). Measures 2ft. long. Is ideal Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, **39/6** with tube. Assembled ready to install. Post and Ins. 6/6 extra.

DREAMLAND CLOCK SWITCH

The wonderful **DREAMLAND** mains operated clock switch will automatically switch your blanket on and off each evening and you will always have a warm bed. It's luminous; you can always see the time and it's a really beautiful unit. An ideal gift. Can also control tape recorder, radio, lamp, etc., up to 500w. **39/6** plus 3/6 post and ins.

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 **39/6.** Full circuit diag. also shows tape controls 5/-.

VARYLITE

Will dim incandescent lighting up to 600 watt from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob **£3.19.6.**

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, 11¾in. diam.—Overall height 5¼in. A £6 speaker offered for only **£3.9.6** plus 7/6 p. & p. Don't miss this offer. 15 in. 30 watt **£7.19.6.** 18in. 100 watt **£24.10.0.**

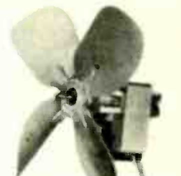
MINIATURE WAFER SWITCHES

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.

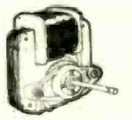
AC FAN



Small but very powerful mains motor with 6½ in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **17/6,** post 4/6. Mounts from back or front with 4BA screws.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions **19/6,** plus 2/6 post and insurance. Or available made up **29/6.** Plus 2/6 post.



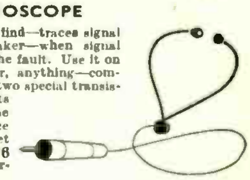
MAINS MOTOR

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.

QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. **19/6,** post and insurance 1/6. 12v. car model also available.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece **29/6**—twin stetoset instead of earpiece **7/6** extra—post and insurance 2/9.

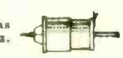
MAINS TRANSISTOR POWER PACK

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.

PROTECT VALUABLE DEVICES

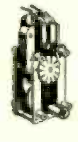
FROM THERMAL RUNAWAY OR OVERHEATING: Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected. Simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90 deg. to 190 deg. F. or with the dial removed range setting is between 80 to 800 deg. F. Price **10/-.**

PHILIPS TRIMMER



0-30pf an old design but one which has never been bettered. **1/-** each. **10/-** doz. **£4.0.0** per 100.

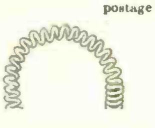
ROTISSERIE MOTOR



Very powerful 7 r.p.m., operates from standard A.C. mains. **29/6,** plus 3/6 P. & P.

230 VOLT SOLENOID

⅜in. stroke. Size 2½in. × 2in. × 1½in. **14/6,** postage 2/9.



SPRING COIL LEADS

as fitted to telephones, 4 core **2/6** each, 3 core **2/-** each.

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.

INSTRUMENT BUZZER

6-12 volts, adjustable tone, a very neat metal cased U.S.A. made unit approx. 1½in. × 1in. × ⅝in. thick. **6/6** each.

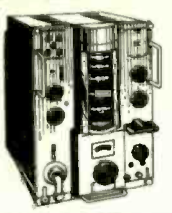
Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LTD

Dept. WW, 266 London Road, Croydon CRO-2TH

Also 102/3 Tamworth Road, Croydon

ADMIRALTY B.40 RECEIVERS

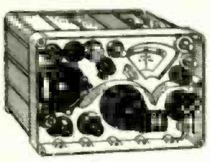


High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 Kc/s-30 Mc/s. I.F. 500/Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19½ × 13½ × 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/-.

SONOTRONIC PORTABLE OSCILLOSCOPES

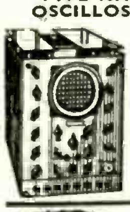
Ex-govt. scope, general purpose. 3in. CRT. Mains operated. Fully tested and checked **£12.10.0**. Carr. 7/6.

R209 Mk. II COMMUNICATION RECEIVER



11 valve high grade communication receiver suitable for tropical use. 1-20 Mc/s. on 4 bands. AM/CW/FM operation. Incorporates precision vernier drive, B.F.O. Aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked. **£15.0.0** 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 µwatt to 6 watts. **£20**. Carr. 20/-.

SOLARTRON CD. 1016. OSCILLOSCOPE

Double beam. D.C. To 5 Mc/s. Excellent condition. **£55** each. 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/-.

EDDYSTONE V.H.F. RECEIVERS

770R. 19-165 Mc/s. **£150**. Both types in excellent condition.

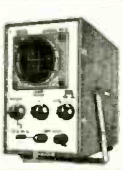
LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

0-20 Kc/s. Output 5K or 500 ohms. 200/250 v. A.C. Offered in excellent condition. **£12/10/-**. Carriage 10/-.

SOLARTRON CD.711S.2 OSCILLOSCOPES

Double Beam. D.C. to 9 Mc/s. Perfect order. **£65**. Carr. 50/-.

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 × 180 × 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 × 215 × 330 MM. Weight 15½lbs. 220/240 V. A.C. Supplied brand new with handbook. **£35/-/-**. Carr. 10/-.

SOLARTRON MONITOR OSCILLOSCOPE TYPE 101

An extremely high quality oscilloscope with time base of 10 µ/sec. to 20 m/sec. Internal Y amplifier. Separate mains power supply, 200/250 V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. **£8/19/6**. Carr. 30/-.

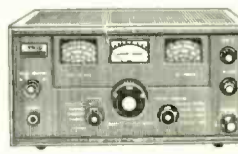
UNR-30 4 BAND COMMUNICATION RECEIVER

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.

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. × 9½in. × 8½in. Wt. 18 lbs. EXCEPTIONAL VALUE **£45**. CARR. 10/-. S.A.E. FOR FULL DETAILS.

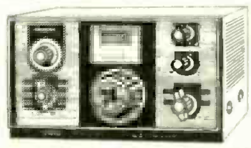
TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



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 × 15 × 10in. With instruction manual and service data. **£42.10.0.** 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. IN STOCK!

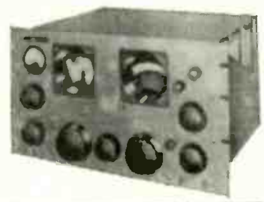
TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER



Covers all the amateur bands in 7 separate ranges between 3.5 and 29.7 Mc/s. 7 valves, 2 transistors and 5 diodes plus 8 crystals: output 8 and 500 ohm and 5,000 ohm phone jack. Crystal controlled oscillator. Variable BFO. VFO. AVC. ANL. S meter. SSB-CW/ Stand-by switch. Special double gear dial drive with direct reading down to 1 kHz. Remote control socket for connection to a transmitter. Audio output 1 watt. 115/250 v. A.C. mains. Superb modern styling. Size 7 × 13 × 10in. with instruction manual and service data. **£69.10.0**. Carr. Paid.

SPECIAL BONUS OFFER! TRIO SP5D Matching Speaker Mate and TRIO HS4 Communication Headphones, Normal Value £10.7.0. FREE OF CHARGE with every JR.500SE purchased.

HAMMARLUND SP600JX COMMUNICATION RECEIVER

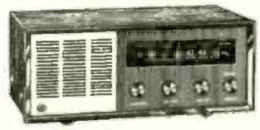


High quality professional dual conversion communication receivers available once again in this country at a reasonable price. Frequency range 540 Kc/s-54 Mc/s in 6 bands, variable tuning or 6 channel crystal controlled. 2.5 watt output into 600 ohms. Input 110/230 v. A.C. 20 valve circuit incorporating: Xtal filter, B.F.O., A.N.L., Xtal calibrator, S meter etc. Size 19 × 12 × 22 in. (List £520). Offered in excellent condition fully tested and checked. **£100** each. Few only.

RCA COMMUNICATIONS RECEIVERS AR88D

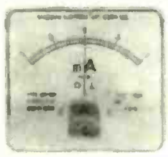
Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s—32 Mc/s continuous. Output impedance 2.5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0**. Carr. £2.

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/-.

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	S 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

LAFAYETTE STEREO AMPLIFIER MODEL STEREO 10

Completely transistorised 5 watts per channel I.H.F. music power. Inputs for gram and tuner. Separate volume controls and variable tone control for Bass and Treble. A compact size, big performance stereo amplifier ideal for limited space systems. Beautifully finished in grey and aluminium. Size 7½in. × 2 15/16 in. × 5½in. AC. 220/240v. Price £11.19.6. Carr. 7/6.

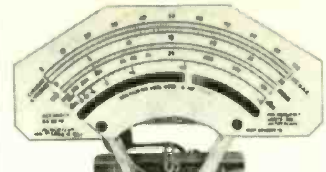
£11.19.6

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



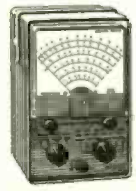
50µA 20KΩ/V.

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

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/-.

TE-65 VALVE VOLTMETER

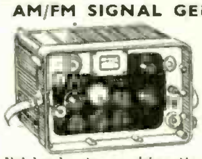


High quality instrument with 28 ranges. D.C. volts 1.5-1,500 v. A.C. volts 1.5-1,500 v. Resistance up to 1,000 megohms. 220/240v. A.C. operation. Complete with probe and instructions **£17/10/0**. P. & P. 6/-. Additional Probes available; R.F. 35/- H.V. 42/6.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.C. coupled. Band width 1 Kc/s. Perfect order. **£25**. Carr. 30/-.

AM/FM SIGNAL GENERATORS

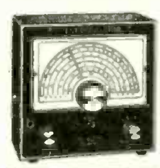


Oscillator Test No. 2. A high quality precision instrument made for the Ministry by Airmec. Frequency coverage 20-80 Mc/s. AM/CW/FM. Incorporates precision dial, level meter, precision attenuator 1µV-100Mv. Operation from 12 volt D.C. or 0/110/200/250 v. A.C. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors, fully tested. **£45**. Carr. 20/-.

GEARED MAINS MOTORS

Paralux type SD19 230/250 v. A.C. Reversible. 30 r.p.m. 40 lb. ins. Complete with capacitor. Excellent condition. **99/6**. Carr. 10/-.

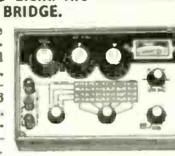
TE-16A TRANSISTORISED SIGNAL GENERATOR



5 Ranges 400 KHZ-30 MHZ. An inexpensive instrument for the handyman. Operates on 9v. battery. Wide easy to read scale. 800 KHZ modulation. 5¼" × 5¼" × 3½". Complete with instructions and leads. **£7/19/6**. P/P 4/-.

FIELD TELEPHONES TYPE L. Generator ringing, metal cases. Operate on 2 1.5 v. batteries (not supplied.) Excellent condition. **£4.10.0** per pair. Carr. 10/-.

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 7¾" × 5" × 2". **£20**. P. & P. 5/-.

AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded
150 W. **32/6**, P. & P. 3/6
300 W. **47/6**, P. & P. 4/6
500 W. **£4/10/0**, P. & P. 6/6
1,000 W. **£5/10/0**, 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

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. 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		
5	3 uf	25	4		
6	64 uf	9	4		
7	20 uf	6	4		
8	20 uf	50	6		
9	30 uf	15	6		
10	8 uf	12	4		
11	8 uf	6	4		
12	1 uf	350	6		
13	8/8/8	350	1 0		
14	50 uf	6	4		
15	100/200	275	6 0		
16	32	150	9		
17	64	2.5	3		
18	100/200/200/50	275	7 6		
19	50/80	300	3 0		
20	150/200	275	6 0		
21	24	275	1 0		
22	10	25	3		
23	125	2.5	3		
24	2	150	3		
25	16/32	350	2 6		
26	32	275	1 6		
27	350	12	6		
28	75/75/75/75	150	2 6		
29	1	20	3		
30	12.5	40	9		
31	640	2.5	3		
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		
37	32	50	9		
38	750	12	1 9		

Stock No.	Capacity	Voltage	Price s. d.	No. Required	£ s. d.
39	100 uf	275	2 6		
40	30 uf	10	3		
41	2000/2000	25	7 6		
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		
63	200	275	2 6		
64	40	6.4	3		
65	50	25	6		
66	250	50	1 9		
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. 5% **EXCELLENT QUALITY. 7/6d. per 100 or 2/- per dozen**
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. 3/- per dozen.
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	420 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.

GANGED STEREO POTS. 250K 2/6d. each.

SKELETON PRESETS. Mixed. 6/- dozen.

VOLUME CONTROLS. ½ meg. 1 meg. with D.P. switch. 2/- each.

TELEVISION REMOTE CONTROLS. Philips. Contain 11' 7-way cable, 1 double pot., 5 resistors, two condensers, 10/- each. (Cost £3/3/-.)

THIN CONNECTING WIRE. 10 yds 1/-, 100 yds 7/6d., 1,000 yds. 50/-.

CO-AXIAL CABLE. Black. 6d. yard, £1 50 yds.

CRYSTAL MIKES. 10/- each.

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.
Transistors similar to OCP 71 (Light sensitive) 2/- each.

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.

RECORDING TAPE GIVE-AWAY!
ALL BRITISH MADE, BEST QUALITY. 5" 600' 7/3d. 5¾" 900' 9/-, 7" 1,200' 12/-. 3" 'odd-ends'—may be standard, long or double play—but minimum 150'—2/3d.

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GIANT SELENIUM SOLAR CELLS. Last few to clear at half price! Circular, 67 mm. diameter 5/- each. 50 mm. × 37 mm. 3 for 10/-.

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 (CAR) 10/-

VERO-BOARD

2½" × 1" × .15	1/3	17" × 3¾" × .15	14/8
3¾" × 2½" × .15	3/3	3¾ × 2½ × .1	4/2
3¾" × 3¾" × .15	3/11	3¾" × 3¾" × .1	4/9
5" × 2½" × .15	3/11	5" × 2½" × .1	4/7
5" × 3¾" × .15	5/6	5" × 3¾" × .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'-.

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Complete stereo system – 28 gns.

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 10 ohms. It incorporates Goodmans high flux 6"×4" speaker and 2½" tweeter. Teak finish 12"×6¾"×5¾". 4 guineas each. 7/6d. p. & p.
Type 2 as type 1. Size 17½"×10¾"×6¾". Incorporating Elac 10½"×6½" 10,000 lines and 2½" tweeter. 3 ohms impedance 5½ guineas plus 7/6d. 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** **9GNS.** **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 1Kc/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.

The Classic

TEAK FINISHED CASE
8½ GNS.
plus 7/6 p. & p.
Built and tested.

SPECIFICATION

Sensitivies 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.

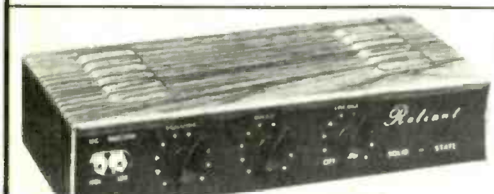
The Viscount

INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFIER
13½ GNS. + 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 gns** plus 7/6 p.&p.



THE RELIANT MK.II

Solid State
General Purpose Amplifier
In teak-finished case
6½ GNS.
+ 7/6 p. & p.

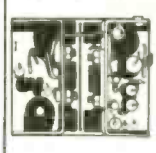
SPECIFICATION

OUTPUT: 10 watts into a 3 ohms speaker.
INPUTS: (1) for mike (10 m.v.). Input (2) for gram. radio (250 m.v.) indivdual bass and treble control.
TRANSISTORS: 4 silicone and three germanium.

MAINS INPUT: 220/250 volts.
SIZE: 10½" x 4¾" x 2¼"
MIKE TO SUIT (CRYSTAL): 12/6d. 1/6d. p. & p.
8" x 5" speaker 14/6d. + 3/- p. & p.
Mk. 1 5½gns. + 7/6d. p. & p. less Teak-finished case.

X101 10w. SOLID-STATE HI-FI AMP

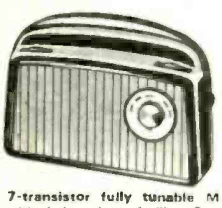
With Integral Pre-amp.



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.

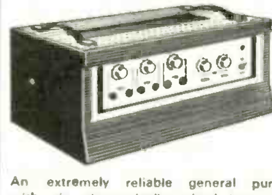
7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulized and pre-alignment techniques makes this simple to build. Sizes: 12" x 8" x 3".

ELEGANT SEVEN MK. III

(350mW Output)
£4.9.6
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



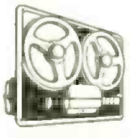
AC MAINS 200-250V
27 gns.
plus 20/- p. & p.

An extremely reliable general purpose valve Amplifier—with six electronically mixed inputs. Suitable for use with: mics, guitars, gram, tuner, organ, etc. Separate bass and treble controls. Output impedance 3, 8 and 15 ohms.

CYLDON 2 TRANSISTOR U.H.F. TUNER

Brand new. Complete with circuit diagram.
£2.10 + 1/- p. & p.

MOTEK



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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

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12Q7GT	4/6
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12SC7	4/-
12SG7	3/-
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EZ40	7/3
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EZ80	4/3
EZ81	4/6
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KT74	12/6
KT76	7/6
KT88	29/-
KTW61	8/6
KTW62	10/-
KTW63	5/9
KTZ41	6/-
L63	3/9
LN152	6/6
LN309	9/-
LN319	15/-
LN339	15/-
ME1400	14/9
LZ329	6/6
MHL4	12/6
MHLD6	7/6
MU12/14	4/-
MX40	12/6
N78	38/4
N108	27/10
N339	25/-
P61	2/6
PABC80	7/3
PC86	9/6
PC88	9/6
PC95	8/3
PC97	8/6
PC900	8/3
PCC84	6/-
PCC85	6/6
PCC88	9/9

PCC89	9/6
PCC189	9/6
PCF80	6/6
PCF82	6/-
PCF84	8/-
PCF86	9/-
PCF801	7/-
PCF802	9/-
PCF805	8/9
PCF806	11/6
PCF808	12/6
PCL81	9/-
PCL82	7/-
PCL83	9/-
PCL84	7/6
PCL85	8/3
PCL86	8/6
PCL88	15/-
PEN45	7/-
PEN45DD	12/-
PEN46	4/-
PEN453DD	19/6
PENA4	19/6
PEN/DD 4020	17/6
PFL200	13/-
PL33	19/6
PL36	9/6
PL81	7/3
PL81A	10/6
PL82	6/6
PL83	6/6
PL84	6/3
PL302	12/-
PL500	12/-
PL504	12/6
PL508	27/10
PL509	28/9
PL802	15/-
PM84	7/9
PX4	14/-
PY32	9/6
PY33	9/6
PY80	5/3
PY81	5/3
PY82	5/-
PY83	5/6
PY88	6/3
PY301	12/6
PY800	6/6
PY801	6/6
PZ30	9/6
QP21	5/-
QQVO3/10	27/6
QS75/20	10/6
QS150/15	9/6
QVO4/7	8/-
R10	15/-
R11	19/6

R16	34/11
R17	17/6
R18	9/6
R19	6/6
R20	11/9
R52	7/6
RK34	7/6
SP13C	12/6
SP42	12/6
SP61	3/3
TDD2A	12/6
TH4B	10/-
TH233	7/-
TP2620	8/9
UABC80	5/9
UAF42	9/6
UB41	6/6
UBC41	7/6
UBC81	7/-
UBF80	5/9
UBF89	6/9
UBL21	9/-
UC92	5/6
UCC84	8/-
UCC85	6/6
UCF80	8/3
UCH21	9/-
UCH42	9/9
UCH81	6/6
UCL82	7/-
UCL83	10/-
UF41	9/6
UF42	9/-
UF80	6/9
UF85	6/9
UF86	9/-
UF89	6/3
UL41	9/6
UL46	12/6
UL84	6/6
UM80	5/-
UR1C	10/6
UU5	7/-
UU8	14/-
UU12	4/6
UY1N	9/-
UY21	9/6
UY41	6/9
UY85	5/6
U10	9/-
U12/14	7/6
U16	15/-
U17	5/-
U18/20	10/-
U19	34/6
U22	7/9
U25	13/-
U26	11/9
U31	6/-
U33	29/6
U35	16/6
U37	34/11
U45	15/6
U47	13/-

U49	11/9
U50	5/6
U52	4/9
U76	4/9
U78	3/6
U107	18/3
U191	12/6
U251	16/-
U281	8/-
U282	8/-
U301	11/-
U329	16/-
U403	6/6
U404	7/6
U801	18/-
U4020	6/9
VP2	3/6
VP2B	9/6
VP4B	10/6
VP13C	7/-
VP23	2/6
VR75	24/-
VR105	5/-
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VT61A	7/-
VT501	3/-
VU111	7/3
VU120	12/-
VU120A	12/-
VU133	7/-
W76	5/9
W81M	6/-
W107	7/-
W729	10/-
XE3	£5
XFY12	9/6
XH1.5	9/6
X41	10/-
X61	5/9
X65	5/-
X66	7/6
X81M	30/6
X109	26/-
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2G225	10/6
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2N2369A	4/3
2N2613	7/9
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2N3121	50/-
2N3703	3/9
2N3709	4/-
2N3866	20/-
2N3988	10/-
2S323	10/-
AA119	3/-
AA120	3/-
AA129	3/-

AC107	3/-
AC113	5/-
AC114	8/-
AC127	2/-
AC154	5/-
AC155	6/6
AC156	4/-
AC157	5/-
AC165	5/-
AC166	5/-
AC167	12/-
AC168	7/6
AC169	6/6
AC176	11/-
AC177	5/6
ACY17	3/-
ACY18	3/6
ACY19	3/9
ACY20	3/6
ACY21	3/9
ACY22	3/6
ACY28	4/-
AD140	7/6
AD149	8/-
AD161	9/-
AD162	9/-
AF102	18/-
AF106	10/-
AF114	4/-
AF115	4/3
AF119	3/-
AF121	6/-
AF124	7/6
AF125	3/6
AF126	5/-
AF127	3/6
AF139	13/-
AF178	13/6
AF179	13/6
AF180	9/6
AF181	14/-
AF186	11/-
AF239	7/6
ASY27	8/6
ASY28	6/6
ASY29	10/-
AY100	26/-
B1181	10/-
BA102	9/-
BA115	2/8
BA116	9/-
BA129	2/6
BA130	2/-
BCY10	5/-
BCY12	5/-
BCY33	5/-

BCY34	4/6
BCY38	5/-
BCY39	4/6
BCZ11	3/6
BC107	4/-
BC108	3/6
BC113	5/-
BC115	3/-
BC116	5/-
BC118	4/6
BD119	9/-
BFY50	4/-
BFY51	4/-
BFY52	4/6
BF154	5/-
BF159	5/-
BF163	4/-
BF173	7/6
BF180	6/-
BF181	8/-
BF185	8/-
BTX34/400	40/-
BY100	3/6
BY101	11/6
BY105	10/6
BY114	6/6
BY126	5/-
BY127	5/-
BYY23	20/-
BYZ10	5/-
BYZ11	5/-
BYZ12	5/-
BYZ13	5/-
BYZ15	35/-
CG12E	4/-
CG64H	4/-
GD4	6/6
GD5	5/6
GD6	5/6
GD8	4/-
GD9	4/-
GD10	4/-
GD11	4/-
GD12	4/-
GD14	10/-
GD15	8/-
GD16	4/-
GET105	18/-
GET111	15/6
GET113	4/-
GET115	17/-
GET116	6/6
GET119	4/-

AAZ13	3/6
GET118	4/-
GET573	7/6
GET587	8/6
GET872	19/-
GET873	3/-
GET874	23/6
GET882	10/-
GET887	4/6
GET889	4/6
GET890	4/6
GET896	4/6
GET897	4/6
GEX13	3/6
GEX35	4/6
GEX36	10/-
GEX45	6/6
GEX55	15/-
GT3	5/-
M1	2/10
M3	2/10
OA5	5/6
OA9	2/6
OA10	8/6
OA47	2/-
OA70	3/-
OA73	3/-
OA79	1/9
OA81	1/9
OA85	1/6
OA86	4/-
OA90	2/6
OA91	1/9
OA95	1/9
OA182	2/-
OA200	1/-
OA202	2/-
OA210	9/6
OA211	13/6
OAZ200	12/-
OAZ201	10/6
OAZ202	9/-
OAZ203	9/6
OAZ204	9/-
OAZ205	9/-
OAZ206	9/-
OAZ207	10/6
OAZ210	7/-
OAZ213	7/-
OAZ224	16/6
OC19	25/-
OC22	5/-
OC23	5/-
OC24	5/-
OC25	5/-

OC26	5/-
OC28	5/-
OC29	23/6
OC30	5/-
OC35	5/-
OC36	7/6
OC38	11/6
OC41	10/-
OC42	12/6
OC43	23/6
OC44	2/-
OC44PM	8/3
OC45	1/9
OC45M	8/-
OC46	3/-
OC65	22/6
OC70	2/3
OC71	2/-
OC72	2/-
OC73	16/-
OC74	2/6
OC75	2/-
OC76	2/6
OC78	3/-
OC78D	3/-
OC79	8/-
OC81	2/-
OC81D	2/-
OC81M	5/-
OC82	2/3
OC82D	2/3
OC83	2/-
OC84	3/-
OC123	4/6
OC139	12/-
OC140	19/-
OC169	3/6
OC172	4/-
OC200	4/4
OC201	5/6
OC202	4/6
OC203	4/6
OC204	5/6
OC205	7/6
OC206	10/-
OC812	8/-
OCP71	27/6
SX1/6	3/6
MAT100	7/9
MAT101	8/6
MAT120	7/9
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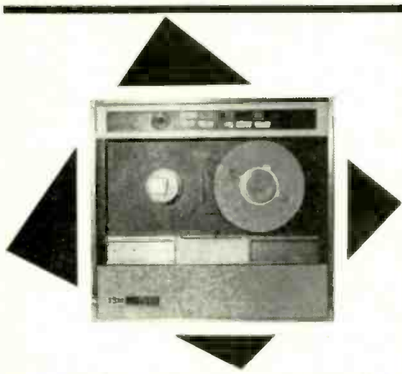
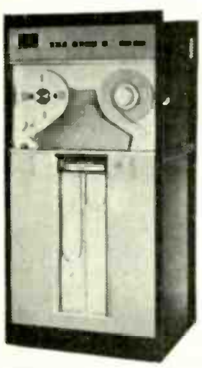


DIGITAL MAGNETIC DATA STORAGE DECK—Seven Track record replay heads
These machines originally ex-computors, multi-track recording units or data storage. Record and Playback Heads encased in one common unit. Head resistance 40 ohms and 7 ohms. Freq. Response approx. 30 c.p.s. - 30 Kc/s with a good response to 50 Kc/s. Finished in brush-aluminium and matt-black. Size 27 × 26 × 8 in. Weight 90 lb. 230 v. - 380 v. A.C. Capstan motor speed 1,500 r.p.m. 48 v. D.C. Rewind motor. c/w VACUUM ASSEMBLY. **£72.10.0.**

SEVEN TRACK Record replay heads—ex-computor, complete with guides, little used. **£12.10.0.**

UNISERVO MODEL 72 MAGNETIC TAPE UNIT



This unit consists of 8 channel read-write head. One track contains sprocket pulse, one contains parity (Check-bits) pulse, and the remaining six contain data any six bit code can be used to record on and can be read from the tape. Data can be read in either a backward or forward direction. The unit contains circuits for receiving and storing instruction signals. Recording density 250 characters per inch. Tape speed 100 in. per minute. **£195.** Excellent condition.

PROGRAMME BOARDS BY SEALECTRO
These boards are basically a multi pole multi throw switch device consisting of a X-Y Matrix with two contact decks in the Z Plane running at 90 degrees to each other. Contact is made by either, shorting or plugging in pins. Ideal for prototype work, etc. Boards available in 16 × 16 2 plane **£4.5.0.** 24 × 60 2 plane **£12.10.0.** Pins available 1/3 each.

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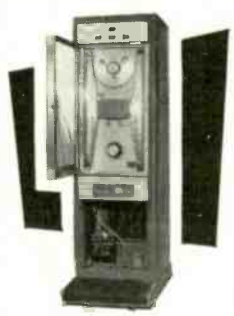
Ferrite core memory planes with wired Ferrite cores. Used for building your own computor or as an interesting exhibit in the demonstration of a computer. Mounted on plastic material, frame 5 × 8 in. Consisting of matrices 40 × 25 × 4 cores each one individually addressable and divided into 2 halves with independent sense and inhibit wires. **£8.10.0.**



AMPEX FR300
Tape deck in free-standing 6 ft. cabinet less heads. Complete with auto transformer for driving capstan motors. **£79.10.0.**

EMI BTR1 Tape Recorder fully overhauled **£175**

CREED TAPE PUNCH MODEL 25. 7 HOLE
A multiwire tape punch designed for general application involving the conversion of parallel wire electrical impulses into punched paper tape at 33 characters per sec. Unit completely self-contained requiring only motor power and signal supplies. £75.

WELMEC 7 HOLE NON PARITY TAPE PUNCH. Almost new.

LOW SPEED 7 HOLE TAPE PUNCH.
60 characters per sec. by well-known manufacturer.

FERRANTI HIGH SPEED 5 HOLE 20 CHARACTERS per second reader. **£19.10.0.**

4K 24 BITS CORE STORE type MM 1044. complete with all read, write electronics and all address decoding, including checking oscilloscope pattern generator all power supplies and cooling unit completely self-contained and 6 ft. free-standing rack cabinet—excellent condition.

DECODER 4 DIGIT READOUT
Can be used in constructing frequency counter or Digital Voltmeter. Consists of 4 transistorised cards each containing 10 NOR gates. Circuits supplied with Decoder. **£25.**

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By Sangamo Weston, suitable for D.C. circuit. A high sensitivity relay more sensitive than the electro-magnetic type. Single Coil Resistance 2K. 50 - 0 - 50 Micro-Amp. List price £4.10. Our price **20/-**

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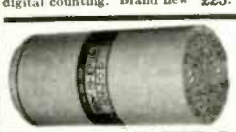
Frequency D.C.—60 c.p.s.
Available in the following ranges:
SE150, SE50 or SE165A.

0 - 25 p.s.i.	0 - 350 p.s.i.	0 - 2000 p.s.i.
0 - 50 p.s.i.	0 - 500 p.s.i.	0 - 3000 p.s.i.
0 - 200 p.s.i.	0 - 750 p.s.i.	0 - 4000 p.s.i.

Also available differential types ± 5 p.s.i., ± 10 p.s.i.
List price £70 + Our price **£15**

DIFFERENTIAL PRESSURE TRANSDUCERS by Sifam Ltd. G.B. Type H33
Range ± 900MB Resistance 942 ohms.
Our price **£19.10.0.**

HOLLERITH 80 COLUMN CARD VERIFIER By ICT, Type No. H 129/2489. Good condtion **£95.**



"V" SCAN DIGITAL SHAFT ENCODER BY MOORE REED TYPE 18 DV-19-EP 116 3 discs. Size 18. Counts 524288 in 1024 revolutions of shaft in V Scan. Brand new in maker's original sealed tins. List price £75 approx. Our price **£22.10.**

PHOTOMULTIPLIER VMP11/44 (CV 2317) by 20th Century Electronics
Cathode sensitivity 40μ A/L. Operating volts for 10 A/L 1100 volts. DARK current 0.004μA. **£8.10.0**

MEASURING INSTRUMENTS AND RECORDERS

KENT STRIP-CHART INDICATING RECORDER

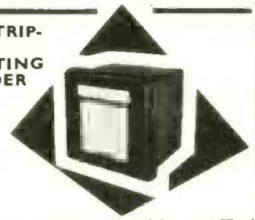
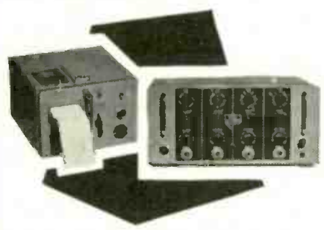


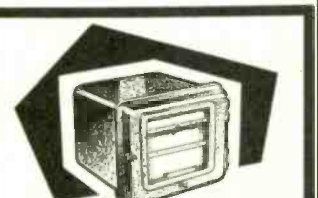
Chart width 9½ in. 10 mV. Sensitivity ± 0.17 of full scale. Source impedance 100 ohms. Speed of operation 33 sec. for full-scale travel. Chart speeds ¾ in., 3 in., 6 in. per hour. Single point **£49.10.0.**

UNICAM RECORDER SP 20 Series
General Purpose Single Pen potentiometric instrument for continuous recording for any input signal from 0 - 10mV D.C. Suitable for use with Spectro-photometer and other laboratory instruments. Chart speed 0.5 to 8.4 cm/min. Linearity ±0.25%. Fully transistorised. Chart width 200 mm. Input impedance 10K ohms max. Available S.P. 20 Plain Linear. S.P. 21 Flat Bed. S.P. 22 Linear/Log. **£135** each.

FOUR CHANNEL HIGH SPEED PEN RECORDER



By Kelvin Hughes, with four channel amplifier, giving a frequency range of 0-100 c/s.
The Recorder consists basically of a magnet carrying in its poles four stiffly suspended moving coil units, each with a stylus arm attached. The stiffness of the coil unit suspension enables the instrument to withstand the effects of vibration and acceleration. Sensitivity ± 3V input for full scale deflection of ± 7.5 mm. Mains operated. 6 chart speeds: 0.5; 1; 2; 4; 8; and 16 cm/sec. Excellent condition. **£149/10/0.**
N.B. Two channel version available, giving ± 16.5 m.m. deflection.



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.**

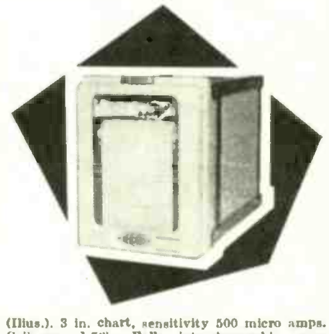
NEW PORTABLE RECORDING AMMETER

Specification. Type: Moving Coil. D.C. Range: 0–1 amp. D.C. Chart Width: 100 mm. Scale Length: 127 mm. Chart Speeds: 20, 60, 180, 600, 1800 and 5400 mm/hr. Precision: 1.5%. Shunts: 75mV (Internal). Operating Temperature: + 5 to + 50°C. Dimensions: 180h × 163 w × 245mm. Weight: 5.5kg. Complete with: 10 chart rolls, gears, inks, pipette, scale template and component case. List price £65. Our price **£35.**

TYPE 67008 EVERSHED BRIDGE MEGGER
500 volts. Insulation 0 - 100 Meg. Bridg 0.01 - 999. 900 ohms. with facilities for "VARLEY LOOP TEST". List price £120+. Our price **£69.10.0**

PORTABLE AC/DC PEN RECORDER
A most versatile pen recorder. Produces a trace on a curvi-linear 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. Chart speed: 1 in. and 6 in./hr. Chart width: 3½ in. curvi-linear. Power supply: 230V 50 Hz driving Synchronous Motor.
Price: **£49.10.0.** Postage and packing £1 5s. 0d.

SINGLE PEN RECORDER BY RECORD ELECTRICAL



(Illus.). 3 in. chart, sensitivity 500 micro amps. Coil res. 1.53k. Fully interchangeable gears available to make a wide range of chart speeds. 200/250v. Size: 8 × 11 × 6 in. Brand new—complete with chart and ink. List over £100. Our price **£49.10.0.**

EVERSHED BRIDGE MEGGER

250 volt, 50 meg. Insulation tester with built-in four decade bridges with ratio arms giving ratios of 100-10 — 1 — 0.1 + 0.01 and Selector switch for insulation, resistance and variety measurements. **£29.10.0.**

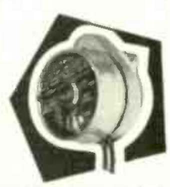
MOTORS

E.M.I. Professional Audio Tape Recorder Model BTR 1. This was the type of equipment used by the B.B.C. Fully overhauled and in excellent condition. **£125.**

HYSTERESIS REVERSIBLE MOTOR
Incorporating two coils. Each coil when energised will produce opposite rotation of output shaft. 240V 50 Hz. ⅓ r.p.m., ¼ r.p.m., 1/6 r.p.m., 6 r.p.m. **30/-** each.

HIGH TORQUE INDUCTION MOTOR. 300Z/inch. Available in the following speeds only 240V 50 Hz ½ r.p.m., 1 r.p.m., 2 r.p.m. 120V 50 Hz 20 r.p.m. **30/-** each.

LOW TORQUE HYSTERESIS MOTOR MA23



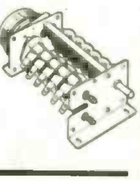
Ideal for instrument chart drives. Extremely quiet, useful in areas where ambient noise levels are low. High starting torque enable relative high inertia loads to be driven up to 60Z/in. Available in the following speeds and ranges: 240V 50 Hz 15 r.p.m., 4 r.p.m. 2 r.p.m., 1½ r.p.m., 1 r.p.m., ½ r.p.m., ¼ r.p.m., 1/3 r.p.m., 1/5 r.p.m., 1/6 r.p.m., 1/10 r.p.m., 1/12 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/75 r.p.m., 1/120 r.p.m., 1/180 r.p.m., 1/360 r.p.m., 1/720 r.p.m., 1/1440 r.p.m., 1/2880 r.p.m.; 120V 50 Hz 1/6 r.p.m., 1/5 r.p.m., 1/15 r.p.m., 1/16 r.p.m., 1/20 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. **25/-** each.

HYSTERESIS CLUTCH MOTOR
with integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz. torque at 1 r.p.m. 240 v., 50 c/s. L=left. R=right. 15 r.p.m. L, 8 r.p.m. R & L, 6 r.p.m. L. 4 r.p.m., ½, ⅓, ¼ 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/-.**

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. 4½ in. diameter with 6 in. diameter flange and 4 fixing holes. **£4.10.0** each. £1.5.0 postage and packing.

LOW COST ELECTRONIC AND SCIENTIFIC EQUIPMENT AND COMPONENTS

REPEAT CYCLE TIMERS

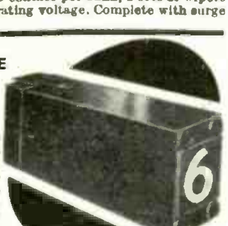


These timers repeat a set cycle of switching operations via a cam and micro switch, for as long as the motor is energised. Single Cam RB 21 in 2 min., 3 min., 4 min., 5 min., 6 min. cycles @ 45/-. Twin Cam RD 22 in 1 min., 2 min., 3 min., 4 min., 5 min. cycles @ 55/-. 4 Cam RD 24 in 4 min., and 5 min. cycles @ 75/-. 6 Cam RD 26 in 1 min., 2 min., 3 min., 4 min., 5 min. cycles @ 95/-. 8 Cam RD 28 in 1 min., 2 min., 3 min., 4 min., 5 min. cycles @ 115/-. All + p. & p. 5/-.

UNISELECTOR

8 and 4 Banks, 25 contact per bank, 2 sets of wipers 2 in. radius. Operating voltage. Complete with surge capacitor.

MINIATURE DIGITAL DISPLAY



Operates on a rear projection 6.3 pilot lamp. The lamp projects the corresponding digit on the condensing lens through a projector lens, on to the viewing screen at the front of the unit. 1 in. width. 3 1/16 in. deep. 1 1/16 in. high. Weight 3¼ oz. Character size ⅝ 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.

OSCILLOSCOPES

AIRMEC OSCILLOSCOPE TYPE 723

4 in. vertically mounted CRT 88D. Sensitivity 100mV/cm. Flat response from D.C. to 5 KHz. Automatic brilliance control. Overhauled. Bargain. £19.10.0.

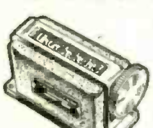
MULLARD OSCILLOSCOPE TYPE 101/3

Dual trace, incorporating extra Y amplifier and beam switch for measuring and making comparison of wave forms. Frequency response 10 Hz (−1 dB) to 4 MHz (−3 dB) by useable up to 8 MHz. Trace velocity variable from 0.1 cm/ms to 50 cm/μs. Sensitivity 0.02V/cm to 100V/cm. Overhauled and in good condition. £85.

COSSOR 1035 Mk. I, III and IV

Good general purpose oscilloscopes. Double beam, delay sweep. Prices from £25.

VEEDER ROOT 6 DIGIT COUNTER



Suitable for counting all kinds of production runs, business machine operation Electromechanically driven 1 count for each electrical impulse received. Reset manual knob. Speed 800 counts per minute. 230 v., 50 cycle. Size 3.25 × 2.5 × 1.62 in. Ex-equipment but new condition. Special price 55/- plus 5/- p. & p.

HI-SPEED QUICK RESET ELECTRO MAGNETIC COUNTERS

Push button reset 6 digits. 48 v. D.C. 3,5 watts. 20 counts per second. Size 3.875 × 2.625 in. Panel mounting. List £8. Our price 79/6.

POWER SUPPLIES

AIRMEC 698B KLYSTRON POWER SUPPLY

Rack mounted (19 in.). Mains operated. Cathode volts from 1.0 to 2.4 kv. negative. Grid Volts, 0 to 220V negative. Reflector Volts, 0 - 500V negative. Cathode Current, 0.18mA max. Heater 4V at 1.5A. Internal Modulation—Square wave 2 - 4 KHz 7V p-p. Saw Tooth 150 - 600 Hg 0 - 30V peak. Price £45.

★ HIGH PRECISION ★ FULLY STABILISED TRANSISTORISED LOW VOLTAGE POWER SUPPLIES

incorporating
- S.C.R. Panel for overload projection.
- OVERLOAD & CIRCUIT BREAKER WITH MANUAL RESET button.
- RIPPLE belter, better than 3000 : 1.
- CHOKE OF CAPACITOR transistorised 120/130 volt A.C. INPUT.

Available in the following types:

6 Volt 9 Amp	£12.10.0
6 Volt 12 Amp	£17.10.0
6 Volt 16 Amp	£22.10.0
12 Volt 8 Amp	£22.10.0
12 Volt 16 Amp	£25. 0.0
12 Volt 22 Amp	£25. 0.0
20 Volt 16 Amp	£25. 0.0
24 Volt 4 Amp	£22.10.0
30 Volt 8 Amp	£18.10.0
56 Volt 7 Amp	£25. 0.0

Ex-equipment but fully tested in our laboratory. Carr. 30/-

ADVANCE TRANSISTORISED DC STABILISED POWER UNITS

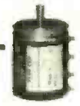
	Imput Volts	Output Volts	Amps	Price
DC 4	200-245 ± 15%	12	4	£17/10/-
DC 3	200-245 ± 15%	12	1.25	£10/10/-

OSCILLATORS

DAWE 444C AUTOMATIC L.F. SWEEP OSCILLATOR (NEW)

Amplitude 0 - 10V. Frequency Range 5 Hz - 5 KHz ± 2% ± 0.5 Hz. 18 Sweep Rates of 10 octaves/min. Frequency Response 0.5 dB. £89.10.0.

PRECISION POTENTIOMETERS



TEN TURN 3600° ROTATION BRAND NEW

Res. Ohms	Linearity Per cent	Manufacturer	Model	Price
100/100/100		Beckman	A	160/-
100	0.5	Beckman	A.8	60/-
200	0.5	Beckman	A	60/-
500	0.1	Beckman	8	70/-
500		Colvern	2501	45/-
500		Foxes	PX4	40/-
500		Colvern	2610	50/-
2K	0.5	Beckman	8A1101	60/-
2K		Beckman	7216	60/-
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.ss	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/-

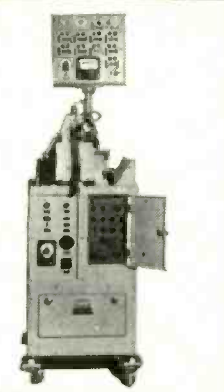
SINE COSINE

Colvern 8601	10K	£12.10s.
Colvern 9501	11K C.T	£16.10s.
CLR 9604—Cam Corrected 25K		£20.
9101A/A 20K		£16.10s.

PRECISION BECKMAN 40 TURN 14,400° ROTATION

Wirewound Precision Potentiometer. 8E 107A 20 watts at 40°C. 3 1/16" Diameter. Servo Mounting. 200 K. Brand New £12.10s. List Price £30.

AUTOMATIC CRYSTAL THICKNESS SORTING MACHINE



Fully automatic dice gauging and sorting system, eliminates all manual operations. This instrument is of extreme interest to manufacturers of semi-conductors. It is offered in good condition at a quarter of its original list price. It is suitable for the sorting of germanium and silicon dices 0.055 in. - 0.16 in. dia. or 0.04 in. - 0.12 in. sq. ± 2.5 microns. The unit can sort up to 2,400 pieces an hour. Pick-up compressed air line 40 lb. max. required. Our price £750. Further information available on request. Complete with manual and spares.

TRANSFER FUNCTION ANALYSER OS103/VP 253

Frequency range 0.1 c/s to Kc/s covering electro-mechanical applications and servo-mechanisms. Resolves network response signals simultaneously into in-phase or quadrature components. Permits direct polar diagram plotting of a servo system frequency response using cartesian co-ordinates. Establishes data for Nyquist diagram, attenuation phase response and other servo characteristics. Gives network phase/amplitude response from 0.1 c/s to 1 K c/s. Deflection sense of two centre zero-meters gives immediate identification of vector quadrant involved. 40 db rejection on amplitude. High sensitivity 50 mV/fsd. High accuracy measurement of true R.M.S. volts. List price £1,600. Our price £595.

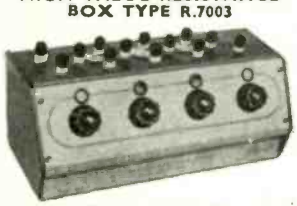
OSCILLATORS

DAWE 443B AUDIO SWEEP OSCILLATOR AND CONTROLLER (NEW)

Meets the need for a low sweep oscillator covering the entire audio range. Providing constant o/p voltage and logarithmic frequency scale. Suitable for automatic measurement and recording of frequency response curves of four terminal network, audio amplifier, tape recorders, studio and concert halls, etc. Frequency Range 20 Hz to 20 KHz ± 1% ± 1 Hz. Frequency Response ± 0.5 dB at 1 W output into matching impedance. £99.10.0.

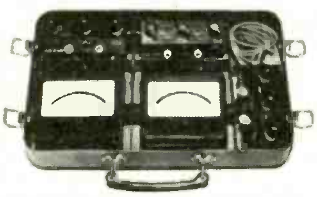
BRAND NEW LABORATORY TEST EQUIPMENT—*AT LESS THAN HALF PRICE!*

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/-.

SET OF MEASURING INSTRUMENTS

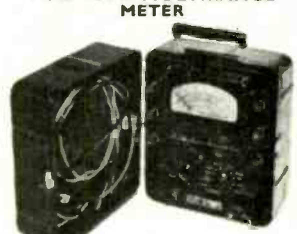


Specification Type: Moving Coil D.C. Ranges: 0-75mV, 0-3V, 3-15-150V, 3-150-450V, 0.3-0.75A, 1.5-7.5A, 15-30A. Scale Length: 82mm. Accuracy: 1.0%. Shunts: 1. 0.3-0.75 amps. 2. 1.5-7.5 amps. 3. 15-30 amps. Case: Moulded plastic. Carrying Case: Stove enamelled metal.
List price £30. Our price £12/19/6.

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. Operating Temperature: +10 to +35 deg. C. Operating Humidity: Yp to 80% R.H. Dimensions: 200 × 110 × 65mm. Weight: 0.9 kg.
List price £25. Our price £9/19/6.

PORTABLE MULTIRANGE METER



Specification.
Ranges: 0-60 & 0-300μA, D.C. 0-3, 0-30 & 0-120mA, D.C. 1.2 & 12 amps D.C. 0.6-3 & 6-30 mA. A.C. 24-120 mA. A.C. 0.24-12A, A.C. 3-12-30-300-600-1,200 & 6,000 V, D.C. 0.6-3, 2.4-12, 6-30, 60-300, 120-600, 240-1,200 & 1,200- 6,000 V. A.C. 3-333 ohms, 0.3-30 Kohms, 0.03-3 megohms D.C. Resistance —12 to +78 Decibels. Frequency: 50 cps. Input Resistance D.C.: 20,000 ohms/volt. Input Resistance A.C.: 2,000 ohms/volt. Temperature Range: —10 to +50 deg. C. Dimensions: 255 × 215 × 170mm. Weight: 8 kg. Supplied with 2 voltage dividers, H.V. leads, spare rectifiers, 1.5 & 22.5 V. battery.
List price £25. Our price £12/19/6.

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 dingings). Case: Polished teak. List price £65. Our price £26.10.0.

SPECIAL PRICE OF £55

is offered if the following equipment is ordered together: High Value Resistance Box, Portable Wheatstone Bridge, Mutual Inductance Box, Mutual Inductance Coil.

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/-.

★ ILLUSTRATED LEAFLETS AVAILABLE ★

ELECTRONIC BROKERS LTD., 49-53 PANCRAS ROAD, LONDON, N.W.1. Tel: 01-837 7781/2 Cables: SELELECTRO

SPEED CHECK!

Revs per Minute or anything else per minute—

P.I. ELECTRONIC TACHOMETER

Type P.I/L with light probe
Type P.I/M with magnetic probe

- ★ Imposes no load
- ★ No mechanical connection required
- ★ Ideal for inaccessible places
- ★ Lightweight for easy movement

External D.C., Battery, and Marine engine speed versions available from—

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COSHAM, HANTS.
COSHAM 71711/5

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CLAPHAM, LONDON, S.W.4
TEL: 01-622 0141/3 & 3211/5

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★

ERRATA

FAIRCHILD Circuit Applications File
Price should read 7/6d.

See our advertisement on page 88

NEW PRICES ON NEW COMPONENTS

RESISTORS
High stability, carbon film, low noise. Capless construction, molecular termination bonding.
Dimensions (mm.): Body: ¼W: 8 × 2·8
½W: 10 × 4·3
Leads: 35
10% ranges; 10 Ohms to 10 Megohms (E12 Renard Series).
5% ranges; 4·7 Ohms to 1 Megohm (E24 Renard Series).
Prices—per Ohmic value.

		each	10 off	25 off	100 off
¼W	10%	2d.	1/6	3/3	10/4
¼W	5%	2½d.	1/9	3/8	11/8
½W	10%	2½d.	1/9	3/8	11/7
½W	5%	3d.	2/-	4/-	12/10

CAPACITORS
Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radial leads.
±10% tolerance. 100 Volt working.
Prices—per Capacitance value (µF)

	each	10 off	25 off	100 off
0·001, 0·002, 0·005, 0·01, 0·02 ..	6d.	4/3	8/4	30/-
0·05	8d.	6/-	12/6	41/8
0·1	10d.	7/1	15/6	51/-
0·2	1/2	10/-	20/10	68/6

Polystyrene film, Tubular, Axial leads. Unencapsulated ±5% or ±1pf tolerance, 160 Volt Working.
Prices—per Capacitance value (µµF)

	each	10 off	25 off	100 off
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 180, 220, 270, 330, 390	5d.	3/7	7/9	24/-
470, 560, 680, 820, 1,000, 1,500	6d.	4/-	8/8	26/8
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6,800, 8,200, 10,000, 15,000	8d.	6/-	13/-	40/-
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POTENTIOMETERS (Carbon)
Superior grade enclosed controls. Low rotational noise. Body dia., 1in. Spindle, 2in. × ¼in. Tolerance, 20%.
Linear: 1K to 2M. (¼W at 40°C).
Logarithmic: 5K to 2M. (¼W at 40°C).

	each	10 off	25 off	100 off
Prices per ohmic value	2/-	18/4	41/8	150/-

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¼W at 70°C. Long Spindle.
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	each	10 off	25 off	100 off
Prices per ohmic value	8/-	70/-	162/6	575/-

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High quality pre-sets suitable for printed circuit boards of 0·1in. P.C.M. 100 ohms to 5 Megohms (Linear only). Miniature: 0·3W at 70°C. ±20% below ½M, ±30% above ½M. Horizontal (0·7in + 0·4in. P.C.M.) or Vertical (0·4in. × 0·2in. P.C.M.). Subminiature: 0·1W at 70°C. ±20% below 2·5M, ±30% above.

Prices—per ohmic value	each	10 off	25 off	100 off
Miniature (0·3W)	1/-	8/9	18/9	66/8
Subminiature (0·1W)	10d.	7/1	14/7	46/8

ELECTROLYTIC CAPACITORS (Mullard.) —10% to +50%.
Subminiature (all values in µF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	1/4	1/3	1/2	1/-	1/1	1/2

Small (all values in µF)

4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	1/6	2/-	2/6	3/-

POLYESTER CAPACITORS (Mullard)
Tubular 10%, 160V: 0·01, 0·015, 0·022µF, **7d.** 0·033, 0·047 µF, **8d.** 0·068, 0·1 µF, **9d.** 0·15 µF, **11d.** 0·22 µF, **1/-**. 0·33 µF, **1/3.** 0·47 µF, **1/6.** 0·68 µF, **2/3.** 1 µF, **2/8.**
400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022 µF, **7d.** 0·033 µF, **8d.** 0·047 µF, **9d.** 0·068, 0·1 µF, **11d.** 0·15 µF, **1/2.** 0·22 µF, **1/6.** 0·33 µF, **2/3.** 0·47 µF, **2/8.**

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- ACV: 0-3-10-50-250-1,000V at 2.5K/OPV 0-1.5-5-25-125-500V at 5K/OPV.
- DC μA: 0-25 μA at 125mA: 0-50 μA at 250mA
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- Output Capacitor (0.1 μF, 400Vw) in series with ACV ranges.
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TTC Model C-1051

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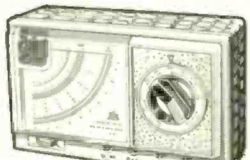

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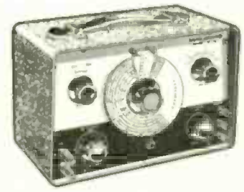

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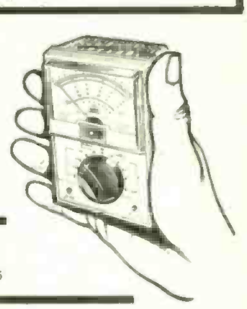
A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ± 3% accuracy on full scale of DC ranges, 4% on AC ranges. 2⅛in. square meter. SPECIFICATIONS: AC/V ranges: 0-10, 50, 250, 1,000V at 1K/O.P.V. AC/V ranges: 0-10, 50, 250 100V at 1K/O.P.V. DC current: 0-1-100mA. Resistance: 0-150K/ohms (3,000 ohms centre scale). Decibels: -10 to +22dB. Operates on one penlight cell. Two colour buff/green case size only 3½x2½x1in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and ins.



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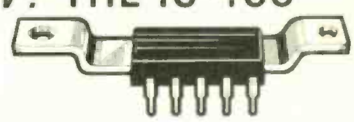

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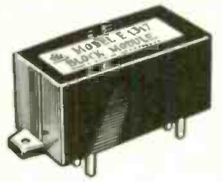

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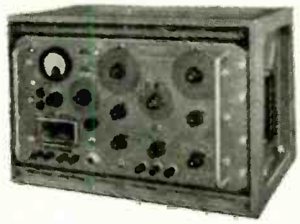

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SOLATRON EQUIPMENT

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12AY7 13/6
12B4A 10/-
12BA6 6/6
12BA7 6/6
12BE6 6/6
12BH7 6/6
12BY7 10/-
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12CU6 15/-
12E1 26/-
12E14 55/-
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12K5 10/-
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12K8 10/-
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12SC7 5/-
12SG7 7/-
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12SJ7 5/-
12SK7 8/-
12SL7GT 8/-
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20CV 62/6
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20P4 20/-
20P5 20/-

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30C18 15/-
30F5 17/-
30FL1 15/-
30FL12 18/6
30FL13 18/6
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30L1 7/-
30L15 17/-
30L17 17/-
30P12 16/-
30P18 7/-
30P19 15/-
30PL1 15/6
30PL13 18/-
30PL14 17/-
35A3 10/-
35A5 11/-
35B5 13/-
35C5 7/-
35D5 13/-
35L6GT 9/6
35W4 5/-
35Z3 11/-
35Z4G 5/-
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42 8/-
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50B5 7/-
50C5 7/-
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53KU 16/-
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85A3 9/-
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90CG 25/-
90CV 25/-
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150B4 11/-
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DL92 7/-
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EBF80 8/-
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EC86 12/-
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EC93 9/6
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ECC82 6/-
ECC83 6/-
ECC84 6/-
ECC85 5/6
ECC86 9/6
ECC89 8/-
ECC91 4/-
ECF80 7/-
ECF82 7/-
ECF83 15/-
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ECH83 8/6
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ECL82 6/6
ECL83 12/6
ECL84 11/-
ECL85 10/6
ECL86 8/6
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EF37A 9/-
EF39 9/-

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U19 50/-
U20 13/6
U25 15/-
U26 15/-
U31 9/-
U33 30/-
U37 30/-
U50 6/-
U52 6/-
U76 5/-
U78 5/-
U81 13/-
U191 14/-
U201 7/-
U281 8/-
U282 8/-
U301 11/6
U403 10/-
U404 7/6
U801 20/-
UABC80 6/9
UAF41 10/-
UAF42 10/6
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UBC41 9/6
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UBF89 7/-
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UCH81 6/6
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UCL82 7/-
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UF42 12/-
UF43 11/-
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UF89 7/-
UL41 12/-
UL84 6/6
UM4 5/6
UM84 4/-
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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:

723A/B; 2K25; 4C35—50/- paid subject to test. Please offer us your special valves and tubes surplus to requirements.

APPOINTMENTS VACANT

DISPLAYED SITUATIONS VACANT AND WANTED: £6 per single col. inch.
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Advertisements accepted up to OCTOBER 10 for the NOVEMBER issue, subject to space being available.

FIELD TECHNICIAN
AVIATION EQUIPMENT

An additional technician is required at our Sunbury-on-Thames laboratory to service and maintain airborne radar, DME, transponder and navigation equipment.

The position requires a broad range of electronic experience and will probably suit an ex serviceman who has worked as an air or ground radar fitter.

Applicants must be prepared to travel both in the U.K. and overseas. Initial training will be given at Sunbury.

Please apply in confidence to **Mr. R. G. Hancock, Personnel Officer, RCA Limited, Sunbury-on-Thames, Middx. Telephone Sunbury 85511.**

RCA

University of Birmingham
Department of Physics

Electronics Technician

required for an interesting post in nuclear research involving maintenance and the building of prototype equipment. Relevant electronics experience or qualifications required.

Salary grade according to age and experience in the range £773-£1,311.

Apply for application form to Assistant Secretary (Personnel), Personnel Office, University of Birmingham, P.O. Box 363, Birmingham 15, quoting reference 113/T/128, or telephone 021-472 1301, extension 434.

2477

Telecommunications Technical Officers

BOARD OF TRADE
CIVIL AVIATION DEPARTMENT

Posts for work on radar, data processing, navigational aids, communication, closed circuit television systems etc., at civil airports and other stations in the United Kingdom. The duties are challenging, demanding a responsible attitude and good judgement. Many involve the will and ability to keep abreast of the most up-to-date techniques. Staff suggestions are encouraged and can lead to financial awards. There is good scope for enthusiastic officers having initiative, who are willing to pull their weight and to work harmoniously with others, or on their own, as the occasion demands.

QUALIFICATIONS: O.N.C. in Engineering (including a pass in Electrical Engineering A), *or* City and Guilds Intermediate Certificate in Telecommunications Engineering (old syllabus i.e. subject No. 50) plus Radio II, *or* Intermediate Telecommunications Technicians' Certificate (new syllabus i.e. subject No. 49) plus Certificates in Mathematics B, Telecommunications Principles B, and Radio and Line Transmission B; *or* equivalent standard of technical education. Appropriate experience essential.

STARTING SALARY (national): from £1.086 (at age 21) to £1,178 (at 23) to £1,418 (at 28 or over), scale maximum £1,601 (somewhat higher in London). Scale will become £1,155-£1,735 on 1.1.70. Promotion prospects. Non-contributory pension.

WRITE to Civil Service Commission, Savile Row, London, W1X 2AA, or telephone 01-734 6010, ext. 229 (after 5.30 p.m 01-734 6464 "Ansafone" service), for application form, quoting *S*/207. Closing date 3rd October, 1969.

2470

C.I. DATA CENTRE LIMITED

SYSTEMS ANALYST-CUSTOMER LIAISON

We are looking for an energetic young man with a degree or equivalent in Mathematics or Physics, to join our well established scientific computer bureau in Aldershot.

The job will be to look after a range of customers' accounts, interpreting their data processing needs in terms of our computer and specialised equipment and checking that work is dispatched on time and to customers' specifications.

The work is extremely varied and requires an alert mind together with a desire to give customer satisfaction. There is a particular requirement for the radio contracts which we hold, previous experience in this field would be extremely useful.

Rewards for the right man may include a salary of £1,800-£2,000 per annum with the private use of a business car.

Applications in writing please to: The General Manager, C.I. Data Centre Limited, Wellington House, Station Road, Aldershot, Hants.

2496

Maintenance Engineers

You can do better for yourself in computers

ICL, Britain's biggest computer manufacturer, needs service engineers in London, the Home Counties, Manchester and Oxford. The job—keeping customer installations at peak efficiency—demands dedication and offers special rewards. A thorough training in computers will be given.

Career development: In the UK alone there are now well over 1000 ICL computer installations, and every week the number increases. Overseas there are ICL installations in 70 countries. So the scope for Field Service Engineers is enormous.

Qualifications: You should:

- Be aged 21-35
- Have City and Guilds Electronics Technicians' certificates or HNC Electronics or equivalent
- Have experience in electronics (perhaps in HM Forces)
- Actively want responsibility, and the chance to get on.

Write: giving brief details of your career and quoting Reference WW/970/C to A. E. Turner, International Computers Limited, 85-91 Upper Richmond Road, Putney, London, S.W.15.

The Computer Industry

ICL International Computers Limited

London Weekend Television

Applications are invited from suitably experienced staff for the following A.C.T.T. graded positions with London Weekend Television.

SENIOR ENGINEERS
ENGINEERS
ASSISTANT ENGINEERS
and
TECHNICAL ASSISTANTS

These are required to supplement present staff based at our colour studios at Wembley and will later be transferred to our new studio complex on the South Bank.

Several years' experience of broadcast engineering will be required of applicants for the more senior posts.

The possession of a formal technical qualification will be an advantage.

Apply to:

The Personnel Manager, London Weekend Television Limited
Wembley Park Drive, Wembley, Middlesex

2503

GEC-Marconi Electronics

ELECTRONIC TECHNICIANS

are required to work on calibration, fault-finding and testing of telecommunications measuring instruments. The work is varied and will enable technicians with experience of r.f. circuits to broaden their knowledge of the latest techniques employed in the electronics and telecommunications industries by bringing them into contact with a wide range of the most advanced measuring instruments embracing all frequencies up to u.h.f.

Entrants may be graded as Testers, Test Technicians or Senior Test Technicians according to experience and qualifications. Our expanding production programme geared to our recognised export achievement provides security of employment combined with good prospects of advancement, not only within these grades, but into other technical and supervisory posts within the Company.

Salaries are attractive and conditions excellent. A Pension Scheme includes substantial life assurance cover provided by the Company. Assistance with removal may also be given in appropriate cases. Please apply in writing, giving brief details including age, experience and salary to:

The Recruitment Manager,
Marconi Instruments Ltd.
Longacres, St. Albans, Herts.

mi

Member of GEC-Marconi Electronics Limited

2520

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

83

EQUIPMENT TECHNICIAN

required by the
GOVERNMENT OF ZAMBIA

Ministry of Power, Transport and Works, on contract for one tour of 36 months in the first instance. Commencing salary according to experience in the scale Kwacha 2292 (£Stg.1337) rising to Kwacha 3216 (£Stg.1876) a year, plus an Inducement Allowance of £Stg.506-£Stg.615. A Direct Payment of £Stg.233-£Stg.291 is also payable direct to the officer's bank in the U.K. Gratuity 25% of total salary drawn. Both Gratuity and Direct Payment are normally TAX FREE. Free passages. Accommodation at moderate rental. Education allowances. Liberal leave on full salary or terminal payment in lieu. Contributory pension scheme available in certain circumstances.

Candidates, preferably between 26 to 45 years of age, should have had not less than 10 years training and experience with a recognised telecommunications administration. They should have had a sound technical education in telecommunications and possess relevant City and Guilds or equivalent certificates. Officers may be stationed anywhere in Zambia, and must be prepared to travel on duty, perform shift work and perform paid overtime as required.

The duties include installation in one or more of the branches of telecommunications engineering listed below and giving technical appreciation to Zambians in field training.

(i) Maintenance of carrier trunk and telegraph transmission systems.

(ii) (*a*) Maintenance of medium powered H.F. radio transmitters and receivers.
(*b*) Maintenance of V.H.F. and microwave radio links.

(iii) Dual maintenance of minor exchange systems and external distribution networks.

Apply to
CROWN AGENTS,
'M' Division, 4 Millbank, London, S.W.1, for application form and further particular stating name, age, brief details of qualifications and experience and quoting reference number M2Z/62916WF.

2495

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 Rediffusion 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.

ANTARCTIC EXPEDITION

requires

WIRELESS OPERATORS/MECHANICS

1st or 2nd Class PMG Certificate with current morse speed of 20 WPM. Servicing experience essential and knowledge of teleprinters desirable. Salary from £938 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

2472

Become a RADIO TECHNICIAN

and work at the nerve centres of civil aviation

The National Air Traffic Control Service, a Department of the Board of Trade, needs Radio Technicians to install and maintain the very latest electronic aids at Civil Airports such as Heathrow, Gatwick and Stansted, Air Traffic Control Centres, Radar Stations and specialist establishments.

This is responsible demanding work (for which you will get familiarisation training) involving communications, computers, radar and data extraction, automatic landing systems and closed-circuit television. It offers excellent prospects with ample opportunities to study for higher qualifications in this fast-expanding field.

If you are 19 or over, with practical experience in at least one of the main branches of telecommunications, fill in the coupon now.

Starting salary is £915 (at 19) to £1,189 (at 25 or over): scale maximum £1,372 (higher rates at Heathrow), and some posts attract shift-duty payments. *From January 1970 these rates will be increased to £985, £1,295, £1,500 respectively.* The annual leave allowance is good and there is a non-contributory pension scheme for established staff.

Complete 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/81

Not applicable to residents outside the United Kingdom.

NATCS **National Air Traffic Control Service**

PLANNING ENGINEERS

International Aeradio Limited has doubled its turnover in the last 5 years to its present level of £7 million and with a dynamic expansion programme in operation is expected to exceed a turnover of £19 million within 10 years. The company is worldwide with over 3,500 employees engaged in the fields of communications, aviation services, engineering and printing, and now wishes to appoint two Senior Engineers who will be based at its new Offices outside Southall.

AIRPORT COMMUNICATIONS SYSTEMS

This position involves the planning of Airport Communications Systems, including Radio Navigational Aids, AFTN, Aeromobile Services and the internal communications appropriate to modern airports.

Applicants for this new appointment should preferably have specialised knowledge in one or more of the fields below. A qualification leading to membership of the I.E.E. or I.E.R.E. would be an advantage.

★ CW Radio Navigational Aids such as ILS, VOR, etc.
★ Airfield Radars, Surveillance, Precision Approach, SSR, etc.
★ Point to Point HF Communications.
★ HF and VHF Air-Ground Communications.
★ Modern Information Display Systems.
★ Public Address and Intercommunications Systems.

DATA TRANSMISSION SYSTEMS

Located in the Systems Planning Department, this position will involve the planning of national and international data transmission systems. These can either be self contained networks or systems allied to computers.

We require an engineer with a broad knowledge of communications systems and practical experience of the problems associated with the transmission of data at low, medium and high speeds. He should possess specialised knowledge in two or more of the following fields:

★ Data modems and international standards for modulation and interface parameters.
★ Commissioning, equalising and subsequent quality control of long distance circuits handling data.
★ Distribution of high speed data from computers to video display terminals.
★ Low speed data switching systems handling telegraph signals, including polling systems.
★ The use of G.P.O. datel services and the problems of demarcation between G.P.O. and lessee's equipment.
★ Operation of long distance leased circuits carrying data with particular reference to reliability of different sections of route.

It is unlikely that the successful applicant will be less than 30 years old. He should preferably have membership of a professional institution or qualification leading to such membership.

Career prospects for these positions are extremely good and starting salaries will be negotiated in the range £1,800 to £2,100. There is an excellent contributory pension and life insurance scheme and holiday airfares can also be obtained at nominal cost to most parts of the world after a year's service.

Application for these appointments should be addressed to
THE GENERAL MANAGER PERSONNEL

IAL ***INTERNATIONAL AERADIO LIMITED***
AERADIO HOUSE · HAYES ROAD · SOUTHALL · MIDDLESEX 2522

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.

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UNIVERSITY OF BIRMINGHAM

Department of Anatomy

TECHNICIAN

required to assist in the design and construction of electronic apparatus for neurological research, also to participate in routine experimental procedures involving animals and man. Some knowledge of linear and digital circuit techniques required, but no previous experience in the medical sciences is necessary. Applicants should have obtained or be studying for H.N.C. or an equivalent qualification in electronic engineering or physics.
Salary: £773-£1077 p.a.

Apply Assistant Secretary (Personnel), Personnel Office, University of Birmingham, P.O. Box 363, Birmingham 15, or telephone 021-472-1301, extension 434, quoting reference 401/T/139.

2493

UNIVERSITY OF ST. ANDREWS

Department of Chemistry

Applications are invited from candidates with an Ordinary Degree, H.N.C or equivalent qualification in Electronics for the position of TECHNICAL OFFICER in the Department of Chemistry. The successful applicant will be expected to assist in the servicing of spectrometers and in the development of electronic equipment. The new chemistry building is equipped with Mass Spectrometers (MS-902 and MS-10), N.M.R. Spectrometers (HA100 and R-10) and a Decca E.S.R. Spectrometer in addition to I.R. and U.V. Spectrometers.

Salary in the range: £1,090-£1,465; grant towards removal; pension scheme.

Applications with the name of a referee should be sent before 31st October, 1969, to the Deputy Secretary, University of St. Andrews, College Gate, St. Andrews, from whom further particulars may be obtained.

2476

TRINITY HOUSE, LONDON

The General Lighthouse Authority for England and Wales requires a

MODEL SHOP MECHANIC

in the Evaluation, Test and Development Section of the Engineer-in-Chief's Department at Tower Hill, E.C.3, to assist in the wiring and setting up of experimental electrical/electronic equipment.
Further details and application forms from The Secretary, Trinity House, Tower Hill, London, E.C.3.

2484

the experts in sound engineering · PYE TVT

PYE TVT the leaders in closed circuit television · PYE TVT

leaders in broadcasting equipment · PYE TVT sound amplification

Senior Commissioning Engineers

COLOUR TV TRANSMITTING EQUIPMENT—HOME & OVERSEAS

Due to rapid expansion, additional vacancies have arisen in our team of Electronic Engineers with specific experience of TV broadcasting or other transmitting equipment.

Applicants will be of H.N.C. standard and possess the essential knowledge and ability to complete their varied tasks without close supervision. These are positions of great interest with opportunity to travel.

An excellent salary and travelling expenses will be paid, holiday commitments will be honoured.

Apply with brief employment details to Personnel Officer:

PYE TVT LIMITED
Coldhams Lane, Cambridge.
Telephone: Cambridge (0223) 45115

2465

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

SCIENCE RESEARCH COUNCIL

RADIO AND SPACE RESEARCH STATION

MALE EXPERIMENTAL and ASSISTANT EXPERIMENTAL OFFICERS are required for service at SINGAPORE and at STANLEY, FALKLAND ISLANDS to operate and maintain radio telemetry equipment for the reception of data from satellites. Married staff are accommodated rent-free in well-furnished bungalows or houses; hostels are available for single personnel.

The tour of duty is for up to 3 years duration in Stanley but is likely to be for a shorter period in Singapore. Shift work may be required at either station. Staff may be considered for permanent appointment to R.S.R.S. at the completion of their contracts.

QUALIFICATIONS

Over age 22, University degree, H.N.C. or equivalent.

Under age 22, five G.C.E. passes, including two in Science or Mathematical subjects at 'A' level (or equivalent).

SALARY

£683 per annum rising to £872 at age 21 years, £1,208 at age 26 years or over, to a maximum of £1,454 for A.E.O. and £1,590 per annum rising to a maximum of £2,006 for E.O. To these scales will be added a £125 p.a. allowance. Overseas allowance and shift allowance will be payable in addition to salary.

Apply: The Secretary, Radio and Space Research Station, Ditton Park, Slough, Bucks. Telephone Slough 24411.

2475

Assistant Signals Officer

METEOROLOGICAL OFFICE

Ministry of Defence (Air Force Department)

Electronic Engineer (man or woman, aged at least 23) for a post of Assistant Signals Officer at the Meteorological Office Headquarters in Bracknell, Berks.

DUTIES relate to the planning, provision and installation of meteorological landline and radio telecommunication systems embracing transmission by both low/medium/high speed data and analogue/digital facsimile, and including facilities for reception from satellites. A particular objective will be to automate the U.K. system making optimum use of computers.

QUALIFICATIONS: Either (a) Corporate Membership of the Institution of Electrical Engineers, the Institution of Electronic and Radio Engineers or the Royal Aeronautical Society, or exemption from their examinations, *or* (b) 1st or 2nd class honours degree in Electrical Engineering, Physics or Applied Physics, together with at least 2 years' training and experience in Telecommunications or Electronic Engineering. Wide knowledge of telecommunications and aptitude for planning essential. Some experience of planning for automation in telecommunications an advantage.

SALARY (national): £1,144-£2,174 (£1,325-£2,300 from 1.1.70). Starting salary may be above minimum. Non-contributory pension.

WRITE to Civil Service Commission, Savile Row, London, W1X 2AA, or TELEPHONE 01-734 6010 Ext. 229 (after 5.30 p.m. 01-734 6464 "Ansafone" Service), for application form, quoting S/7249/69. Closing date 10th October, 1969.

2486

BBC tv

TRAINEE ASSISTANT FILM RECORDISTS

FILM OPERATIONS DEPARTMENT

BBC requires Trainee Assistant Film Recordists in London. Age limit 18-28. After technical and operational training those selected will work on sound transfer and dubbing recording duties, based in London. Later, they may be deployed on mobile recording work requiring extensive travel and must be able to drive or learn to drive a car. G.C.E. standard of education, knowledge of basic electronics and tape recording and a real interest in modern film sound production essential.

Salary whilst training £1,050 p.a., rising to £1,560 when fully qualified.

Write for application form (enclosing addressed foolscap envelope and quoting reference 69.G.855.W.W.) to Head of Appointments Department, BBC, Broadcasting House, London W1A 1AA by September 22nd.

2483

INTERTEL COLOUR TELEVISION

REQUIRES

ENGINEERS

IN THEIR

VIDEO TAPE DEPARTMENT

Applicants should have a good working knowledge of Colour Video Tape recording and be prepared to travel extensively throughout Europe if required

Applications to:

Head of Technical Operations
INTERTEL COLOUR TELEVISION LTD.
Wycombe Road, Wembley, Middlesex

Not later than September 30th, 1969

2497

UNITED PRESS INTERNATIONAL

requires an ELECTRONICS ENGINEER for the position of

CHIEF EUROPEAN TELEPHOTO ENGINEER

He must have a sound theoretical training in Radio-Electronics and practical experience in this field. A knowledge of phototelegraphy, landline, and shortwave radio working is required; knowledge of European languages preferable.

Good salary and permanent position offered to the man with the necessary qualifications prepared to accept responsibility for the planning, design, construction and implementation of equipment.

Applications to Mr. D. H. Till,
UNITED PRESS INTERNATIONAL,
8 Bouverie Street, London, E.C.4

2498

SENIOR SERVICE ENGINEER

To supervise Regional Service Department based in Manchester. Experience public address equipment essential. Vehicle allowance or vehicle provided.

Write giving full details previous experience and salary to

SERVICE MANAGER, MAGNETA (B.V.C.) LTD.
PARSONS GREEN LANE, LONDON S.W.6

2481

RADIO AND INSTRUMENTATION ENGINEERS

Required for WEST AFRICAN PROJECTS

C.O.D.E.C.O.

62 STEPHYNS CHAMBERS • BANK COURT
MARLOWES • HEMEL HEMPSTEAD • HERTS

2403

ENTHUSIASTS

have you considered a career in Technical Authorship? If you have sound experience in electronics or communications and ability to write clear concise English we would train you. The vacancies are in the Home Counties and the Midlands and salaries range from £1,600 to £1,900 p.a. depending on experience. Box W.W. 5056

2332

ELECTRONIC TECHNICIAN

Do you enjoy playing around with electronic gadgets?

Here's your chance to make a career of your hobby. We offer you interesting and varied work in the field of electronic instrumentation. This small but expanding department is concerned with the design and application of electronic circuits required for the testing of diesel engines and their fuel injection system.

Staff conditions are good and include sickness and contributory pension and life assurance schemes, restaurant facilities.

In the first instance applicants should write in confidence giving only brief personal details to:-

The Personnel Manager
SIMMS MOTOR UNITS LTD.
Oak Lane, East Finchley, N.2
Tel: 01-346 2692

2504

UNIVERSITY OF STIRLING

TECHNICAL OFFICER (ELECTRONICS)

Applications are invited from electronic engineers qualified to H.N.C. level or equivalent with the ability to assist in the design and development of a wide range of prototype electronic equipment.

Applicants must be able to show proven ability in a particular field of analogue or digital circuit design and a willingness to enter new fields of development. This post provides a career of unusually wide interest with congenial working conditions and surroundings in a new and expanding University.

Salary scale £1,385-£1,578 (in special cases up to £1,828) per annum. Placing according to age, qualifications and experience. Pension scheme in operation.

Further particulars from the Deputy Secretary (W.W.), University of Stirling, Stirling, to whom applications with names and addresses of two referees should be sent by 13 October, 1969.

2499

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

AUDIO ENGINEERS required for new company in S.W. London, to work on broadcast quality sound consoles, etc. Duties: circuit development, detail design, commissioning, installation, field service and customer liaison. Experience of similar equipment essential. Write to: Helios Electronics Limited, 95 Railway Road, Teddington, Middlesex. [2487

EXPERIMENTAL OFFICER required by Biophysics Dept. to be responsible for maintenance and development of electronic equipment (including high-gain amplifiers, oscilloscopes and digital equipment). Minimum qualification HNC. Salary in range £1,470-£2,045 plus £60 London allowance. FSSU. Application forms from Personnel Officer (Tech. Staff FD/1). University College London, Gower Street, W.C.1. [2488

LIVERPOOL CLINIC, 1 Myrtle Street, Liverpool, 7. Applications are invited for the post of MEDICAL PHYSICS TECHNICIAN GRADE II in the Department of Nuclear Medicine. Person appointed will be required to maintain nucleonic and electronic equipment and would be expected to assist in the design and building of new equipment and modification of existing apparatus. Duties are principally in the Liverpool Clinic, but at times extend to other hospitals in the region. Possession of Higher National Certificate or equivalent is desirable. Whitley Council Conditions of Service. Salary scale £1,313 rising to £1,671 per annum. Application forms obtainable from Personnel Section, Clatterbridge Hospital, Bebington, Wirral, Cheshire. [2489

MAN required in small factory situated in N. London to assist with the production of precision electrical measuring instruments. Excellent prospects for an energetic and versatile young man. Write in confidence to the Director, Lionmount & Co. Ltd., Bellevue Road, New Southgate, London, N.11, giving details of experience, qualifications and salary required. [2506

MARINE RADIO ENGINEER, fully conversant with Yacht RT/DF, Auto Pilots, Radar, Sounders, etc., installations and service. Willing to live in or near London. Salary in region of £1,350 p.a. Start immediately.—Telesonic Ltd., 92 Tottenham Court Rd., London, W.1. 01-636 8177. [2390

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

SITUATIONS WANTED

8 ELECTRONICS ENGINEERS seek overseas positions. Bewildering fund of experience. Apply Duty Engineer, c/o I.A.L., Box 144, Bahrain, Arabian Gulf. [404

ARTICLES FOR SALE

BBC2 KITS and T.V. SERVICE SPARES. Suitable for Colour: Leading British Makers dual 405/625 six position push button transistorised tuners £5 5s. 0d., 405/625 transistorised sound & vision IF panels £2 15s. 0d. incl. circuits and data, P/P 4/6. Basic dual purpose 405/625 transistorised tuners incl. circuit £2 10s. 0d., P/P 4/6. UHF list available on request. UHF tuners, PYE/EKCO incl. valves 55/-, P/P 4/6. EKCO/FERRANTI 4 position push button type, incl. valves, leads, knobs £5 10s. 0d., P/P 4/6, SOBELL/GEC UHF tuner kit incl. valves, right angle slow motion drive assy, leads, fittings, knobs, instructions £5 18s. 6d., P/P 4/6. FERGUSON 4 position push button transistorised UHF tuners incl. leads & knobs £5 15s. 0d., P/P 4/6. SOBELL/GEC 405/625 IF & output chassis incl. circuit 42/6, P/P 4/6. Ultra 625 IF amplifier plus 405/625 switch assy incl. circuit 25/-, P/P 4/6. New VHF tuners, Cyldon C 20/-, Ekco 283/330 range 25/-, Pye CTM 13 ch. incremental 25/-, P/P 4/6. Many others available incl. large selection channel coils. Fireball tuners, used good cond. 30/-. Push button tuners RGD 612/619 type used good cond. 30/-, P/P 4/6. LOPTs, Scan coils, Frame output transformers, Mains droppers etc., available for most popular makes. TV signal boosters transistorised PYE/Labgear B1/B3, or UHF battery operated 75/-. UHF mains operated 97/6, UHF masthead 85/-, post free. Enquiries invited, COD despatch available. MANOR SUPPLIES, 64 GOLDERS MANOR DRIVE, LONDON, N.W.11. CALLERS 589B, HIGH ROAD, N. FINCHLEY, N.12 (near GRANVILLE RD.). Tel. 01-445 9118. [60

BRAND NEW MINIATURE ELECTROLYTICS with long wires, 15/16 volts, 0·5, 1, 2, 5, 6, 8, 10, 15, 20, 30, 40, 50, 100, 200 mfds. 8s. per dozen, postage 1s. per order.—The C.R. Supply Co., 127 Chesterfield Rd., Sheffield S8. [402

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

COSSOR Scope 1049 Mk. 3a, £26; AVO.1 Electronic M/Meter, £19; Advance Signal Gen. D1, £7. Box W.W.406, Wireless World.

COSSOR 2100 B.B. Scope D.C.-5MHz, £55. Offers for Eddystone 880 Professional Comm RX, Hammarlund SP600JX, £90. E.M.I. TR51C Professional Tape Recorder, £50. Williams, 71 Station Road, Llanishen, Cardiff 753743. [401

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

OSCILLOSCOPES, Test Gear, Valves, Transistors, Components, Veroboard. Bargain clearance. List, s.a.e. Ransome, 4 Draycott Road, Southmoor, Abingdon, Berks. [405

SOLARTRON 'scopes, reconditioned AVO's, receivers, components, etc. Send 9d. stamps or p.o. for details. D.F. Electr-vision, 4 Huntington Close, Cranbrook, Kent. [407

UFO DETECTOR CIRCUITS, data, 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts. [396

WIRELESS WORLD 1950 to 1965, also 1943 to 1949, with six missing, any reasonable offer.—Box WW400 Wireless World.

4μF PAPER CAPACITORS, 12,500 volts WKG. (T.C.C.); offers. Ring 0494 30043 (High Wycombe). [403

BUSINESS OPPORTUNITIES

CONTRACTS SOUGHT

Electronic agency based East Anglia for service and installation of all types of equipment.

Box No. W.W. 2501

TEST EQUIPMENT — SURPLUS AND SECONDHAND

DUE to closure of electronic laboratory—Test Equipment and Component Stock available for disposal. Oscilloscopes, Digital Voltmeters, Oscillators, Power Supplies, etc. Offers invited; list on request. Minerva Laboratories (Instruments) Ltd., Factory B.16, Treforest Industrial Estate, Nr. Pontypridd, Glam. [2490

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

TAPE to disc transfer, using latest feedback disc cutters; EPs from 22/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [70

VALVES

VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A. Boxmakers, 75a Godwin St., Bradford, 1. [10

FOR HIRE

FOR hire CCTV equipment including cameras, monitors, video tape recorders and tape—any period. —Details from Zoom Television, Amersham 5001. [75

ARTICLES WANTED

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [63

WANTED: SPECTRUM ANALYSER. American war surplus might suit. Hatfield Instruments Ltd., Burrington way, Plymouth. Tel. 72773. Telex 25592. [2491

WANTED, televisions, tape recorders, radiograms, new valves, transistors, etc.—Stan Willetts, 37 High St., West Bromwich, Staffs. Tel. Wes. 0186. [72

VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Walton's Wireless Stores, 55 Worcester St., Wolverhampton. [62

SERVICE & REPAIRS

YOU MAKE IT, let us install and maintain it. South of Ireland.—Box No. WW395 Wireless World.

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

PLASTIC Injection Moulding Specialists in short runs up to 1 oz. Low tooling costs.—K.T. Plastics Ltd., Dept. 10, 23 Hunters Hill South Ruislip, Middx. 01-845 2824. [90

TECHNICAL TRAINING

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. home-study courses in radio, TV, servicing and maintenance. R.T.E.B., City & Guilds, etc., highly informative 120-page Guide—free.—Chambers College (Dept. 837K), 148 Holborn, London, E.C.1. [16

CITY & GUILDS (Electrical, etc.), on "Satisfaction or Refund 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 Rado, TV and Electronics through world-famous ICS. For details of proven home-study courses write: ICS, Dept. 443, Intertext House, Stewarts Road, 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

BOOKS, INSTRUCTIONS, ETC.

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a Moffat Road, Thornton Heath, Surrey, CR4-8PZ. [66

SIGNALS ENGINEERING LABORATORY

MINISTRY OF DEFENCE (AIR FORCE DEPARTMENT) RUISLIP, MIDDX.

ELECTRONICS ENGINEERS

(graded EO/AEO) required for two posts

Post (A) is concerned with work on radar and navigation aids, air traffic control and blind landing, for which applicants must have experience of microwave measurements and of pulse techniques whilst a knowledge of display systems is desirable.

Post (B) involves work on navigation aids, telemetry and data processing. Applicants for this post must have experience of HF, VHF, UHF and line communications plus a knowledge of digital techniques; familiarity with integrated circuits is also desirable.

The duties of both posts include laboratory work and field trials, and circuit design and development of electronic equipment on a "quick reaction" basis (i.e. time scale of a development not longer than about 9 months). Some of the work will be undertaken at RAF Stations in the United Kingdom and overseas, and an ability to maintain good relations with service personnel at all levels is necessary.

Salary: A.E.O. £683 (at 18)—£940 (at 22)—£1,208 (at 26 or over)—£1,454: E.O. £1,590—£2,006.

Qualifications: Degree, H.N.C., or equivalent in appropriate subject. Under 22, minimum qualification is G.C.E. in five subjects, including two Scientific/Mathematical subjects at 'A' level or equivalent level. Age: A.E.O. 18-27, E.O. normally 26-30.
Prospects of permanent pensionable appointments.

APPLICATION FORMS from HED LAB, Signals Engineering Laboratory, RAF Northolt, Ruislip, Middlesex. **Closing date: 30th October 1969.**

2502

UNIVERSITY COLLEGE LONDON

DEPARTMENT OF MECHANICAL ENGINEERING

ELECTRONICS WORKSHOP

requires person to set up and run a small stores for electronic equipment and components, and (according to experience) to carry out maintenance on a wide range of equipment. Design and construction work would also be involved for a suitably experienced applicant.
Electronics technicians or those with more general experience and a strong interest in electronics work will be considered.
Technician or senior technician according to age, experience and qualifications, salary range £868 to £1,436. Opportunities for further study, prospects of promotion.
Application forms from Personnel Officer (Technical Staff ED/1), University College, Gower St., W.C.1).

2505

ALL GOODS GUARANTEED

CONVERTOR/BATTERY CHARGER. Input 240v 50 c/s. output 12v 5 amp DC. Input 12v DC. output 240v AC. 170 watt max. With 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/- extra.

Synchronous chopper AEI type CK4. As new **22/6** ea. Top connector **2/6** ea. **CARPENTERS** polarised relays. Single pole c/o 20 ohm and 65 ohm coils. As new. complete with base, **14/-** ea.
AMPHENOL. Blue 24 way ribboned plug and socket, gold plated. Ex. eq. but mint. **17/6** a pr. Miniature Belling Co-ax double plug and socket ex. eq. as new, **5/6**; 3-pair plug and socket holder, **2/6** ea. T.M.C. Precision Capacitors. Plastic. 1 mfd 250v DC working 0·1% at 45°C. As new **£2/10/-**.

G.M. TUBES. Brand new. G24/G38/G60 at **27/6** ea. G53/1, brass cased, **£6** ea.

PHOTOMULTIPLIERS. 6097B at **£5** ea. EMI 6097X at **£8/10/-** ea.

SOLARTRON stab. P.U. type AS516 300v 50mA, **£3/10/-**; AS517 300v 100mA. **£6**. P. & P. 10/- extra.

TRANSISTOR OSCILLATOR. Variable frequency 40 c/s to 5 kc/s. 5 volt square wave o/p. for 6 to 12v DC input. Size 1¼ × 1¼ × 1½in. Not encapsulated. Brand new. Boxed. **11/6** ea.

TIMER UNIT, consisting standard mains input transformer 200/240v 50 c/s; output 18v 4 amp (conservative); GEC bridge rectifier; detachable accurate 1 sec timer subchassis with transistor STC type TS2, 2 × 12AU7; one 500 ohm relay heavy duty contacts 2 make; lamps, fuse, switch, etc., etc. In case. Size 10 × 10 × 5in. Ideal battery charger, one second timer, transistor power supply, etc.
Tested and guaranteed working. **£2/15/-** ea. P. & P. 15/-.

OSCILLOSCOPES

Cossor DB 1035, **£20**; 1035 Mk. 2, **£25**; 1035 Mk. 3, **£32/10/-**; 1049, **£22/10/-**; 1049 Mk. 3, **£30**; CT52, **£15**; **HARTLEY** 13A. Now only **£17/10/-**.
All scopes carefully serviced and in excellent condition. Carriage 30/- extra.

ADVANCE Signal generator type D.1. 2mc/s to 190mc/s. Sine and square mod. With original charts. Excellent condition. **£12/10/-**. P. & P. £1.

RELAYS

Omron/Schrack octal based plug-in relays. 2 pole c/o 5A. 230v and 6v. State which. Brand new. Boxed. **12/6** ea.
G.E.C. 4 pole c/o 6/12v operation 180 ohms. Platinum contacts. Brand new. Boxed. **14/6** ea.
Min. VARLEY type VP4. 4 pole c/o 430 ohm or 15 K/ohm. Brand new **6/6** ea.
3.000 series. 500 ohms 2 pole c/o and 2 make. As new condition. **4/6**.
2,000 ohm. 4 pole c/o and 1 make 1 break
3 break 1 make and 3 make heavy duty
2 make 2 break, 4 make heavy duty.
All at **4/6** ea. As new condition.
S.T.C. sealed 2 pole c/o 48v only. Complete with base, **4/6** ea.
Standard pots. Brand new. 22K; 50K; 250K; 500K; 1 meg; 2.5 meg. All at **1/9** each.

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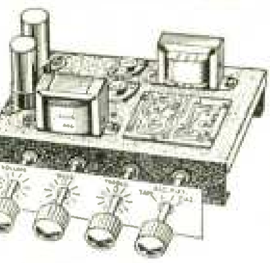

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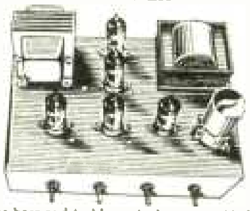

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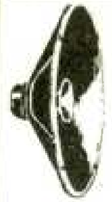

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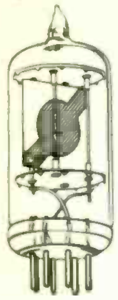

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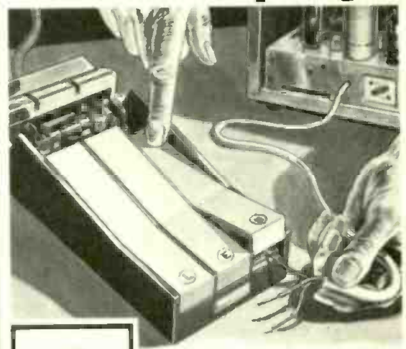

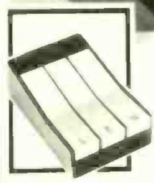

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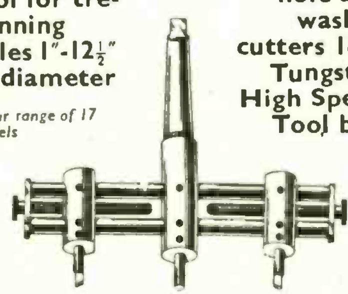

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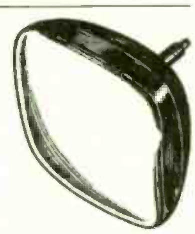

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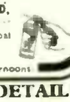

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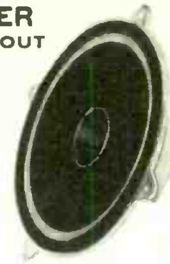

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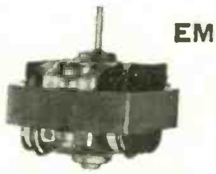

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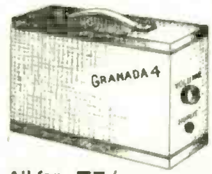

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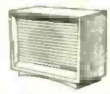

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