Wireless World

November 1969 Three Shillings

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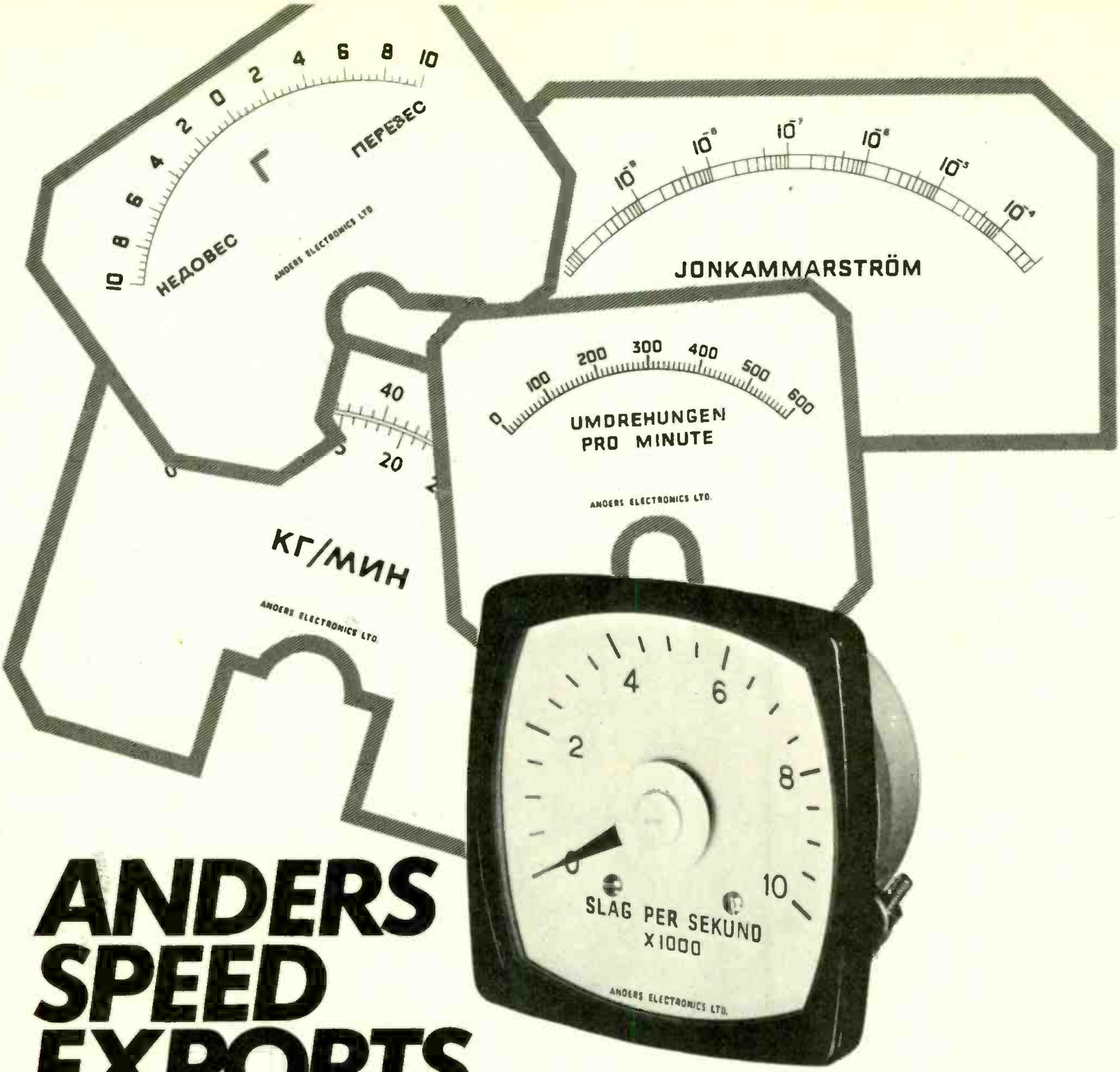

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Vortexion

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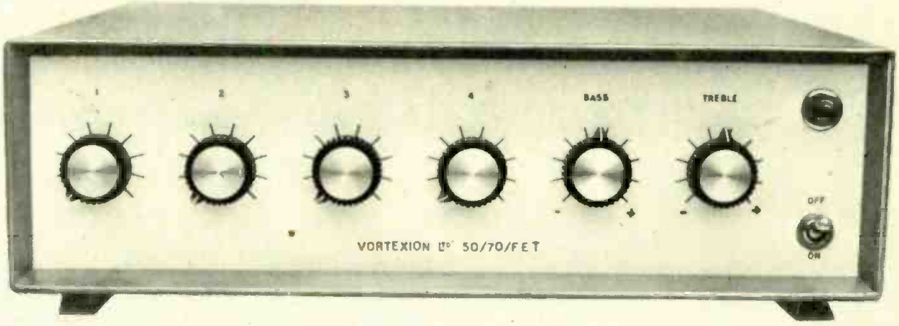
THE VORTEXION 50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4 WAY MIXER USING F.E.T.s.



Size 14" × $11\frac{1}{2}$" x $4\frac{1}{2}$"
100μV on 30/60 ohm mic. input.
100mV to 100 volts on gram/auxiliary input 100KΩ.

Weight 20lb.

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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.

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Models available with 1 gram and 2 low mic. inputs. 1 gram and 3 low mic. inputs or 4 low mic. inputs.

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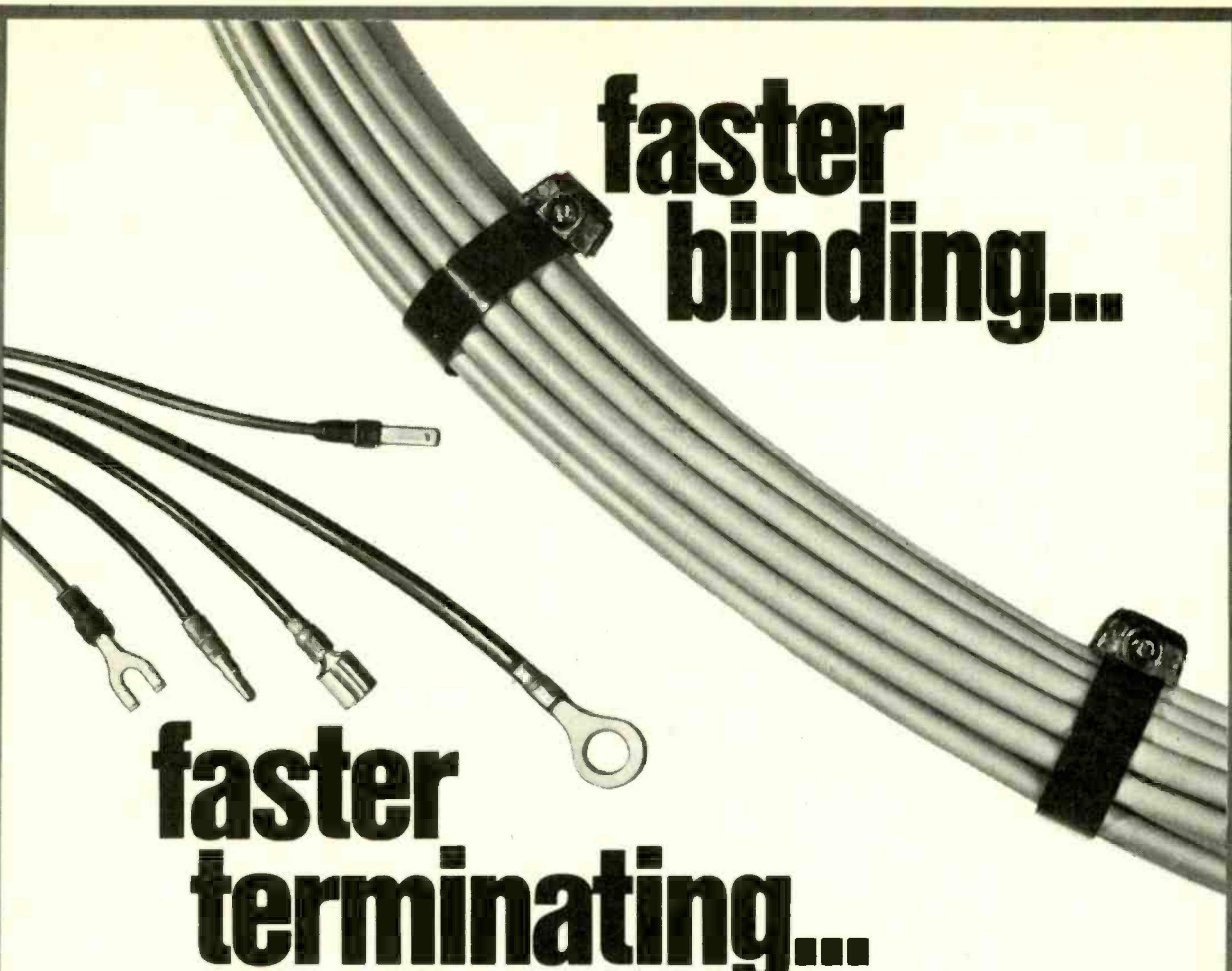

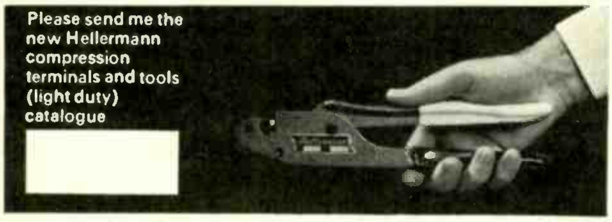

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MODEL WG50. For use on very small to medium size electronic circuits. Power rating 50 watts. Voltages available 12v., 24v., 100/120v., 210/250v. Five bit sizes from $\frac{1}{16}$" to $\frac{1}{4}$".

59/6

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89/6

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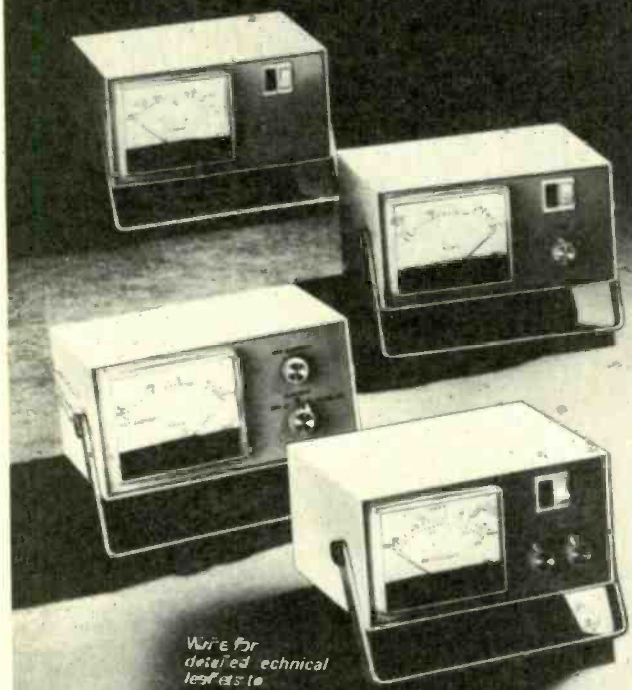

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Response from 1Hz to 3MHz with amplifier output available. Two versions differ only in meter size and bandwidth switch on type TM3B.

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Accuracy ±1% ±1% f.s.d. ±1μV at 1kHz.

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−100dB to +50dB in 10dB steps. Scale −20dB to +6dB. 0dB = 1mW into 600Ω.

FREQUENCY RESPONSE

Above 500μV: ±3dB from 1Hz to 3MHz. ±0·3dB from 4Hz to 1MHz.
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On 150μV: ±3dB from 4Hz to 1MHz.
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150mV at f.s.d. on all ranges. Will drive a load of 200kΩ and 50pF without loss.

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

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£99

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

H.F. dB RANGES

−50dB, −40dB, −30dB . . . . +20dB. Scale −10dB to +3dB. 0dB = 1mW into 50Ω.

H.F. RESPONSE

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

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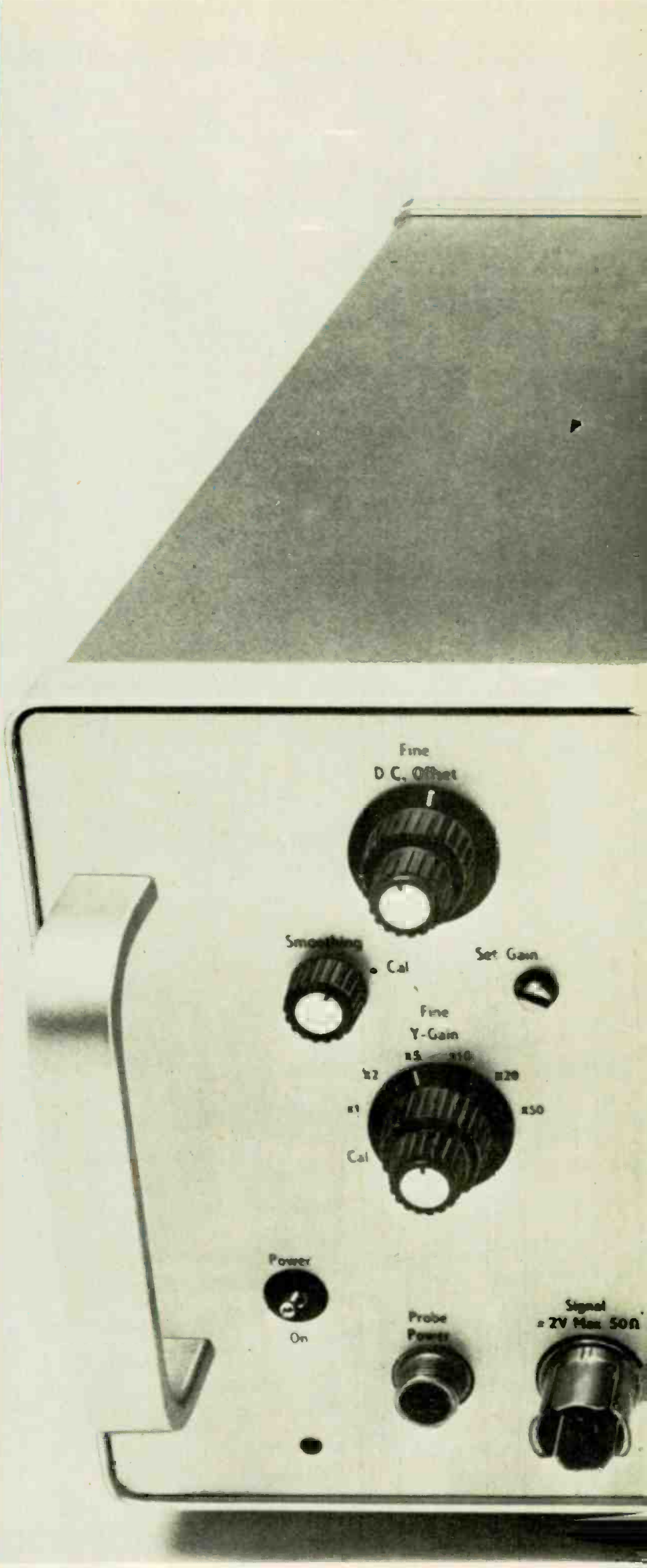

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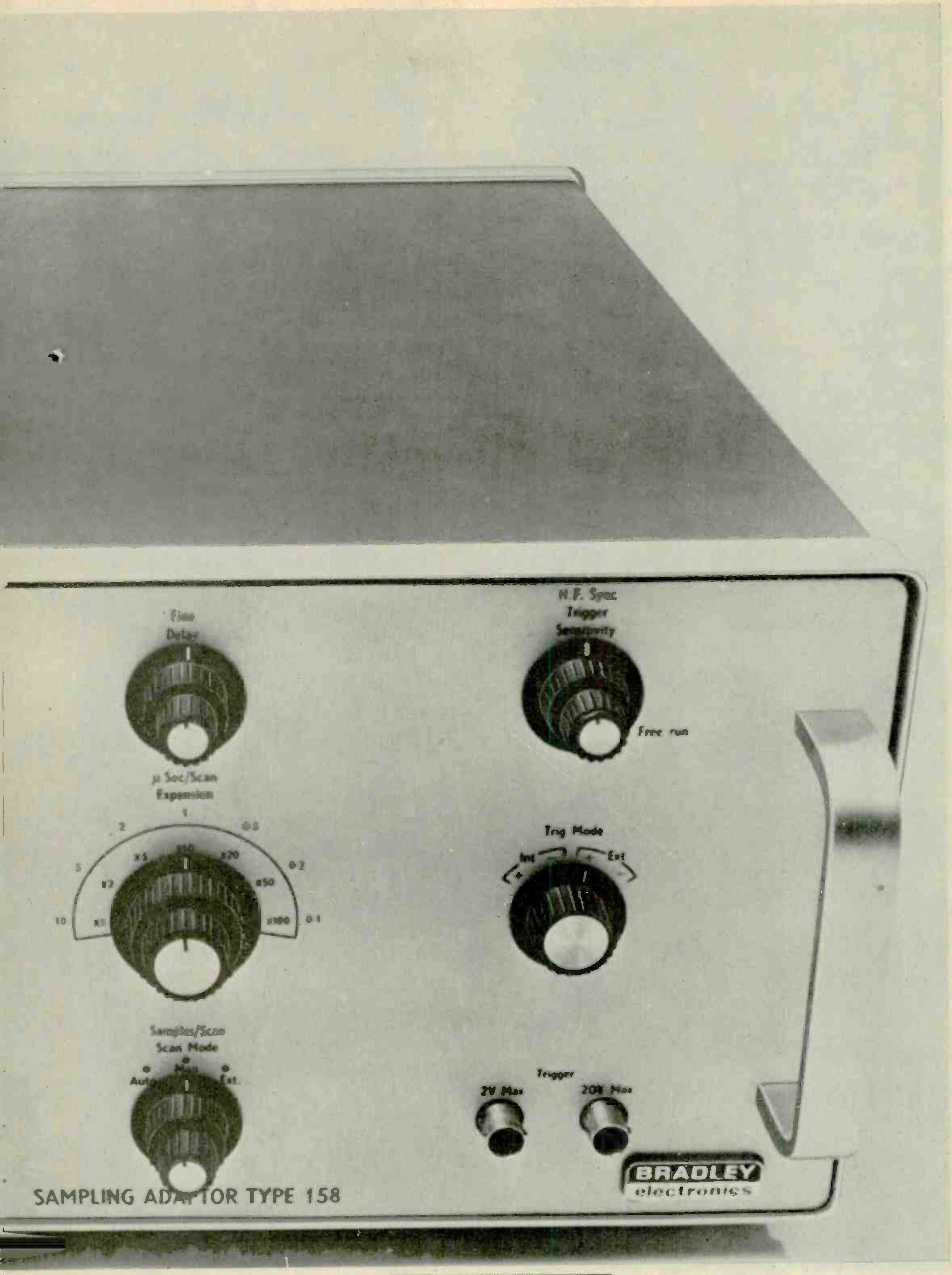
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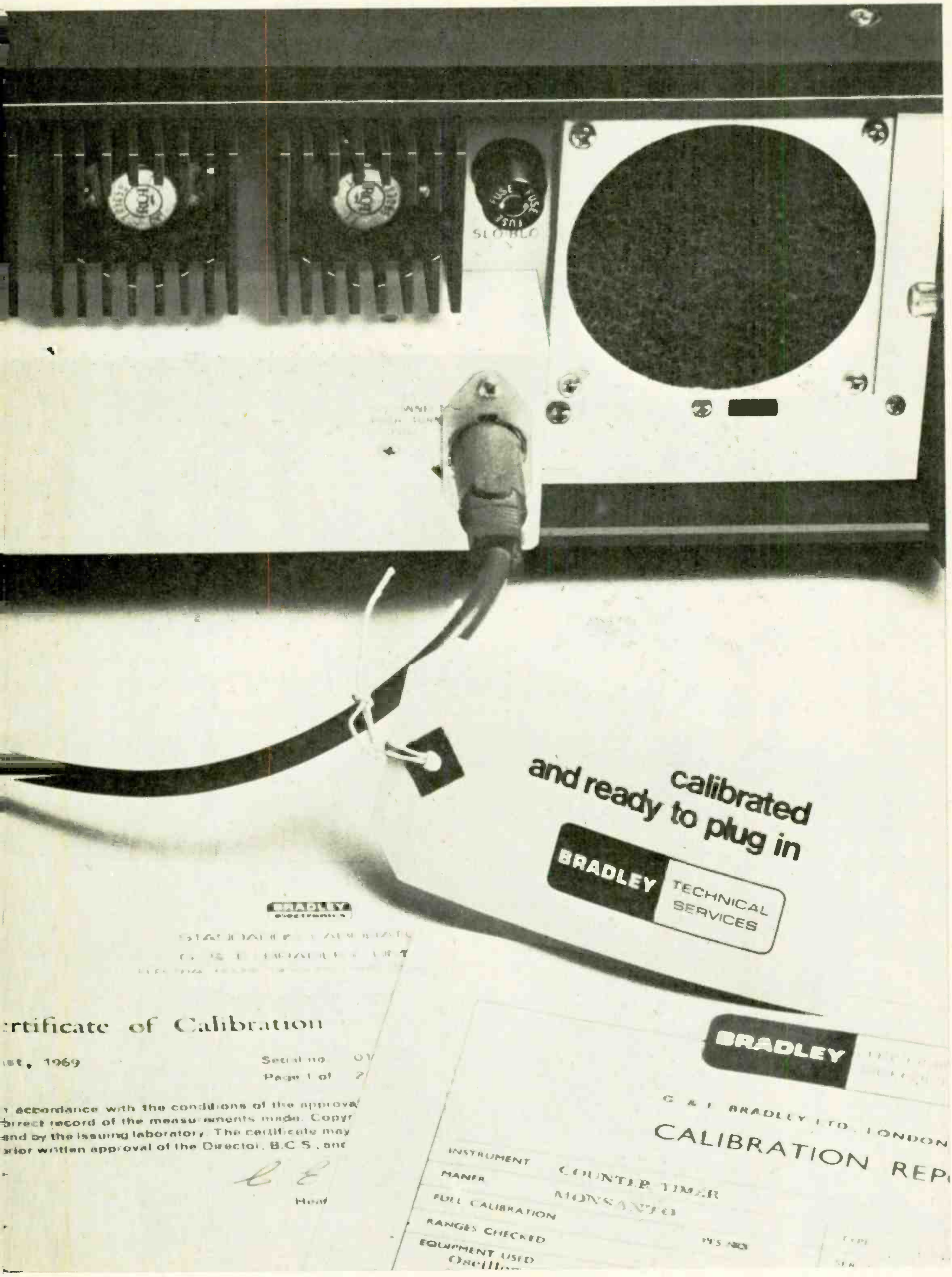
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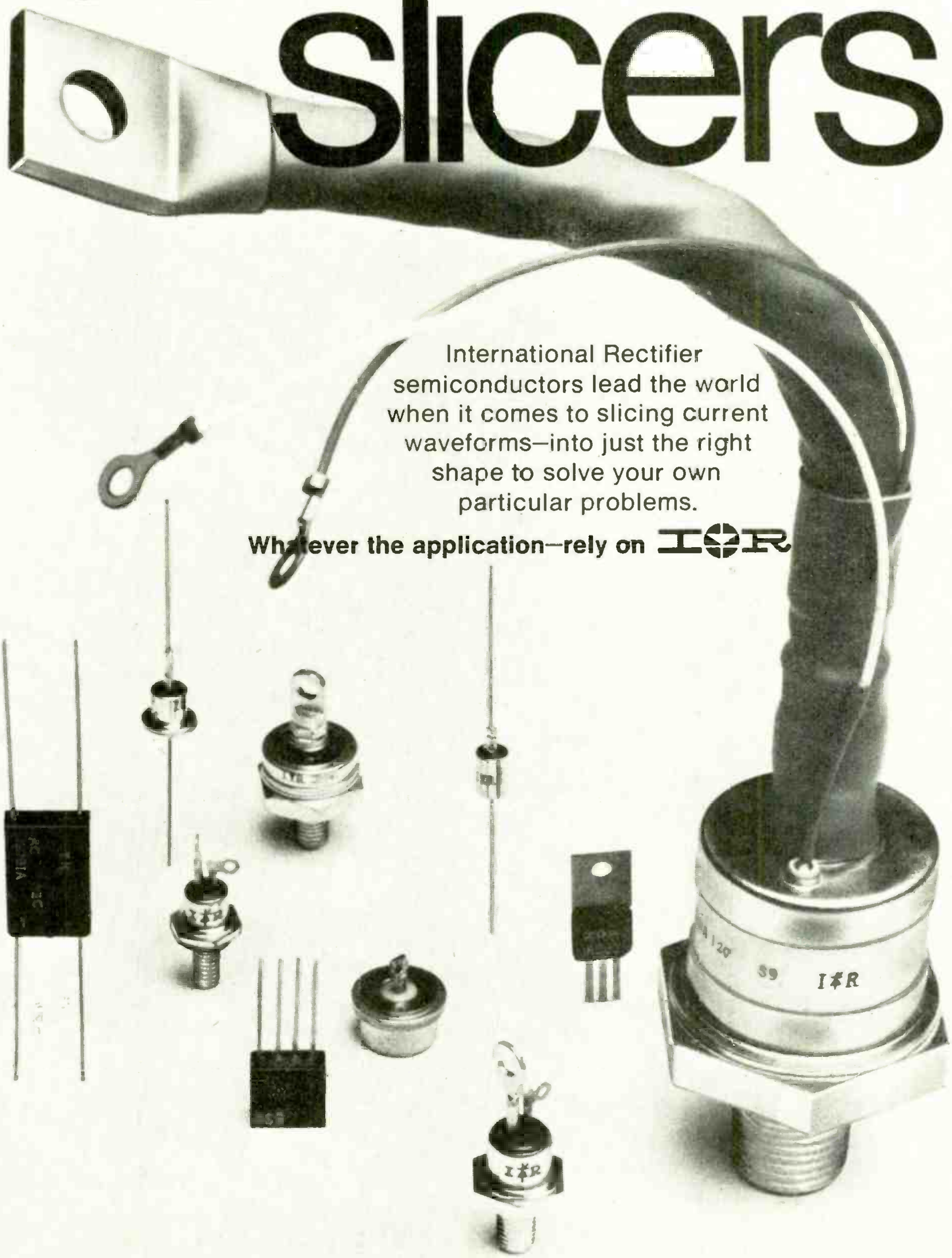

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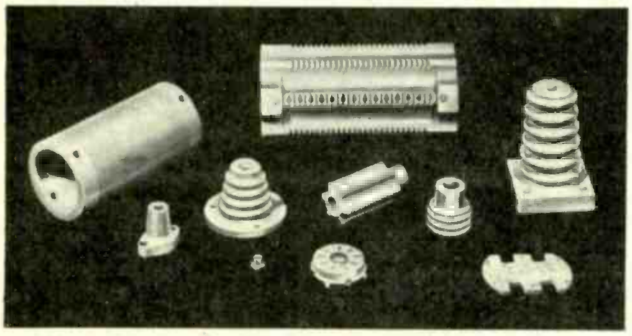

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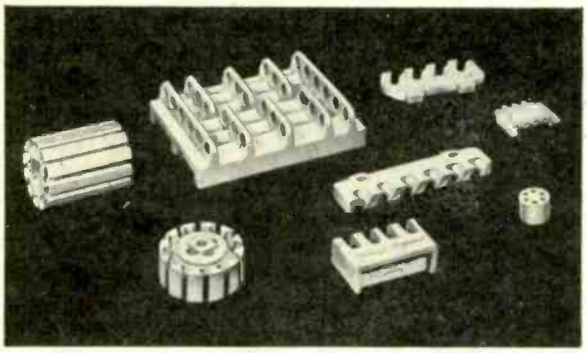

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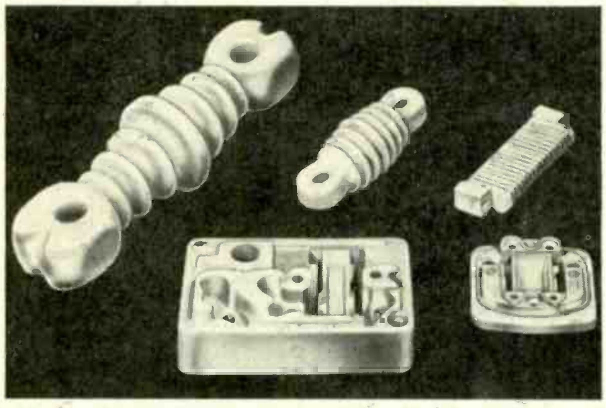

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NKT
FOR
CUSTOM HYBRIDS

If you have read as far as this, you either know what "custom hybrids" are, or want to know what they might be.

For the uninitiated, a "hybrid" is a modern form of microcircuit (integrated circuit) which produces the performance of a bulky, conventional-component, printed-circuit-board assembly inside a small sealed package by hybrid assembly techniques, combining printing of components with attaching separate discrete devices.

Electronic equipment manufacturers are changing over from printed-circuit-boards to hybrid microcircuits. Larger ones are trying to produce their own hybrids. Smaller ones tend to look to a specialist custom-hybrid manufacturer, like NKT, for units custom-built to their exact specifications.

A survey of customers to whom NKT have supplied custom-hybrids over the last two years indicates that the commonest reasons for them "going hybrid" have been:

1. They had to have smaller circuits.
2. They had only short runs, expensive in engineering.
3. They had high assembly labour costs relative to materials.
4. They had to use high-cost special-selection components to achieve close overall circuit performance.
5. They had long runs of identical packages.
6. They had to find improved environmental stability.
7. They had a need for greater reliability.
8. They had a problem in getting skilled assembly labour.
9. They had to reduce production costs.
10. They had a cost problem in multiple-component stock holding.

You may have equipment design problems such as these to which custom hybrids can provide an answer.

Why not write in on your company letter heading to our Marketing Manager for NKT's CUSTOM HYBRID BROADSHEET No. 5, and a free copy of our "CUSTOM HYBRID GUIDANCE MANUAL".

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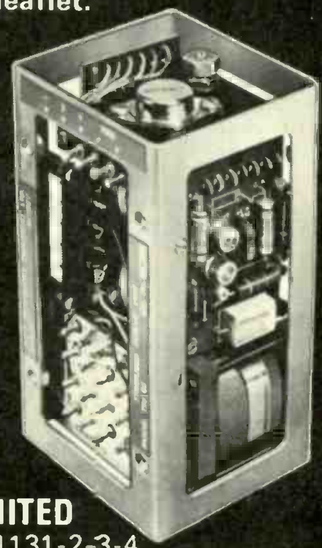
Very small size 14.3 x 7.8 x 7.0 cm high ($5\frac{5}{8}$" x $3\frac{1}{16}$" x $2\frac{3}{4}$").
Price £19.0s.0d. net ex-works, prompt delivery.

For further details send for fully descriptive leaflet.



the power pack people

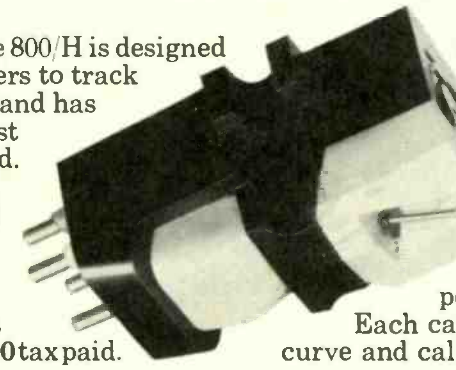
A.P.T. ELECTRONIC INDUSTRIES LIMITED
Chertsey Road, Byfleet, Surrey. Tel: Byfleet 41131-2-3-4

WW—030 FOR FURTHER DETAILS

You're on the right track-with Goldring 800 magnetic cartridges

Goldring 800 magnetic cartridges track unerringly. Because that's the way we make them. They're designed to translate even the most delicate information stored in the groove back into an identical electrical signal. We call it the sound of true transduction.

Hear it for yourself. You'll know you're on the right track.



Goldring 800/H... the 800/H is designed for inexpensive changers to track between $2\frac{1}{2}$–$3\frac{1}{2}$ grams and has a high output of at least 8mV. **£10.13.6** tax paid.

Goldring 800
... the 800 is designed for standard arms and changers where the requirements of high fidelity and robustness usually conflict. **£13.0.0** tax paid.

Goldring 800 E... is designed for transcription arms and a micro-elliptical diamond is fitted to a finer cantilever, end damped against natural tube resonance **£18.17.1** tax paid.

Goldring 800 Super E... the 800 Super E is for those to whom perfection is barely good enough. Extraordinarily low mechanical impedance for superb tracking capabilities. Each cartridge is supplied with its individual curve and calibration certificate. **£26.0.0** tax paid.

Send for details and complete range of Goldring Hi-Fi equipment
Goldring Manufacturing Co. (Great Britain) Ltd.
486-488 High Road, Leytonstone, London, E.11. Tel: 01-539 8343.

WW—031 FOR FURTHER DETAILS

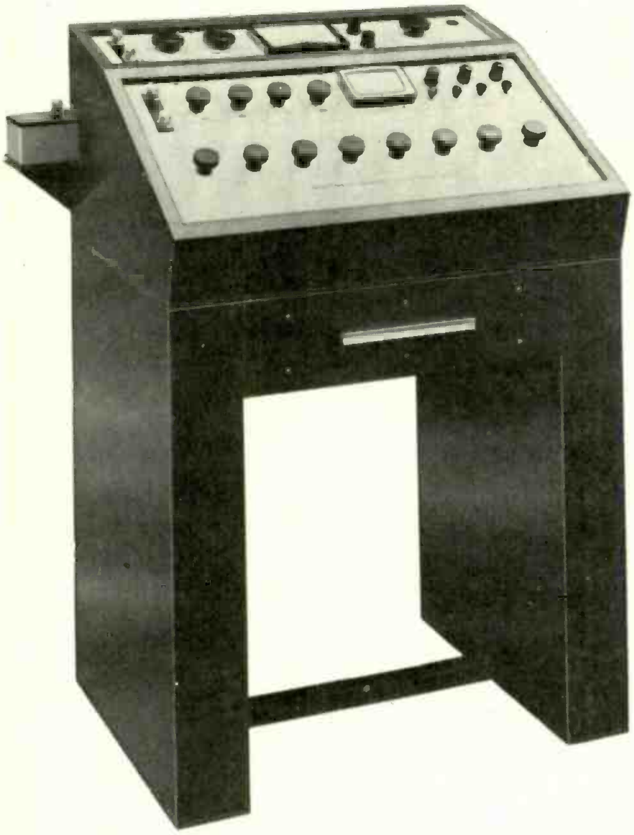
PRECISION VERNIER POTENTIOMETER TYPE 5590C

This is a single range 5 dial potentiometer readable to 7 decimal places, with 8 figures above one volt and 7 figures below. It retains all the advantages of the double potentiometer without continual cross-calibration. Range: 0 to 1.8010110V in steps of 0.1 μV. Calibrated Accuracy: ± 0.0005% of reading +0.1 μV. Leaflet 208F./3514.

PHOTOCELL GALVANOMETER AMPLIFIER TYPE 5214

This amplifier is primarily intended for use with an indicating galvanometer for the most sensitive null detection in d.c. bridge and potentiometer work of the highest precision. The amplification is such that a robust type of indicating galvanometer can be used and no very special precautions need be taken to eliminate vibration. Leaflet 175./2043.

FOUR FROM... TINSLEY



HIGH SENSITIVITY PORTABLE GALVANOMETER TYPE M.R. 4/45

Optical magnifier gives effective scale distance of 1.5 meters in an instrument about 22cm in length. The case has a completely removable cover and detachable screen. Double light beam giving 2 separate spots, centre zero scale and fine zero adjuster. Considerable space saving—with an increase in sensitivity. Leaflet 175/2021A.

INDUCTIVELY COUPLED DOUBLE RATIO BRIDGE TYPE 5650

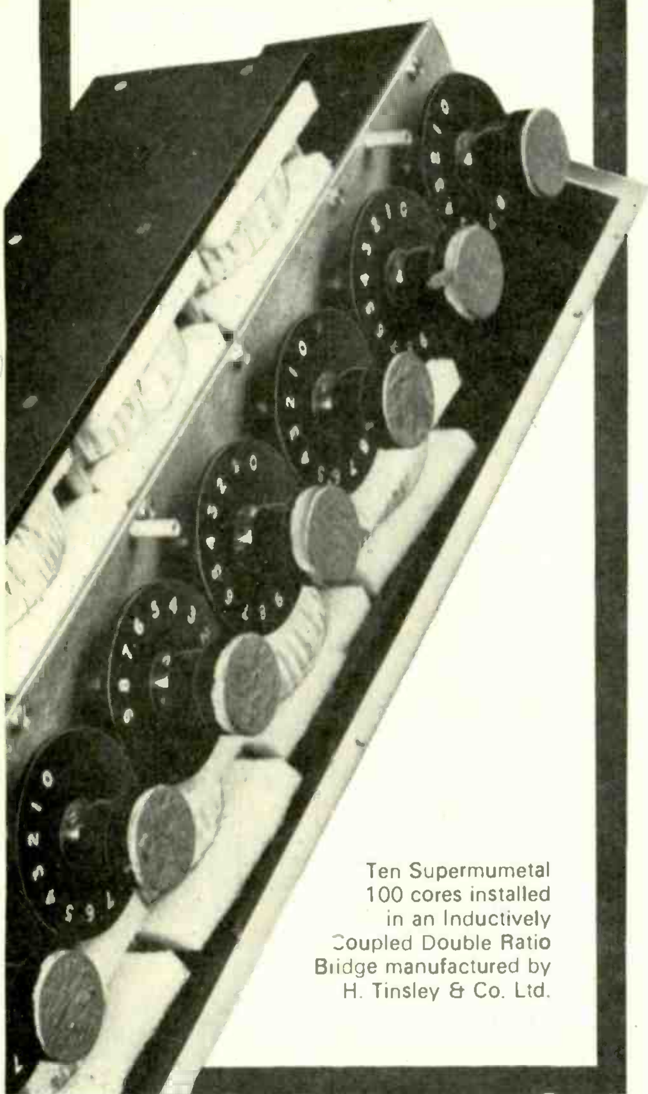
For platinum resistance thermometry, this Bridge operates at 400 Hz and is readable to 8 figures with an accuracy of ratio measurement to 1 in 10[illegible]. The desk console contains the Oscillator, Mains Operated Charging Unit, Selective Amplifier, Double Inductive Ratio (8 decades), Lead Compensating Unit and a set of Resistance Standards. Leaflet 139D.

TINSLEY

H. TINSLEY & CO LTD · WERNDEE HALL
SOUTH NORWOOD · LONDON SE25 · 01-654 6046

WW—032 FOR FURTHER DETAILS

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



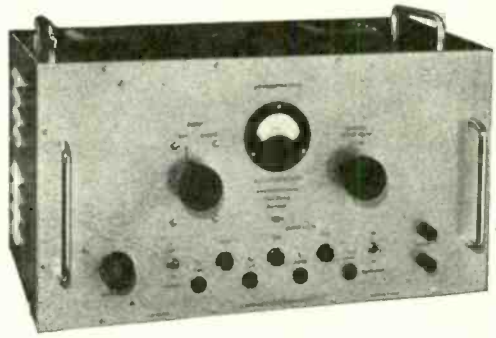
Ten Supermumetal 100 cores installed in an Inductively Coupled Double Ratio Bridge manufactured by H. Tinsley & Co. Ltd.

look ahead with— **TELCON**

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

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

TWO FROM TINSLEY



PATCHET A.C. STABILISER TYPE 5105B

For very high precision measurements in a.c. potentiometry. The unit is simple and automatically protected from damage. Stabilisation ratio 1000/1 and response time of about 0.03 sec., total harmonic distortion less than 1%. Leaflet 215.

PRECISION NON INDUCTIVE STANDARD RESISTOR TYPE 5576 M

This is one of a group of four Grade 1 a.c./d.c. oil filled resistors, for use with a.c. at power frequencies or up to 1,000 Hz. The range of resistance available is from 10,000 ohms to 0.0001 ohm. The resistance material is a Cu-Ni-Mn alloy. Leaflet 11.

TINSLEY

H TINSLEY & CO LTD · WERNDEE HALL
SOUTH NORWOOD · LONDON SE25 · 01-654 6046

WW—036 FOR FURTHER DETAILS

NEWS OF THE DECADE...

Capacitance
50pf to 1.1115μf with infinite resolution.
Accuracy = 1% or ± 0.5% on all decades.

Inductance
Air Spaced 1mH to 1H ± 5%.

Resistance
0.1 Ω to 1.1111 M Ω Average accuracy ± 0.1% Resistance elements suitable for use up to 1MHz.

JJ INSTRUMENTS

All ranges available from stock.
Write for descriptive leaflet or demonstration.

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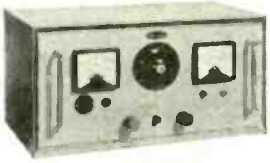
Brook Avenue, Warsash, Southampton SO3 6HP Tel: Locks Heath 4221

WW—038 FOR FURTHER DETAILS

SMOOTHED POWER UNITS WITH THE ACCUMULATOR PERFORMANCE.

Valradio



Type 250VRU/30/20

Versatile power units providing all the usual voltages and currents normally required for development, servicing and production testing of practically all domestic and industrial equipment, up to a loading of 600W DC or AC.

APPLICATIONS

- ★Production testing and servicing of battery operated equipment.
- ★Testing fuel pumps—DC motors—relays—windscreen wipers—car radios—and other types of battery equipment.
- ★Multiple outputs.
- ★Continuously variable DC voltage.
- ★Continuously variable AC voltage.

FEATURES

- ★Output stabilised to accumulator performance.
- ★Very low ripple.
- ★Incorporating silicon rectifiers.
- ★All models incorporating surge current limiting.
- ★Low voltage outputs completely isolated from mains.
- ★Quick delivery.

Type 250VRU/30/20. Output 1, 0-30V 20A DC. Output 2, 0-60V 10A AC. Output 3, 0-250V 4A AC. Price £131-5-0. Input 200/250V 40/60 Hz. Also available for 60V, 120V, 240V outputs.

VALRADIO LTD.

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Telephone: 01-890 4242

WW—042 FOR FURTHER DETAILS

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

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

FAN FLOW EXTRACTOR FANS. Undoubtedly today's greatest bargain for domestic or industrial use. For 200/250 volts A.C. 7,500 cu. ft. per hour. Easily installed, fitted weatherproof louvres which open when motor is switched on and close when off. Only 6½ in. dia. Our nett price only **£8/2/6** (despatch 7/6).

DESK OR TABLE FAN. An ideal fan for the hot weather, lightweight polythene, weighs only 1½ lbs. Resiliant 7 in. Blade can be touched without injury. Finish: Two-tone Black and White, Red and White, Blue and White. 25 watts, 450 c.f.m. Complete with switch and flex. Only **£4/2/6** (des. 5/-).

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

ELECTRIC FANS (Papst), for extracting or blowing. The most exceptional offer we have yet made. 200/250 v. A.C. Induction motor—silent running. 2,800 r.p.m. duty 100 C.F.M. Only 4½in. square and 2in. deep. Ideal for domestic or industrial use. Easy mounting. **£3/5/-** (des. 3/6).

SMALL GEARED MOTORS. In addition to our well-known range (List GM.169), we offer small open type S.P. Units 200/250 v. A.C., 1, 6, 12, 24, 60 r.p.m., approx. 5in. long, with 1in. shaft projection each side and enclosed gearbox. Suitable for display work and many industrial uses. Only **69/6** (des. 3/-).

MINIATURE COOLING FANS. 200/250 v. A.C. With open type induction motor (no interference). Overall 4in. × 3½in. × 2½in. Fitted 6-bladed metal impeller. Ideal for projection lamp cooling, light duty extractors, etc., still only **28/6** (des. 4/6).

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

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

SYNCHRONOUS TIMER MOTORS (Sangamo). 200/250 v. 50 c/s. Self-starting 2in. dia. × 1¾in. deep. Choice of following speeds: 1 r.p.m., 12 r.p.h., 1 r.p.h., 1 rev. 12 hours, 1 rev. per day. Any one **42/-** (des. 2/-). Also high-torque model (G.E.C.), 2¾in. × 2in. × 1¾in. 6 r.p.m., **57/6** (des. 2/-).

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

MINIATURE D.C. MOTORS. 6/12 volts D.C. Ideal model makers. 4,000/9,000 r.p.m. no load. 1½ in. × 1½ in. diameter. Flange fixing. Only **9/6** (des. 1/6).

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

EXTRACTOR FANS. Ring mounted all metal construction. T/E induction motor, silent operation, 8in. blade, 10in. max. dia., 400 CFM, **£6/2/6** (des. 5/-). Same model 10in. blade, 12in. max. dia., 500 CFM, **£6/12/6** (des. 6/-).

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

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(Telephone: 01-636 2958)

Best Reception with TRIO

Model 9R-59DE

BUILT IN MECHANICAL FILTER 8-TUBE COMMUNICATION RECEIVER

* Illuminated dials permit easy tuning and band spread readings.
* Continuous coverage from 550KHz to 30MHz and direct reading dial on amateur bands.
* Close callibration accuracy with an excellent anti-back-lash mechanism.
* A mechanical filter enabling superb selectivity with ordinary IF transformers.
* One RF and two audio stages of amplification, insuring high sensitivity and selectivity.
* A Product Detector making possible clear SSB reception.

SPECIFICATIONS:

* Frequency Ranges: Band A 550-1600KHz,
  B 1.6-4.8MHz,
  C 4.8-14.5MHz,
  D 10.5-30MHz.
* Sensitivity: 2μV for 10dB S/N Ratio (at 10MHz)
* Selectivity: ±5KHz at −50dB
* Power Consumption: 45 watts
* Audio Power Output: 1.5 watts
* Tube & Diode Complement: 6BA6×3, 6BE6×2, 6AQ8×2, IN60×2, SW-05S×2, SW-05×2, 6AQ5
* Dimensions: Width 15", Height 7", Depth 10".

Model JR-500SE

CRYSTAL CONTROL TYPE DOUBLE CONVERSION COMMUNICATION RECEIVER

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

the sound approach to quality

TRIO

TRIO ELECTRONICS, INC.

TO: B.H. Morris & Co., (Radio) Ltd. WW

Send me information on TRIO COMMUNICATION RECEIVERS & name of nearest TRIO retailer.

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

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

WW—039 FOR FURTHER DETAILS

Heathkit Present The 'Compact' Sound of the 70's

'COMPACT' AD27

'COMPACT' AD17

AMBASSADOR SPEAKERS

See what's New in the world of sound from Heathkit at the Audio and Cine Fair, 1969, Olympia, London.

Daystrom Ltd. will be exhibiting the latest Heathkit Hi-Fi Stereo Amplifiers, Tuner-Amplifiers, F.M. Tuners, Stereo 'Compacts', Loudspeakers etc. A selection of these will be on demonstration in the Audio Studio on our stand.

New models include two stereo 'compacts', models AD-17 and AD-27. The AD-17 comprises a BSR MA65 turntable with Shure M44-MB magnetic cartridge and a 10 watt (rms) per channel stereo amplifier all mounted on a teak or walnut plinth. The AD-27 is similar but uses the MA70 turntable and includes an FM stereo tuner. In this case the 'plinth' is better described as a small cabinet. It has a 'roller shutter' lid and is available in teak or walnut.

A new loudspeaker has been added to the Heathkit range. The 'Ambassador' is a first class hi-fi loudspeaker. The cabinet comes ready assembled and finished in teak or walnut to match other current Heathkit equipment. It uses three loudspeaker units —a 12" bass unit, a 5" mid range and a small tweeter.

See these New models and many more . . . in the Heathkit 1970 CATALOGUE. its FREE on request!

HEATHKIT

DAYSTROM LTD,
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☐ Please send me details of the new Heathkit HiFi models
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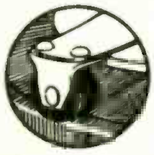
ADDRESS ....
WW.11A

WORLD FAMOUS I·M·O (ELECTRONICS) LTD.
VARIABLE VOLTAGE CONTROLS

VARIABLE TRANSFORMERS

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

Inset shows latest pattern Brush gear ensuring smooth continuous adjustment.



£5.10.0 1 amp

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

CONSTANT VOLTAGE TRANSFORMER.

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

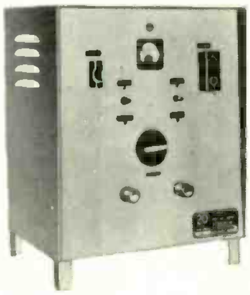
Specification:
- ★ Output 240V
- ★ Accuracy ± 1%
- ★ Input 190-260V
- ★ Capacity 250 watts
- ★ Corrected wave

£12.10.0 C & P 20/-

20 AMP LT SUPPLY UNIT

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

£35.0.0



SOLID STATE VARIABLE CONTROL

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

5 amp model **£8.7.6**

10 amp model **£13.15.0**

UNIVERSAL MICRO SWITCH

MLC-3
5 amp C/O
1/6
each in quantity

10 amp C/O PUSH-BUTTON MICRO-SWITCH

panel mounting.
Buttons in Red, Green, White & Black
Type SS-1. 4/8 each per 1,000

IMMEDIATE DESPATCH
FULL SPARES AND SERVICE AVAILABLE

PROCESS TIMERS-MICRO SWITCHES

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

£11 dependent on quantity

SYS TIMER

SYNCHRONOUS MOTOR & CLUTCH
Matchbox size frontal area
Automatic re-set
- ★ PLUG-IN OCTAL BASE
- ★ INSTANTANEOUS AND TIMED OUT 2 AMP CONTACTS
- ★ RANGES: 10 SECS. TO 36 MINS.

£5 dependent on quantity

STP TIMER

★ 1 MILLION OPS.
5 Amp c/o Sub-miniature Micro-switch
2/6 each per 1,000

"ACTUAL SIZE"
S5G MICRO SWITCH

- ★ Light force wire operated Micro-switch
- ★ Designed for even more economical coin-op mechanism

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

CC5-R MICRO SWITCH

PROXIMITY SWITCHES, LIMIT SWITCHES AND LIQUID LEVEL CONTROLS
MANUFACTURERS AND IMPORTERS FOR MINISTRY OF DEFENCE, G.P.O.

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DIVISION OF IMO PRECISION CONTROLS LTD.
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WW—043 FOR FURTHER DETAILS

NKT

FOR

GERMANIUM TRANSISTORS

One in five transistor sockets in this country are still calling for germanium transistors at a time when most semiconductor manufacturers have stopped producing them.

NKT has been expanding its germanium facilities to take the load and can readily supply most of the devices in current demand.

Apart from a comprehensive standard "NKT"-range of house coded devices, NKT specialises in the supply of:

(a) **CV Germanium Transistors** such as CV 5309, 5327, 5791, 5929, 7001, 7002, 7005, 7006, 7007, 7008, 7012, 7074, 7083, 7084, 7085, 7086, 7376, 7436, 7437, 7438, 7439, 8004, 8126, 8386, 8559, 8640, 8765, 8794, 8801, 8802, 8810, 8837, 8838, 9190, 9308, 10809, 10992, 10995, 11175.

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(c) **"Old-European" Standard Germanium Transistors** such as OC 28, 29, 35, 36, 42, 44, 45, 70, 71, 72, 74, 75, 76, 77, 80, 81, 82, 83, 84.

(d) **"New European" Standard Germanium Transistors** such as AC 128, 176; ACY 17, 18, 19, 20, 21, 22, 30, 39, 40, 41; AD 140, 149; AF 114, 115, 116, 117.

(e) **Other Manufacturer House-code Germanium Transistors** such as TK 23, 30, 31, 40, 42, 45, 46, 47, 48, 49.

YOU may be in trouble over continuing supplies of germanium transistors such as these.

Why not contact **NKT Sales Office** with your requirement.

NKT—Newmarket Transistors Ltd.,
Exning Road,
Newmarket, Suffolk.
Tel. Newmarket (0638) 3381. Telex 81358

WW—044 FOR FURTHER DETAILS

Valradio DC to AC TRANSVERTORS

(transistorised DC Invertors/Convertors)

Carry out your field tests using standard AC equipment.

A VALRADIO TRANSVERTOR will enable you to use all types of test instruments in the field or in motor vehicles.

Standard models are available for loads of **20W to 1000W** for battery inputs of **12V & 24V** and equally important to you most types are available from stock.

Prices range from £5 to £170.

The range is covered by three basic groups, having distinct characteristics.

T series—Square wave, frequency tolerance ± 3Hz
Q series—Square wave, frequency tolerance ± ¼Hz
S series—Sine wave, frequency tolerance ± ¼Hz

Typical model B12/200S input 12V output 115-230V 200W.

Price £67-12-0

Type B12/200S

Send for full information and technical details:
VALRADIO LTD., Dept. W.C.4,
Browell's Lane, Feltham, Middlesex, England. Tel.: 01-890 4242

WW—045 FOR FURTHER DETAILS

POWER AT ANY FREQUENCY?

Our model PPA1K power supply will provide 1 kW of AC power at any frequency within the range 40 Hz to 10 kHz

A large selection of units from stock over the range 120W to 160 kW

- low distortion
- high frequency stability
- continuously variable output voltage
- single-phase or three-phase

LTV
LING ALTEC

LTV Ling Altec Limited

Baldock Road, Royston, Herts, England
Telephone: Royston 2424. Telex: 81174

WW—046 FOR FURTHER DETAILS

There are a couple of things you should know about the Welbrook All Silicon Stereo Amplifier

DISTORTION

0.1% at all output levels

PRICE

£42. 0. 0d.

A new and unique method of equalising impedances in the output stage enables only Welbrook to offer such true high fidelity reproduction at such low cost.

This technical breakthrough brings you the Welbrook W20 Stereo Amplifier, with no distortion rise at any level, for only £42. 0. 0d. This is a truly remarkable bargain among high quality stereo amplifiers, using Class B operation.

Performance:
Power Output:
24 watts R.M.S. (12 watts per channel) into 4 ohms load.
20 watts R.M.S. (10watts per channel) into 8 ohms load.
14 watts R.M.S. (7 watts per channel) into 15 ohms load.
Total Harmonic Distortion:
Typically 0.1% for 10 watts per channel into 8 ohms load at 1 KHZ with no increase at low levels.
Hum and Noise:
With volume control at minimum 80 dB. With volume control at maximum-55 dB.
Frequency Response:
-1 dB at 30 HZ and 15 KHZ.
Inputs: Pickup:
R.I.A.A. characteristic, sensitivity adjustable up to 3 MV to suit crystal; ceramic or magnetic cartridges.
Tuner:
Flat characteristic-sensitivity 100 MV-input impedance 100 K ohms.
Tape:
Flat characteristic-sensitivity 100 MV-input impedance 100 K ohms.
Outputs:
Loudspeakers output to suit 4, 8 and 15 ohms. Tape output for recording-200 MV for rated input sensitivities-minimum external impedance 10 K ohms.
Tone Controls Bass:
Ganged control giving ± 14 dB at 30 HZ
Treble:
Ganged control giving ± 14 dB at 15kHZ
Balance Control:
Facility to reduce output from either channel continuously from maximum output to zero.
Dimensions:
14¼" wide x 9" deep x 4" high (cabinet)
Price:
Recommended retail price; £42. 0. 0d. including cabinet.

For full details of the Welbrook Stereo Amplifier post the coupon to:

WELBROOK ENGINEERING & ELECTRONICS LIMITED,
BROOKS STREET, STOCKPORT, CHESHIRE, SK1 3HT

To: Welbrook Engineering & Electronics Limited;
Please send me full details of the Welbrook Stereo Amplifier.

NAME ....

ADDRESS ....

....

.... (WW1)

WW—056 FOR FURTHER DETAILS

Get across loud and clear with AKG microphones!

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

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

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

Find out more about AKG mikes from

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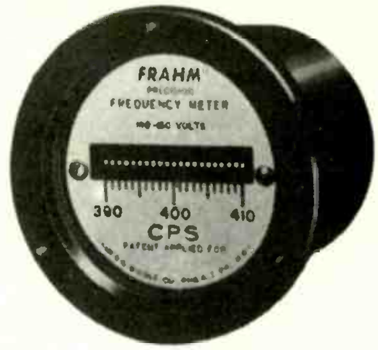
AKG microphones

WW—057 FOR FURTHER DETAILS

FRAHM vibrating reed FREQUENCY METERS



are widely used as standards in many industries because:—

1) They are accurate (to $\pm 0.3\%$ or $\pm 0.1\%$ 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
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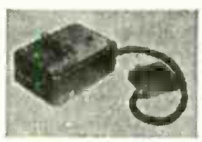

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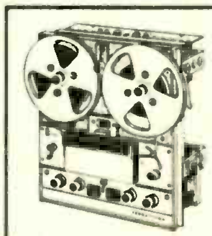

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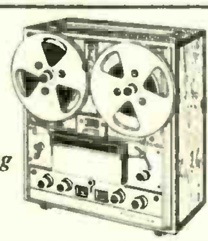

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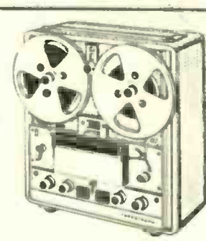

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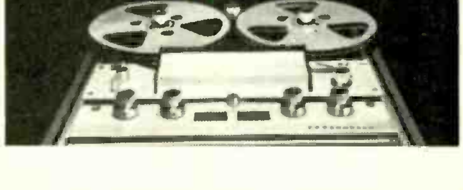

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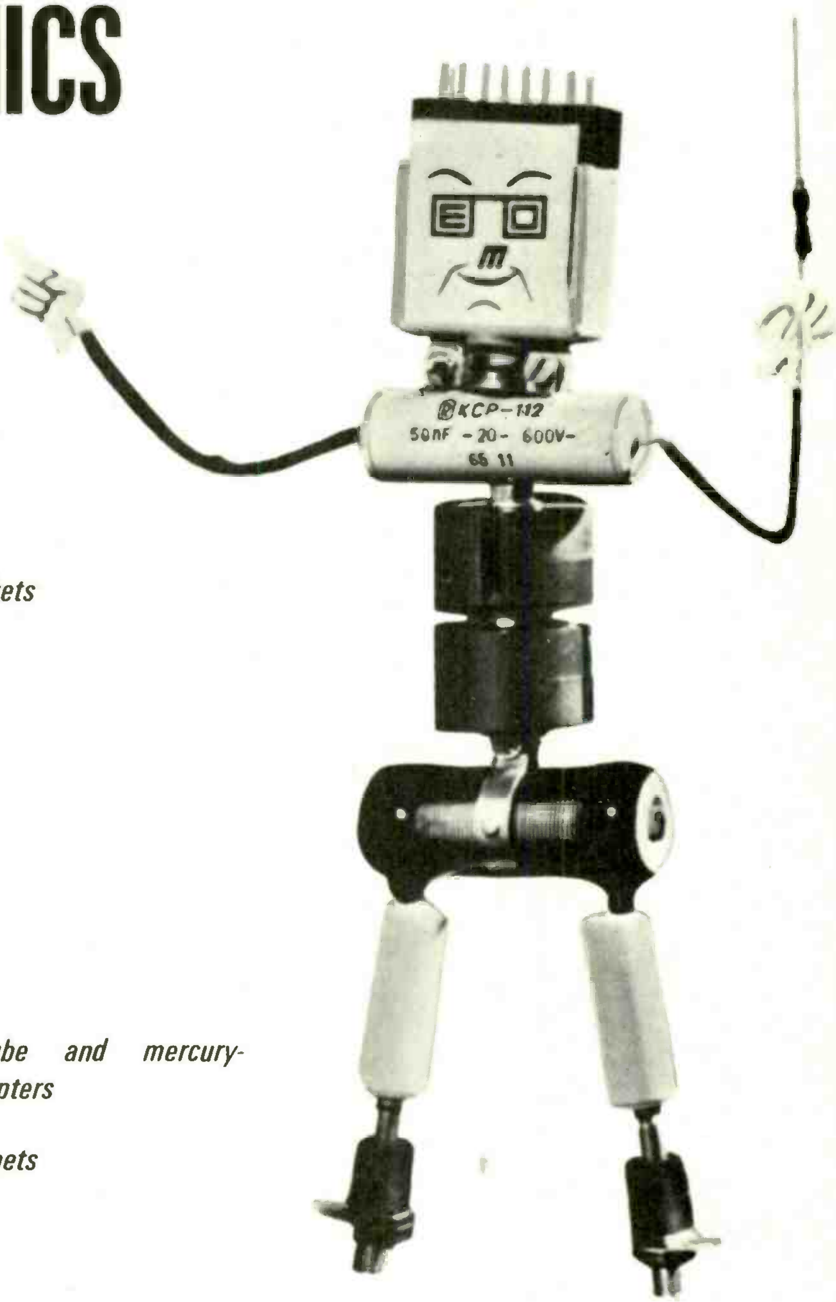

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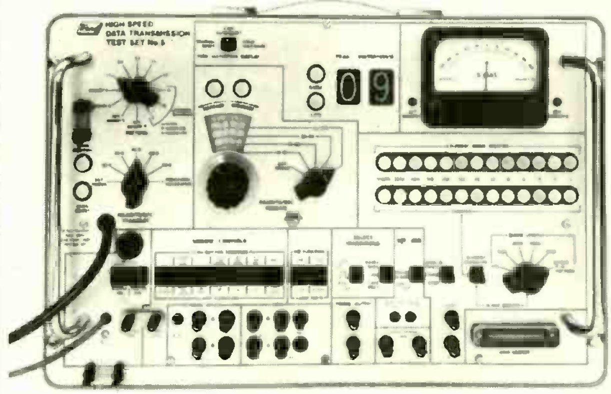

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Some notes on Bridge Measurement by WAYNE KERR

Number 4
The Electric Field

The first three issues of these notes have described the basic principles of the Transformer Ratio Arm Bridge and have shown how high impedance components, such as small capacitors, can be accurately measured at the end of very long lengths of screened cable. The use of the bridge neutral connection enables the capacitance of the connecting cables to be isolated from the component being measured, the balance point of the bridge being unaffected by the presence of the screened cables. In this issue the use of the neutral connection to control the electric field surrounding an electrode forming part of a parallel plate or coaxial capacitor is described.

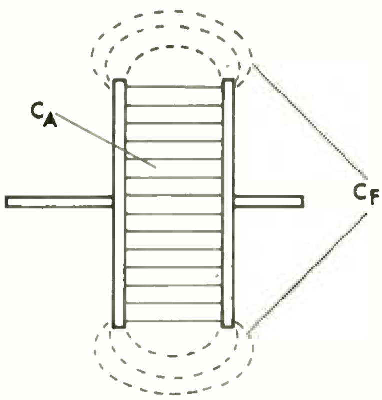

Figure 1

If a parallel plate capacitor is drawn, together with the associated electrostatic field, it will be apparent that the measured capacitance of this arrangement can be considered as the sum of two components; (C_A), the value for the centre part of the field in which the lines of force are linear, and (C_F), the value for the non-linear fringe field. Figure 1 illustrates these fields.

The electrical value for such a capacitor is exceedingly difficult to calculate, owing to the complicated nature of the fringe field, and so it has become common practice to use plates which are large in diameter and also placed closely together, in order to reduce to a minimum the effect of the fringe field. Furthermore, a difficulty arises in the determination of the permittivity of a substance comprising the dielectric. This is a simple ratio of the capacitance of the plates with the material placed between them to the capacitance of the plates in free space. In theory, an infinitely large disc of material would be necessary in order to carry out such a measurement and avoid errors due to lines of force in the fringe field traversing the edge of the disc.

The transformer ratio arm bridge offers a practical solution to these difficulties and Figure 2 shows how these errors can be eliminated by the use of the bridge neutral connection.

The right hand circular electrode is surrounded by an annular guard ring and is separated from it by a thin ring of insulating material.

When the system is balanced, both the central electrode and the guard ring are at the same potential and the bridge will only measure the capacitance formed by the central part of the field (C_B).

Further consideration of this arrangement shows that the thickness of the insulation in the annular gap becomes a limiting factor in the accuracy of the measurement—a wide gap would start to produce locally curved lines of force proportional to the width of the insulation. Fortunately, a technique developed recently enables an insulating layer to be produced only a few microns thick substantially removing this difficulty.

So far, the discussion of the transformer ratio arm bridge and its application to capacitance measurement has neglected a fundamental necessity, the creation of a precise standard of capacitance. The techniques already described can be used to design a basic standard, dependent only on the determination of the exact mechanical dimensions and the velocity of light for its achievement.

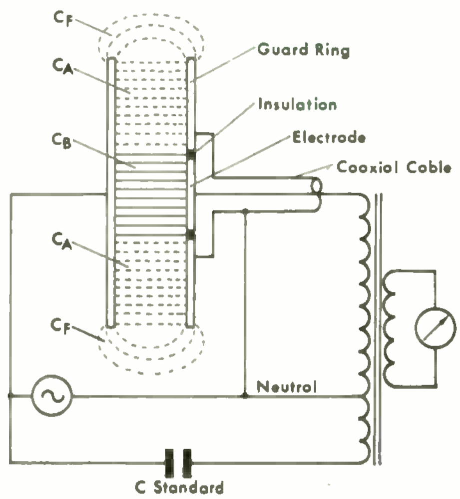

Figure 2

The ability to measure the capacitance between two electrodes precisely without correction being necessary for the effect of the fringe field creates new possibilities in metrology as well as electronics. Bridges can be constructed to measure reciprocal capacitance, and as the distance between linear-field electrodes varies as 1/C, a voltage output can be given from the bridge directly proportional to this distance.

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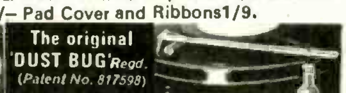

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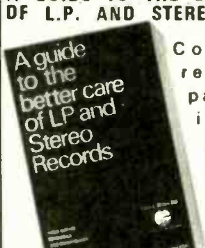

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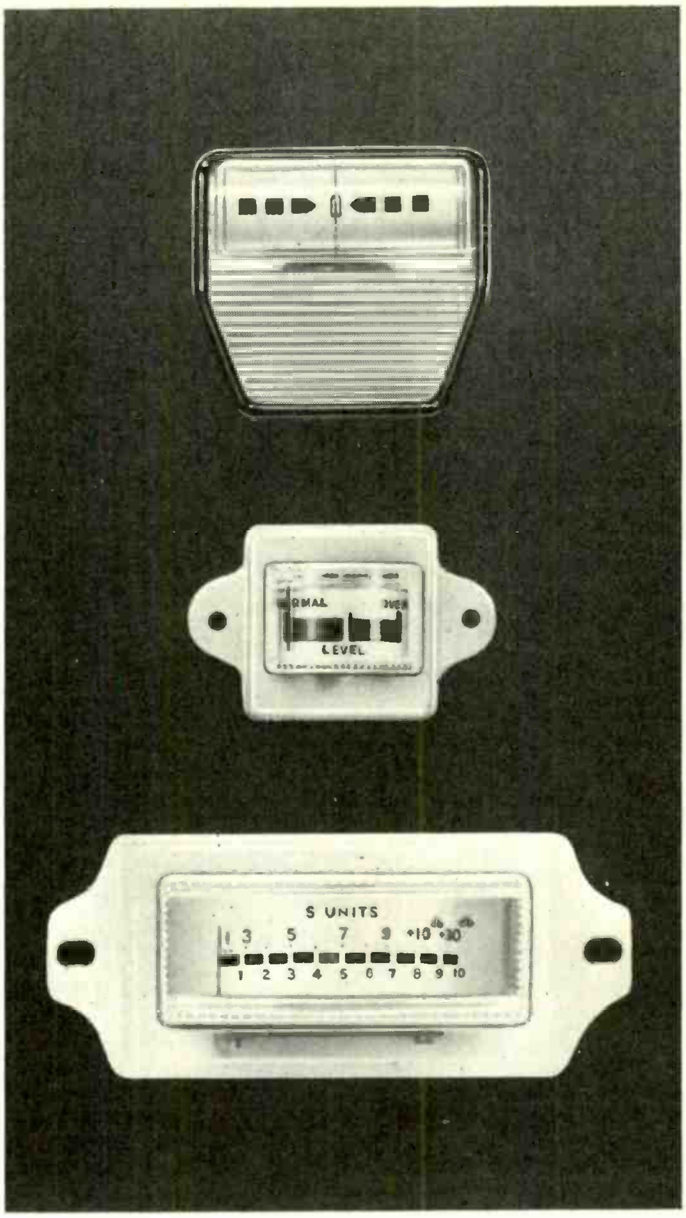

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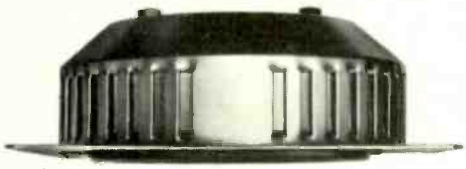

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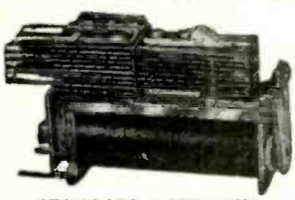

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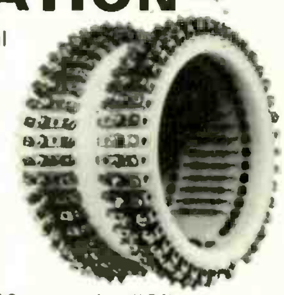

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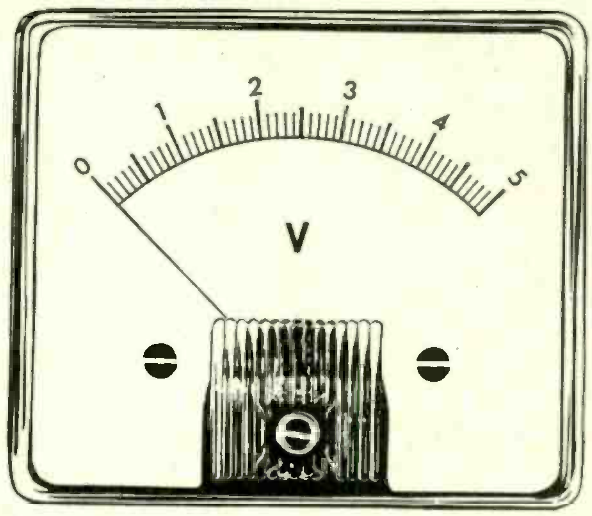

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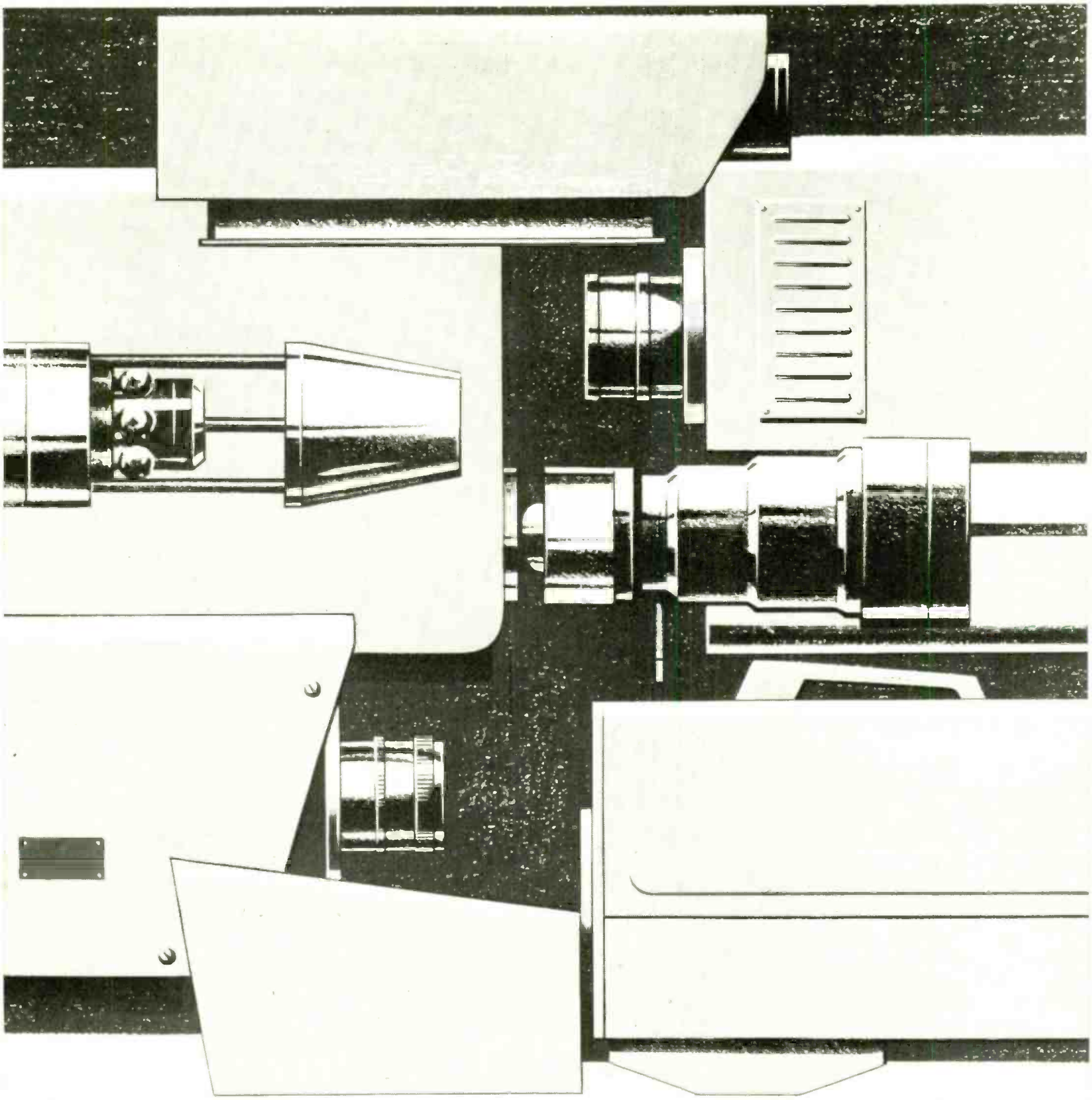

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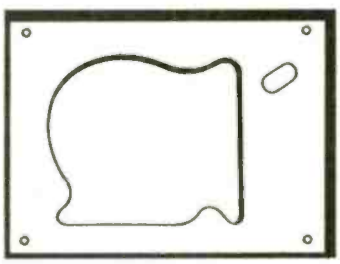

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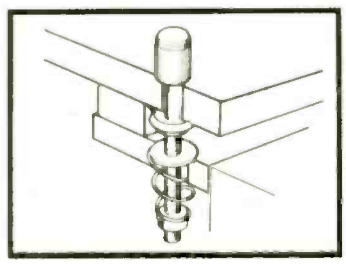

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Wireless World

Electronics, Television, Radio, Audio

Fifty-ninth year of publication **November 1969** **Volume 75 Number 1409**

This month's cover symbolizes the report on electronics in civil aviation which will be found on p. 511.

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OUR NEXT ISSUE

Pickup Survey—a critical review of the various types of transducer available.
A Thermistor Hygrometer using a single i.c. operational amplifier is described.
Review of the London Audio Fair.

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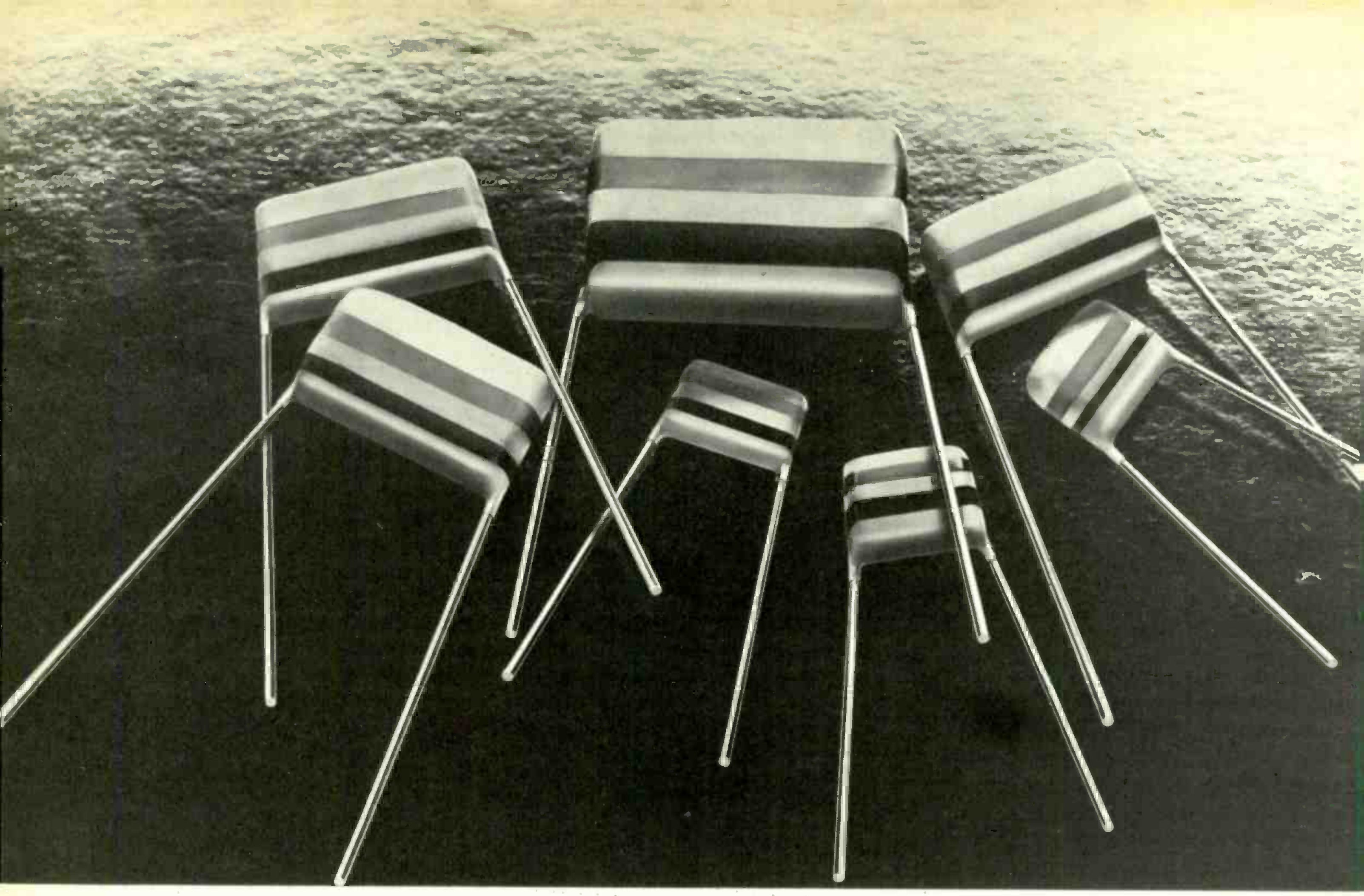

How we set the trend in plastic film capacitors

Ten years ago, Mullard introduced the C296 series of plastic film capacitors to replace the paper components then used exclusively in consumer applications in the UK. The film used is polyethylene-terephalate generically known as polyester. This revolutionary film transformed the British capacitor market. It enabled Mullard to reduce component size by as much as 15% compared with paper types. Working voltages were up to 400V d.c. Insulation resistances greater than 50,000MΩ at 20°C were achieved for the first time in commercial quantities. The polyester film itself was non-hygroscopic and chemically inert. It was wound with aluminium using an extended foil technique to give minimal self-inductance. And the finished capacitors were encapsulated in hard, water repellent lacquer, which was unaffected by temperatures up to 150°C.

New techniques New manufacturing techniques were then introduced in plastic film capacitors, which allowed a metallised layer to be deposited on the film. This reduced our capacitor sizes by up to a further 50%. About this time, the general acceptance of printed circuits created a strong demand for various components in different shapes, with particular dimensions to close tolerances. And because we at Mullard anticipated this trend we now produce the C280 miniature metallised film capacitors. These small devices have radial terminations in the standard I.E.C. 0·1 inch grid spacing, making them the economic answer to the problems of improving packing densities and reducing assembly production times. Due to their distinctive colour coding, small size and wide capacitance range the demand for these capacitors is far in advance of all others. The 400V units have a more recent polyester film (polycarbonate) which reduces losses at frequencies of 20kHz and above. This also applies to the C281 series with their axial leads and moulded encapsulation.

Development Work of course continues, and encouraging results are being achieved with capacitors for a.c. power handling, for example for interference suppression and power factor correction, using polypropylene films.

Higher demand The demand for discrete passive components has increased enormously during the last ten years. And today there is a continual demand for polyester capacitors in the range 0.001μF to 10μF for most applications in the domestic field.

Worth it? Right from the beginning we've anticipated the changing requirements, tested new materials and techniques so that we can be sure the product will give consistent service. This also enables us to relate quality with the best possible price. Something which applies across our very wide capacitor range including electrolytic, variable and ceramic types.
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Wireless World

Domestic Broadcasting

It is now 20 years since the Copenhagen Plan for medium- and long-wave broadcasting in Europe was implemented and the present chaotic state in the medium-wave band beggars description.

There are those who consider that the situation in the medium-wave band is beyond redemption and that only a v.h.f. national network can provide a worthwhile service (see 'Letters' p.518). While we would whole-heartedly agree with this view on the grounds of the quality of service v.h.f. provides we would like to see a bolder plan introduced by the broadcasting authorities in this country for the efficient use of the medium-wave band. We are not necessarily pleading for a new European plan—the U.K. would probably be worse off as the result of such a reallocation—but, are the potentialities of this band being fully exploited? Have we moved very far since the introduction of the B.B.C.'s Regional Scheme in, was it 1936? We believe the aerials at Brookmans Park, London, are very little different from those originally used!

Talking of aerials. Readers may have seen in the lay press references to the scheme put up by Hughie Green for 100 local radio stations in the medium-wave band. At first sight this seemed ludicrous in the present congested state of the band but the scheme, which was rejected by the Post Office, depended, to some extent at least, on the use of directional aerials serving a very limited area of up to five miles radius with a low-power (2 kW) transmitter. While the use of such aerials would certainly avoid the stations causing interference with other transmitters sharing the frequencies it would not eliminate interference from Continental stations. Incidentally, Mr. Green's scheme was based on a survey conducted by a German company. A British company declined to carry out the work because the kind of publicity arising from the proposed scheme would impair its relationships with "two of its most important customers, the Post Office and the B.B.C".

In our August leader we considered, somewhat philosophically, the utilization of the radio spectrum, suggesting that the channels should be "tailored" to the information they are to carry. Some readers took us to task for this; commenting that our attention should have been directed to the B.B.C.'s use of its existing resources. One reader, who listed the 16 frequencies used by the B.B.C. in the medium- and long-wave bands, asked why the technique of synchronizing transmissions (as was done during the 1939-45 war to prevent them being used for homing by enemy aircraft) is not more widely used. Synchronization does, of course, necessitate national *network* operation and therefore precludes any "regional" variations. Such a network, or networks, provided by the B.B.C. could, and should, be supplemented by low-power local stations of the type envisaged by Mr. Green—whether they be commercially operated or as a non-commercial enterprise by a local authority.

It may not generally be known that the B.B.C. has been experimenting with compatible single-sideband transmissions in an endeavour to improve the signal-to-noise ratio in the medium-wave band. When the results of the experiments have been assessed maybe we shall hear of a scheme as bold as the television changeover from 405 to 625 lines.

A Design in Retrospect

by J. Dinsdale, M.A.

The designs for high-quality audio amplifiers published in 1961 and 1965 gave rise to several hundred letters from readers. In this article those letters referred to the designer have been analysed to establish the most popular topics of interest, and some of the more interesting suggestions and comments are examined in detail.

When Dick Tobey and I published our first articles in 1961[1,2] describing the design of a transformerless high-quality audio amplifier using transistors, we did not expect to awaken more than a passing interest among a few enthusiasts. It was therefore with a mixture of surprise and delight that we received (and duly answered) over 100 letters from readers of *Wireless World*. Of these letters, the majority were either from engineers who were not conversant with transistor techniques (especially the use of complementary transistors and the application of a.c. and d.c. feedback) or from constructors wishing to know where certain components might be obtained. There were also a few letters from more perceptive readers who offered some useful advice and criticism, and these proved to be of great value later on in developing the mk.II system.

The circuit had originally been developed from a servo-amplifier, which was found to have an exceptionally good frequency response and low distortion. The idea of using the so-called quasi-complementary class B stage, in which complementary driver transistors are followed by an output pair of transistors of a single type had first been proposed by H. C. Lin in 1956[3]. The circuit which Tobey and I devised took advantage of Lin's concepts, but incorporated a modified form of feedback which gave lower distortion while maintaining satisfactory gain and phase margins for the whole amplifier. Tobey and I were both very keen on sound reproduction at that time (mid-1959) and we were anxious to exploit the then very new devices called semiconductors, which were only just becoming available to home constructors in the U.K. at reasonable prices. I was then listening (single channel) via a Williamson amplifier with Partridge output transformer feeding a 12-in Magnavox loudspeaker in a bass reflex enclosure. My pickup at that time was a Collaro Studio 'P', later to be replaced by the Decca ffss mk.I which, when used with the S.M.E. 3009 series 1 arm and Garrard 301 turntable, gave results which at that time I considered to be little short of miraculous. However, the size and weight of the Williamson amplifier, and the heat produced by the valve heaters, made the prospect of constructing another identical amplifier for stereo distinctly unattractive. So when we found that a transistor servo amplifier, which we had developed for the inertial navigation system of a guided missile, sounded very nearly as good as the Williamson, could be assembled on a printed circuit board 5 inches square, and required only 40V d.c. at less than 1A peak current to give 10W into a loudspeaker load, we decided to modify the design to make it as good as possible for high-quality sound reproduction.

The performance of the transformerless quasi-complementary circuit developed by Tobey and myself appeared to be far superior (on paper) to the circuits then available (which employed transformers) and listening tests seemed to confirm this.

The two articles published at the end of 1961 described a class B quasi-complementary transformerless power amplifier and a pre-amplifier with comprehensive input, filter and tone-control facilities. The techniques used are commonplace nowadays, but they attracted considerable interest when published. Features in the power amplifier which were novel at that time included the quasi-complementary output stage and the use of a thermal feedback loop (utilizing the variation with temperature of the voltage across a diode junction) to stabilize the operating point of the output stage (and hence crossover distortion) against changes in ambient temperature. The method of earthing the equipment for single-channel operation was discussed, with particular reference to the high asymmetrical currents which flow in the output stage of a class B amplifier. The article also suggested how to select suitable transistors in the light of cut-off frequency, gain and noise.

The pre-amplifier employed two transistors, and gave an adequate performance without being particularly elegant. The method of equalizing the playback characteristic on disc replay utilized the self-inductance of the magnetic pickup in order to avoid designing a high-impedance input circuit. This method was subsequently found to be both difficult to apply with a single channel, and distinctly undesirable for two-channel operation because it caused excessive cross-channel interference. The tone controls used a Baxandall-type circuit, and the output fed directly into the power amplifier. The point was made that by applying the feedback networks for both the tone controls and the filters around the same stage, the characteristics of the two controls interacted in a beneficial way to increase the slope of the h.f. filter when the treble control was set to maximum boost. The stereo balance control operated by varying the feedback ratio around the second stage. This provided only 6dB variation between channels, a figure subsequently found to be inadequate, and also tended to interfere with the operation of the tone controls. The complete system had been in operation since October 1959, some two years before publication, and we hoped that most of the obvious defects had been eliminated.

The mk.II design was constructed during 1963, and details were published early in 1965[4,5]. The reason for publishing the new version was to improve the areas of weakness in the previous design, and to provide full details of the construction, which our correspondence had shown were badly needed. It also gave an opportunity of discussing some of the more interesting points in the design. The principal area of difference was in the pre-amplifier, which had been largely re-designed. The range of input circuits was closer to that then available from valve amplifiers, and the method of equalization for disc replay had been made completely independent of the inductance of the pickup. The tone controls and filters were much the same as before, but the balance control now utilized a log/antilog twin-gang potentiometer to give an infinite

Jack Dinsdale, aged 31, graduated in mechanical sciences at Trinity College, Cambridge and subsequently took a post-graduate diploma in advanced engineering at The College of Aeronautics, Cranfield. He spent several years with Elliott Automation and recently became senior research engineer with the Unit for Precision Engineering at the College of Aeronautics where he is responsible for the application of electronic control and digital computing techniques to machine tools and measuring machines.

Table 1. Performance of Mk. II system

Output power	10W r.m.s. per channel
Frequency response	± 3dB from 35Hz to 20kHz
Total harmonic distortion	0.3% at 1kHz and 10 watts
Signal-to-noise ratio	70dB at 10W
Power requirements	40V at 800mA (max.) or 150mA (average)
Controls	Input selector (microgroove, standard, radio, microphone, tape replay), treble, bass, filter, volume, balance, function (stereo, reverse stereo, mono)
Channel separation	Radio: − 60dB at 10kHz Mic: − 50dB at 10kHz
Output impedance	Less than 0.25Ω

range of control while keeping the attenuation at the central position to a mimimum. The particular problem of earthing the stereo system was discussed at length, but the most elegant method was suggested in subsequent correspondence[6]. The power amplifier circuit was little changed. The principal additions were a resistor to improve earthing and an a.c. centre-tapped coupling for the loudspeaker load to minimize the "plop" sound, which is caused when the circuit is switched on, by the coupling capacitor charging up via the loudspeaker.

The second article on the mk.II design gave full details of metalwork, printed circuits, wiring, and general hints on construction. There was also a comprehensive list of transistor alternatives, and details of the typical d.c. working points of all the transistors to aid fault-finding. The network for equalization to the R.I.A.A. disc replay characteristic was given, together with the method of calculating component values. Several correspondents have queried the derivation of these values, and a formal analysis has been included as the appendix to the present article. Two methods of dealing with crystal pickups were described: normal loading and velocity loading. Both have their disadvantages, and a number of readers commented on these. The correspondence on this subject has been summarized later in the article. Table 1 shows the performance of the complete mk.II system, and table 2 the main areas of the difference between the mk.I and mk.II designs. Table 3 shows a breakdown of the principal topics raised by correspondents after publication of the two sets of articles. A number of letters raised several points, so this table does not reflect the total number of letters received. Topics have been included only as initially raised; subsequent correspondence has been omitted.

Component availability

Many of the letters received, especially after the 1961 articles, referred to component availability; the majority requested information on the n-p-n transistor, originally the 2N388A. The articles had not specified where this component could be obtained. This was an unfortunate omission as germanium n-p-n transistors with a V_{CB} of 45V are not easily obtained, even now. There were a few alternatives, such as the 2N2613 (RCA) and the AC127Z (Mullard), none of which was quite as good as the 2N388A for its sustained gain over the specified working range of collector current. A number of writers proposed using alternatives especially the OC139 or OC140, as these were the only British germanium n-p-n transistors then commonly available. Unfortunately, the value of V_{CB} for the OC139 and OC140 is only 25V, and it is possible for the full h.t. of 40V to appear across the transistor. A number of disappointed constructors did in fact write saying that they had blown up OC139s in the circuit.

Several constructors attempted to use a silicon n-p-n transistor, allied with a germanium p-n-p transistor, for the complementary pair, but the characteristics of the dissimilar materials only serve to upset the symmetry of the amplifier. In addition, the thermal loop via the diode, which compensates for changes in ambient temperature, relies on all the transistors possessing similar values of V_{BE}, and the effect of using a silicon transistor is to prevent this temperature compensation from operating correctly. If a silicon n-p-n transistor is to be used, then the complementary p-n-p transistor should also be silicon, to preserve the symmetry of the circuit. When the mk.II circuit was published it was equally difficult to obtain silicon p-n-p transistors.

Component tolerancing

The components used in most circuits, and the audio amplifier is no exception, may be divided into three categories when it comes to tolerancing.

These are:—

(i) Components whose values are by no means critical, where ±50% is more than adequate. This applies to most electrolytic capacitors, resistors used to suppress switch clicks, etc.

(ii) Components whose value determines d.c. operating points: ±10% is normally adequate.

(iii) Components whose value sets a precise parameter, for example equalization of recording characteristics, roll-off frequencies, etc. Here, the tolerance should strictly be determined from the maximum acceptable departure from the desired characteristic.

In this design I decided to recommend ±2% for the components in category (iii) as a compromise between faithfulness to the R.I.A.A. equalization curve, and reasonable price and availability. It is also worth noting that any inherent accuracy of equalization is nullified by the action of tone controls. Nevertheless I received a number of letters complaining that the performance of an amplifier departed by 5dB from the R.I.A.A. curve (one of these from a man who had used ±20% capacitors) and other letters saying that a design which had to rely on ±2% components could not possibly be a viable proposition. I think that here one literally pays one's money and takes one's choice, and I would recommend ±2% tolerance where stated for those readers interested in achieving the published sensitivity (optional) or the standard equalization curves (desirable). Incidentally although the Mullard polyester capacitors specified in the equalization circuits are rated at ±10% from 0°C to 85°C, intensive tests on these established that over the normal domestic ambient temperature range of 15° to 25°C, the values remained within ±2% of nominal.

All other resistors were specified as ±5% even though in many cases ±10% would have been adequate, on account of the high degree of negative feedback. The use of 5% resistors was principally to facilitate postal fault diagnosis, by ensuring that the d.c. operating conditions in all models of the amplifier would be closely controlled.

Tape recorder modifications

Many correspondents requested information concerning the use of the amplifier with domestic tape recorders. First of all, how should the amplifier be connected to the "record" input socket? This connection is normally best taken from the collector of the second transistor via a suitable coupling capacitor, the value depending on the input impedance of the tape recorder. The signal will be equalized at this point, and at a level of 30 − 50mV r.m.s.; all controls are bypassed since one normally relies on those of the tape recorder itself. If the input impedance of the recorder is 1MΩ (a typical figure) then the coupling capacitor should be of value 0.5μF.

The earthing can also lead to trouble, and it may be found worthwhile to avoid possible earth-loops by disconnecting the tape recorder mains earth and using that of the pre-amplifier. This approach is satisfactory provided that the tape recorder is individually earthed again when it is disconnected from the pre-amplifier.

Table 3. Principal topics of correspondence

Topic	Number of Times Mentioned in Letters 1961	1965
1. Suppliers of n-p-n transistors	16	—
2. Matching and equalization of magnetic pickups	4	5
3. Matching and equalization of crystal pickups	1	11
4. Power supplies	3	5
5. Suppliers of printed boards	8	5
6. Transistor equivalents	3	12
7. Queries on circuit and fault finding	18	23
8. Earthing problems	1	9
9. Balance control	2	—
10. Mixing circuits	2	—
11. Mono/stereo switching	1	1
12. General component queries	4	—
13. Loudspeaker coupling	1	5
14. General component availability	—	9
15. Modifications for tape recording	—	5

Table 2. Summary of differences between Mk. I and Mk. II designs

Switch Position	Function		Mk. I version: Sensitivity (10W at 1kHz)	Mk. I version: Input Impedance kΩ	Mk. II version: Sensitivity (10W at 1kHz)	Mk. II version: Input Impedance kΩ
1	Microgroove	(mag.)	5mV	6	4mV	56
	pickup	(crystal)	100mV	100	400mV	50
2	Standard	(mag.)	8mV	7.5	8mV	56
	pickup	(crystal)	150mV	100	800mV	50
3	Radio		150mV	100	80mV	92
4	Microphone		1.5mV	1	5mV	92
5	Tape replay		2.5mV	1	3mV	92

In addition, the Mk. II version gave slightly improved figures for frequency response, distortion and channel separation.

The other tape recorder queries mainly concerned input to the pre-amplifier. Although equalization for $7\frac{1}{2}$ i.p.s. from a low output tape head was provided in my design, I really expected users to take the output from the replay pre-amplifier on the recorder itself into the radio or auxiliary sockets on the pre-amplifier. I was therefore surprised to learn that many users required information on equalization for tape speeds of $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ and 15 i.p.s. at various sensitivities. The C.C.I.R. standard of 70μs for $7\frac{1}{2}$ i.p.s. was used in the published design. For the two lower speeds the time constants become 140μs and 280μs, and the value of the feedback capacitor must be proportionately increased in each case. If the resistor in series with the feedback capacitor is changed, to alter the sensitivity, the capacitor value will need adjusting to preserve the correct time constant.

Disc replay equalization

There has been much discussion in recent years in *Wireless World* and elsewhere, on the importance of accurate equalization of the disc replay characteristic, and the best means of achieving this. As far as magnetic pickups are concerned, the most appropriate way of dealing with these is to present the device with the manufacturer's recommended load impedance (normally 47 kΩ) and then to apply the R.I.A.A. replay characteristic by means of negative feedback. Provided that the high input impedance is achieved by feedback techniques, so that the base of the input transistor can be connected to ground via the pickup itself (and a suitable blocking capacitor), and the gain demanded from the stage is not excessive, this will result in low distortion and a good signal-to-noise ratio. It must be remembered here first, that if a transistor has a gain of (say) 100, then the amplifier stage containing this transistor should not be expected to give a gain greater than 10; and secondly that the R.I.A.A. characteristic requires nearly 10 times more power gain (18dB extra voltage gain) at 20Hz than at 1kHz where sensitivity is normally specified.

In the mk. II design the input impedance is 47kΩ closely, and the stage voltage gain in the 'LP' position is 12 at 1kHz rising to about 110 at 20Hz. This bears favourably with the minimum specified gain of 100 for both Tr_1 and Tr_2. Many correspondents have written to me complaining of a lack of bass in the 'LP' position. I have examined two such cases, and both were caused by low-gain transistors in Tr_1 and Tr_2 positions; the stage was just not capable of providing the extra 18dB at 20Hz. A final word of caution on this subject: it is always advisable to check the output waveform on an oscilloscope when measuring frequency response curves. There is otherwise the danger of starting the test at 1kHz, and failing to notice that the additional gain at lower frequencies is causing the waveform to square off and hence give an incorrect reading. The correct method of conducting this test is to present the input of the pre-amplifier with the *inverse* of the R.I.A.A. playback characteristic, and then to check the output for a *flat* response at the appropriate level.

Turning to amplitude-sensitive pickups (the piezo-electric types such as crystal and ceramic) many letters have implied a basic misunderstanding of how these devices operate. Curve A in Fig. 1 shows the amplitude of movement of the recording (cutting) stylus when recording a flat signal at all frequencies. Curve B shows the output of a velocity-sensitive (magnetic) pickup tracking the signal of curve A; the output is proportional to the rate of change of magnetic flux linkage, and will thus increase with frequency. Application of the R.I.A.A. playback equalization (shown in curve C) to curve B will give a flat response. The output of a perfect amplitude-sensitive pickup would be expected to mirror curve A, but the output of crystal and ceramic pickups is purposely modified by the mechanical characteristics of the mounting in such a way as to compensate for the recording characteristic and provide a reasonably flat output under no-load conditions. However, the performance of these pickups has, in my experience proved somewhat disappointing and I have obtained far better response curves from correctly equalized magnetic pickups. The equivalent electrical circuit of a crystal or ceramic pickup may be approximated by a constant voltage generator in series with a capacitor, as shown in Fig. 2(a). When this is loaded by a resistor, as must occur when it is connected to the input of the pre-amplifier the resultant response is as shown in Fig. 2(b) the turnover frequency f_1 being given by the expression

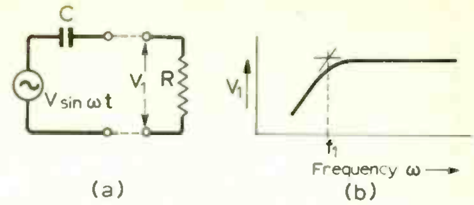


Fig. 2. (a) Equivalent circuit and (b) response of crystal pickup.

$$f_1 = \frac{1}{2\pi CR}$$

The value of C is fixed by the design of the pickup itself, and may lie in the range 200-2000pF, and the value of R is the apparent input impedance of the pre-amplifier as seen by the pickup.

There are three methods of loading a crystal pickup, as shown in Fig. 3:

(i) Employ a very high load-resistance (1 to 4 MΩ) with no further electrical equalization since this is performed approximately by the mechanical circuit of the pickup. This will place f_1 below the audible frequency spectrum.

(ii) Load the pickup with a relatively low resistance and equalize by using a feedback circuit composed of a series capacitor and resistor with the same time constant as the pickup capacitance and loading resistor.

(iii) Load the pickup by the more complex circuit described in my letter to *Wireless World*[7] which provides, in combination with the mechanical circuit of the pickup, an output closely resembling that from a magnetic pickup. This may now be equalized exactly as for velocity-sensitive devices.

Since the inbuilt mechanical equalization is not affected by electrical loading, the output of a crystal pickup when loaded by a low resistance as in method (ii) will only approximate to the output of a velocity-sensitive device and equalization of this output by the conventional R.I.A.A. network will only approximate to an ideal response.

My choice of velocity-loading for crystal pickups was made because it permitted a single position 'LP' on the input switch, instead of two positions 'LP Magnetic' and 'LP Crystal'. In addition a number of high quality ceramic pickups require a loading impedance greater than 1MΩ to achieve a bass response to 40Hz using method (i) and my circuit is not ideally suited to this. Subsequent work has confirmed that resistive loading followed by equalization via method (ii) above is marginally best. Method (iii) is the easiest to implement with my published design, as in this case the feedback network is the same as that used for magnetic pickups. I would however emphasize that the optimum velocity-loading network varies for each pickup, and is ideally associated with the pickup itself (mounted in the arm at the

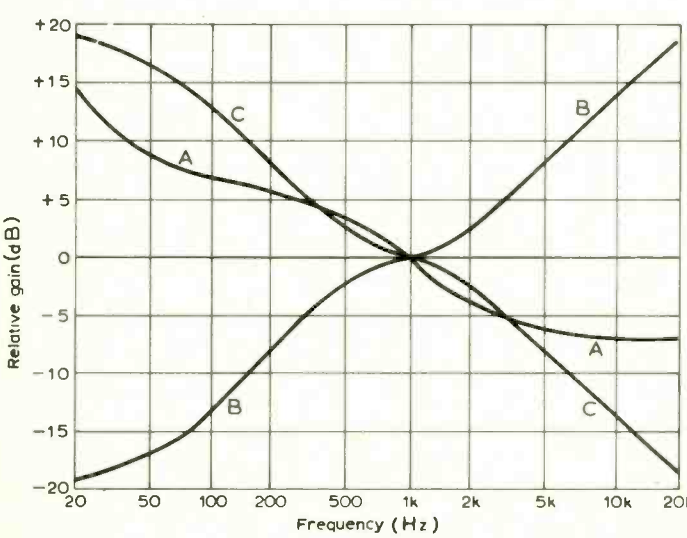


Fig. 1. Recording/playback curves.

cartridge terminals) rather than in the amplifier. It is possible to adopt more complex equalization networks, as advocated for example by Mr. J. L. Linsley Hood[8], but my personal experience suggests that it is better to purchase a good magnetic pickup.

In spite of using the exact values of components for equalizing replay characteristics, the true response curves will not be obtained unless the treble and bass controls are set to a true 'flat' position, which may not coincide with the geometrical centre of rotation, or indeed may not be the same for both sections of a twin-ganged control. For this reason, several correspondents asked for the values of resistors for a switched control, and these are given in Fig. 4. The preferred switch is the Radiospares 2-pole 6-way midget wavechange switch, which is about the same diameter as the potentiometers it replaces.

Stereo switching

It was found convenient to carry out mode switching, i.e. stereo / reverse stereo / mono, at the output of the pre-amplifiers. The 'reverse stereo' position permits channels to be reversed so as to use the loudspeakers with the best bass response in the most appropriate channel (where non-identical speakers are employed); it can also be used to transpose the 'positions' of instruments from left to right, and reverse the 'direction' of trains and other stereo demonstration gimmicks. However, a number of readers have pointed out that by combining the two channels at this point for mono operation, the balance control must be set truly mid-way for correct cancelling of the out-of-phase component of the signal, and also the signal-to-noise ratio is degraded by 6dB. These are certainly valid points, but the switching problems involved if the channels are paralleled earlier in the pre-amplifier make any alternatives undesirable.

Input switching

It is clearly a disadvantage to run the leads from the input sockets right up to the front panel for switching. A better arrangement would be to place the input switching wafer at the extreme rear of the unit, with wiring directly from the input sockets. The 'feedback switching' wafer should be placed at the front of the unit as at present, and the switch should of course have a long shaft.

Power, sensitivity and distortion

On occasion, correspondents have asked whether the output power can be increased. The power available from a transformerless class B output stage depends on the applied voltage and the loudspeaker impedance. More specifically it is given by

$$P=\frac{(V-v)^2}{8\ R}$$

where P=output power (r.m.s. watts), V= supply volts, v=volts lost in output transistors, etc., and R=load impedance.

Thus for a given load impedance, the only way to increase the power is to increase the supply voltage. This is possible only if the transistors and other components will stand

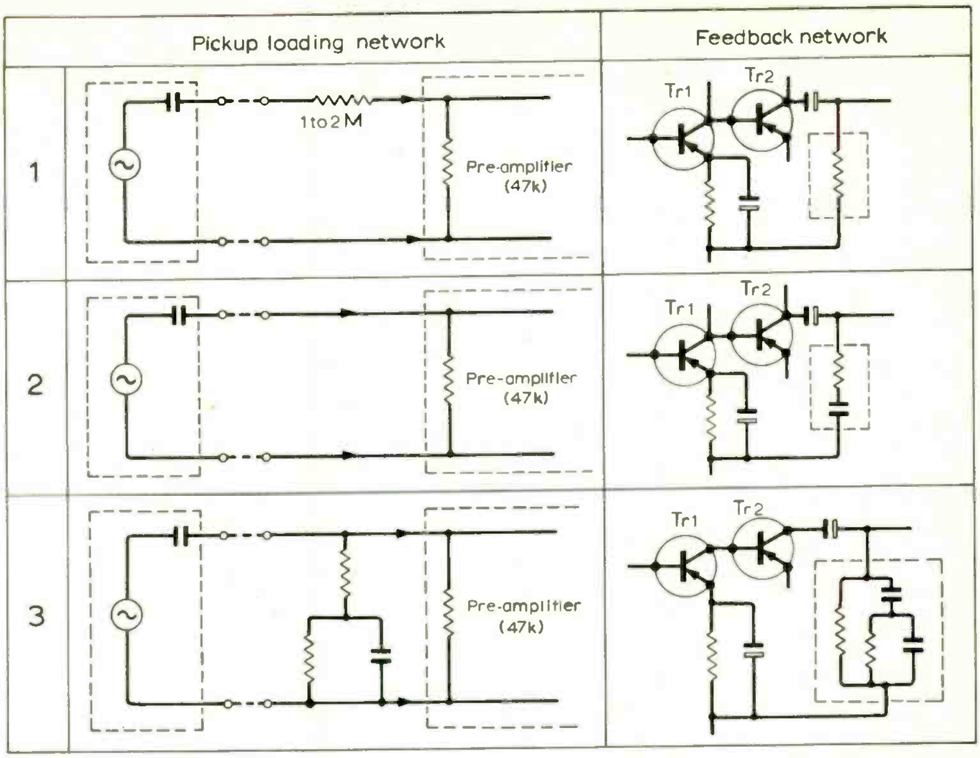


Fig. 3. Methods of loading crystal pickups. In 2 and 3 the time constants of the loading and feedback networks must be matched.

the increased voltage without breakdown. Alternatively, the load impedance may be reduced (e.g. from 15 to 8 Ω). In this event the additional power is supplied by increased currents in the output and driver stages, and this is liable to result in increased crossover distortion.

The sensitivity of the power amplifier is given closely by the expression

$$\frac{R_f+R_e}{R_e}$$

where R_f is the feedback resistor from the amplifier output to the emitter of the first transistor and R_e is the value of the unbypassed emitter resistor of the first stage. (In the mk. II circuit, the sensitivity is

$$\frac{3900+39}{39}$$

i.e. 100.) The sensitivity of the pre-amplifier is given by

$$A\frac{(R_f+R_e)}{R_e}$$

where R_f is the impedance of the appropriate feedback network, R_e is the unbypassed emitter resistor of the first stage, and A is the attenuation of the input network (if any). If (as some readers have enquired) it is necessary to increase the sensitivity, this may be carried out in either the power amplifier or pre-amplifier or both. However attempts to do this may result in increased distortion, worsening of the signal-to-noise ratio, and impairment of the frequency response.

Several readers wrote to say they were experiencing severe distortion, and subsequent investigation showed that they were using a 3-Ω loudspeaker with the 15-Ω design. As a result, the output and driver

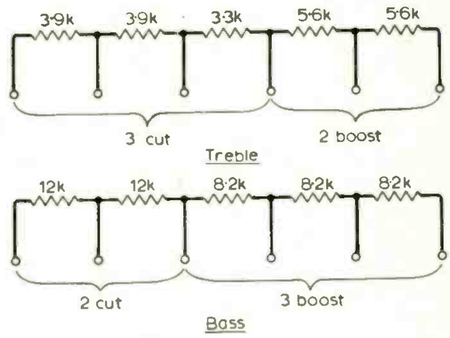


Fig. 4. Switched tone control networks.

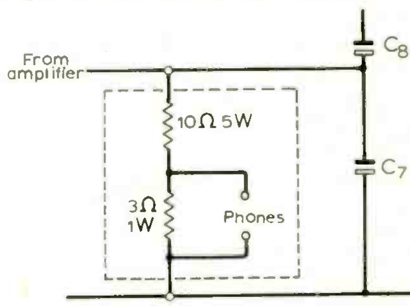


Fig. 5. Loading network for high-sensitivity earphones.

stages were supplying a higher current than the design permits, and crossover distortion was excessive. I do not recommend reducing the load to below 8 Ω (when using the 40-V design) if distortion is to be kept reasonably low. It is worth noting that the component of crossover distortion remains fairly constant regardless of output power level, and as a result the distortion increases from 0.2% at 10W to 0.5% at 0.5W (both figures measured at 1kHz). At higher frequencies the distortion is still larger. If the amplifier is to be used to drive earphones, which normally require a very low power, it is worth loading the output with a resistor network in order to ensure that the amplifier itself operates at a power level of a few watts. Fig. 5 shows a suitable network for this purpose. If load impedances of less than 15Ω are to be used, the values of the coupling capacitors C_7 and C_8 should be increased in order to maintain a satisfactory bass response. As a rule of thumb, 1000μF should be used with 15-Ω loadspeakers, increasing to 2000μF for 8-Ω speakers.

The use of two electrolytics (C_7 and C_8) is recommended for reducing the 'plop' sound when switching on both mono and stereo systems; a single pair of electrolytics shared by the earthy ends of both speakers is not recommended because it introduces audible cross-talk and distortion in stereo systems owing to the finite impedance (frequency-variable) of these components. It is worth noting that there will be audible hum when two electrolytics are used per amplifier unless a choke (e.g. 50mH) is used in the power supply to provide additional smoothing.

If the power amplifier is to be run either as a separate unit or with a different pre-amplifier, it is important to ensure that the input is loaded to ground by an impedance of under 10kΩ. Failure to do this will not only reduce the signal-to-noise ratio but will prevent the series feedback from operating correctly.

One potential source of catastrophic failure in the power amplifier is the biasing diode, setting the quiescent current of the output stage. If this diode fails, or the bases of the driver transistors are open-circuited for any other reason, then the output transistors will both be turned hard on and will fail in less than one second. It is for this reason that the resistor in series with the diode should not be replaced by a potentiometer, as these are notorious for intermittent loss of contact. A good alternative would be to use a fixed resistor with a trimming potentiometer in parallel. Failure of the potentiometer would not then be catastrophic. It is possible to use in place of the diode a suitable transistor as a 'super diode', i.e. with its collector and base strapped together.

More than one reader has commented on the increase of supply current with signal frequency; this is however quite normal with this amplifier. It arises because the output transistors (OC35s, etc.) have a very low cut-off frequency f_T of about 5kHz. The supply current rises with frequency for two allied reasons: firstly as the gain of the output transistors decreases, the very high feedback around the amplifier automatically increases their base currents to maintain the correct amplifier gain; secondly, the non-conducting transistor does not cut off until just after the conducting transistor has started to turn on, and so there is a short period during which current flows through both transistors. In spite of the above situation, the performance of the complete amplifier remains within the quoted limits. Obviously, distortion increases with frequency, but total harmonic distortion is still below 1% at 15kHz. Furthermore, the percentage of the audio power spectrum which lies above 5kHz in music is very low, so the performance of music remains at a satisfactory distortion level.

Interested readers are referred to the note "Dinsdale Amplifier Mod"[9].

Transistor alternatives

It was perhaps inevitable that, from the beginning, queries would be raised regarding alternative transistors. In many instances there were a number of well-known alternatives; but it was with care that the 1961 articles specified the polarity, gain and voltage rating of each device. In spite of this, many correspondents enquired whether quite unsuitable transistors could be used; some complained that they had used these, and not unnaturally the devices had failed, often carrying more of the circuit with them because of the overall d.c. feedback. For the benefit of those about to embark on this design a list of currently available transistor alternatives is given in table 4, but this is by no means exhaustive. An important point concerns the complementary drive pair (Tr_3/Tr_4). It is vital that both of these devices and the diode are of the same material (germanium or silicon). If a silicon pair is used, then two silicon diodes in series with the resistor should be employed.

Instability

A number of writers complained of instability. Without exception, the effect, which occurred only when pre-amplifier and power amplifier were connected together, took one of two forms:

(i) supersonic oscillation from 30 to 50kHz.

(ii) subsonic oscillation at below 2Hz.

The first of these is generally caused by feedback from the output of the power amplifier (loudspeaker terminal) to the input to the pre-amplifier between which two points the phase difference is such as to give positive feedback. If this oscillation (which tends to start as the volume control is advanced and is exacerbated by treble boost) is allowed to continue, it will rapidly lead to thermal breakdown of the output transistors and the destruction of high-frequency loudspeakers (especially ribbons). The remedy is to use screened input leads (a sound precaution anyway) and to ensure that the pre-amplifier and power amplifier are well screened within the unit itself. It is worth noting that all complaints of this nature stemmed from equipment in which one of these points had not been complied with. The subsonic oscillation occurs in the pre-amplifier, and is due to the high-pass filter via the resistor coupling the emitters of the first and last transistors. Faulty decoupling capacitors will lead to this low-frequency motor-boating.

Noise testing

The input transistor of the pre-amplifier, Tr_1, requires its base to be loaded to ground via not more than 10kΩ in order to maintain the correct function of the emitter feedback. If this condition is not fulfilled, a serious degradation of signal-to-noise ratio occurs. Normally the base is loaded via the impedance of the microphone, pickup or tape head in use (or by padding resistors if these are in circuit). In fact resistive and inductive loading give an audible difference to the character of the background noise; some observers have suggested that the "pink" noise resulting from inductive loading is more pleasing than the "white" noise due to resistive loading. However, this illustrates the obvious need to provide the appropriate loading resistor (or transducer) at the input terminal before noise tests are carried out. Failure to do this gives a misleading picture, which a number of constructors were quick to discover, especially as open-circuit high-gain input terminals have on occasion been known to pick up local radio interference. Thus the magnetic pickup terminal (for example) should be loaded to ground by about 2kΩ (a typical pickup impedance) for testing signal-to-noise ratio.

In general the interposing of resistor networks between a signal source and the input transistor will degrade the signal-to-noise ratio. This is because the signal and noise are attenuated in equal manner, and in addition the resistors themselves will generate noise. However, where the signal has to be attenuated (as for example with high-output crystal pickups) it is worth while ensuring that the apparent source impedance presented to the input transistor is optimized to about 1kΩ Table 5 shows the results of an experiment which illustrates this latter point, about which, incidentally, there has been much correspondence, including letters published in *Wireless World*. The signal-to-noise ratio is

Table 4. Transistor alternatives

	Transistor Number	Type	Gain (Typical)	Max. Working Voltage	Typical Types
Pre-amplifier	1, 2, 3	p-n-p, small-signal, low-noise	60 at I_c = 1mA	10	OC44, OC75, AC107, SN2613 (Selected for low noise)
Power amplifier	1	p-n-p, small-signal, low-noise, high frequency	60 at I_c = 1mA	6	OC44, 2N2613
	2, 3*	p-n-p, sustained gain, over wide, current range	30 at I_c = 100mA	40	OC77, ACY17
	4*	n-p-n, sustained gain, over wide, current range	30 at I_c = 100mA	40	NKT227, 2N385A, 2N388A
	5 & 6	p-n-p, good turn-off characteristic	30 at I_c = 3A	40	2N1605A, OC28, OC29, NKT401, AD140, OC35, OC36, 2N2147†

*Drivers. †See modifications for 2N2147 (ref. 9).

Table 5. The effect of input loading on noise level

R_1 Ω	R_2 Ω	Signal/noise ratio (dB)
100k	1k	60
1.2M	12k	55
4.7M	47k	40
10M	100k	21

largely dependent on the voltage amplifying transistors, especially Tr_1 and Tr_2 in the pre-amplifier and Tr_1 in the power amplifier. The use of low-noise devices in these positions cannot be emphasized enough, with the added proviso that Tr_1 in the power amplifier must also be a high frequency (15MHz) device to enable the feedback to operate correctly.

Earthing

The 1961 articles did not emphasize sufficiently the need for avoiding earth-loops, to judge from the correspondence on this subject. The currents flowing in the output valves of the then conventional valve amplifiers were small, and the effects of incorrect earthing were negligible. The precautions necessary to avoid distortion due to the high asymmetrical currents flowing in the output of a transistor amplifier were mentioned in both articles, but correspondence still arrives complaining of troubles due to this cause. Rather than repeat the necessary precautions here, I would refer readers who are in doubt to the original articles and to the correspondence in *Wireless World*[7]. Two readers wrote describing the pick-up of radio/TV interference giving an audible signal. These phenomena were never entirely solved, as they ceased in both cases on re-wiring the systems, and could not be reinduced. They may have been due to a semi-dry joint acting as a detector diode.

Immediately after publication of the mk. II design in 1965, there was a considerable correspondence discussing methods of avoiding an earth loop. It was clear that the method proposed by Mr. C. Artus[6] was far more elegant than that originally published, and I have now adopted this method. Most of the alternative earthing schemes proposed by readers failed to appreciate the need to prevent the asymmetrically-distorted output waveform from appearing in series with the input signals, and were therefore not valid solutions to the problem. However one method which several readers proposed was to design the complete power amplifier and pre-amplifier circuits symmetrically on either side of an earth 'tree-trunk'. This method avoids earth-loops, but it introduces other problems in the areas of overall screening between channels, screening between power amplifier and pre-amplifier in each channel, and wiring to the front panel controls. In addition, the complete board tends to be some 12 inches square, and this is not easy to accommodate in a cabinet. I still believe the Artus solution to be the most elegant.

Stabilized power supply

The power supply specified in both sets of articles consisted simply of an unstabilized capacitor-loaded bridge-rectified supply. The mk.II version included additional choke-capacitor smoothing. The disadvantages of this type of supply are first that the output voltage falls with prolonged loud sounds, and secondly that with this fall in voltage there is a corresponding rise in hum level. The drop in output voltage can lead to premature "squaring off" of the waveform, and hence gross distortion and may also affect the "character" of the sound in an unmusical way. The increase of hum, which admittedly occurs only with loud sounds and is thus not immediately audible itself, produces a most unpleasant effect by modulating the output at 100Hz. This effect is particularly noticeable with organ music. The remedy is to use a stabilized or semi-stabilized supply.

Pilot lamps and mains switching

The use of a d.c. pilot lamp has been criticized on the grounds of false economy. Nevertheless I have measured an improvement of 10dB in hum level resulting from using a d.c. lamp. The use of a neon mains indicator introduces a "buzz", and steps must be taken to eliminate this with suitable r.f. chokes.

A further source of hum is the a.c. mains switch ganged to the volume control; if this switch can be positioned as far as possible from the pre-amplifier circuitry, so much the better. Placing the mains switch external to the amplifier is satisfactory, provided there is little chance of switching the amplifier on or off with the volume control at maximum rotation. Alternatively it might be possible to place the switch at the *rear* of the unit, with a long shaft connecting it to the front panel.

Fault diagnosis

Nearly half the letters I received described a set of symptoms and requested a diagnosis. I had carried out many tests during development of the circuit and had also helped personally in the construction and commissioning of over twenty amplifiers, so many of the symptoms were familiar, and could be identified. I always invited correspondents to let me know if my recommendations were successful, and many of them kindly replied giving me this information. This in turn helped others.

The greatest difficulty however occurred with letters describing modifications which were either proposed or which had been carried out and did not work, or which used different components to those specified. This situation frequently applied when commercial kits based loosely on the original design had been used. The kits or equipment often used cheaper components, and alternative transistors which were not suitable. In all of these cases, once the situation was established, it was possible to replace the faulty components with those originally specified, and in most cases the equipment then met the original specification.

I am always loath to recommend modifications especially where this involves personal expenditure by constructors, unless I have personally checked and tested the proposed alterations. As may be imagined I do not have the time or money to check all of these queries personally, especially as many involved proprietary equipment which it was desired to connect to my amplifier. In general, I feel that an author cannot normally be expected to comment with authority on modifications to his design; at the same time, I welcome letters describing modifications which have been carried out successfully.

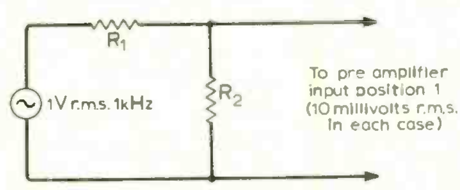


Fig. 6. Test circuit to investigate effect of input loading on noise level.

Use with commercial equipment

The 1965 article referred to the difficulty of designing equipment which will work equally well with every pickup, tape deck, microphone, tuner, and loudspeaker marketed. Sensitivities and impedances (which are often complex and non-linear) are by no means standardized, and one can choose only a reasonable compromise; this is, after all, what the manufacturers of commercial amplifiers do. Perhaps one should increase the number of input sockets and switched alternatives, but this would put the price out of the home constructor bracket.

Nevertheless, a number of letters either enquired whether a particular tape head (for example) would work with the amplifier, or else complained that a certain device did not work satisfactorily. In these latter cases, inspection of the manufacturer's literature (where available) was generally enough to explain why either the gain or input impedance of the amplifier were not suitable for the device in question. To offer alternative input circuits was a temptation that had to be resisted, because I could not guarantee that all the other performance characteristics of the amplifier would be maintained, without building and testing the proposed new circuit myself.

Conclusions

It is now ten years since the "Tobey-Dinsdale Amplifier" was developed. It is still advertised in both kit and made-up form, and a number of commercial equipments have been based on the original circuit. A conservative estimate based on the supply of kits and transistors by two well-known companies suggests that over ten thousand of these amplifiers have been manufactured. It is not now the best available. Recent tests have shown that the quasi-complementary class B output stage produces audible crossover distortion, especially at low signal levels, and this in turn leads to aural fatigue. Nevertheless, I would like to believe that the amplifier, appearing when it did, fulfilled a need by providing an incentive for more able designers than myself to identify and tackle the principal obstacles in the design of a high-quality amplifier. This they have now done, and many amplifiers now on the market give an excellent performance.

Can anything be learned from a retrospective study such as this? I hope that if I have the opportunity again to write an article describing a circuit I will try to remember the following points:

(i) All components should be precisely defined, and a number of commercial sources should be given.
(ii) Alternative components should be given whenever possible (especially semiconductors).
(iii) Suppliers of printed circuit boards and metalwork should be named.

(iv) It is obviously impossible to satisfy everyone; however if the design can give a number of options which between them cover all anticipated uses, then constructors can make the appropriate choice.

Of course one tries to design a system which will give perfect reproduction of music, and I personally regard distortion figures, frequency response curves, and all the other scientific and pseudo-scientific terms as a tiresome but necessary means to the ideal end. But when I heard a visitor to the 1965 London Audio Fair say to his companion, "The trouble is all this music—it's a pity I can't sit down and listen to the hi-fi", I decided to forget about pleasing everybody.

I will also try to remember that when writing to an author with queries, all relevant information should be given and the enclosure of a stamped addressed envelope is appreciated. And finally, if the author's suggestions prove to be successful, then writing to tell him so will make him feel far happier and it may make it easier for him to diagnose similar faults on other people's equipment.

References

1. R. Tobey and J. Dinsdale, "Transistor Audio Power Amplifier", *Wireless World*, November 1961.
2. R. Tobey and J. Dinsdale, "Transistor High Fidelity Pre-Amplifier", *Wireless World*, December 1961.
3. H. C. Lin, "Quasi-Complementary Transistor Amplifier", *Electronics*, September 1956.
4. J. Dinsdale, "Transistor High-Quality Audio Amplifier, pt.1", *Wireless World*, January 1965.*
5. J. Dinsdale, "Transistor High-Quality Audio Amplifier, pt.2", *Wireless World*, February 1965.*
6. C. Artus, Letters to the Editor, *Wireless World*, February 1965.
7. J. Dinsdale, Letters to the Editor, *Wireless World*, February 1966.
8. J. L. Linsley Hood, "Modular Pre-amplifier Design", *Wireless World*, July 1969.
9. J. Dinsdale, "Dinsdale Amplifier Mod", *Wireless World*, May 1969.

*A reprint of these two articles is available from Dorset House, Stamford Street, London SE1, price 5s.

Appendix

Derivation of component values for R.I.A.A. disc equalization

$$\text{Network impedance} = \frac{R_1\left[\frac{1}{pC_1} + \left(\frac{R_2/pC_2}{R_2 + 1/pC_2}\right)\right]}{R_1 + \left[\frac{1}{pC_1} + \left(\frac{R_2/pC_2}{R_2 + 1/pC_2}\right)\right]}$$

$$= \frac{R_1[1 + pR_2(C_1 + C_2)]}{1 + p(C_1R_1 + C_1R_2 + C_2R_2) + p^2(C_1R_1C_2R_2)}$$

$$= \frac{R_1(1 + pT_2)}{(1 + pT_1)(1 + pT_3)}$$

where $T_1 = \frac{1}{2}(b + \sqrt{b^2 - a})$

$T_2 = R_2(C_1 + C_2)$

$T_3 = \frac{1}{2}(b - \sqrt{b^2 - a})$

and $b = C_1R_1 + C_1R_2 + C_2R_2$

$a = 4C_1R_1C_2R_2$.

For the case where $T_1 = 3180\ \mu s$

$T_2 = 318\ \mu s$

$T_3 = 75\ \mu s$

It may be shown that:

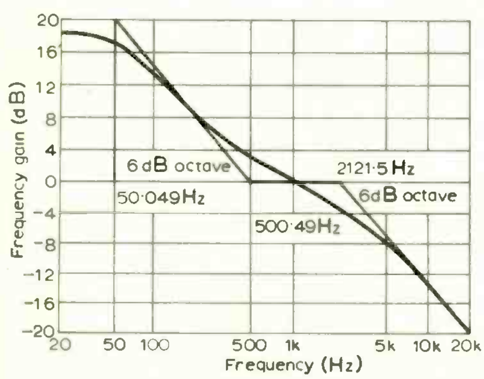
$C_1R_1 = 2940$

$C_2R_2 = 81{\cdot}2$

$C_1R_2 = 237$

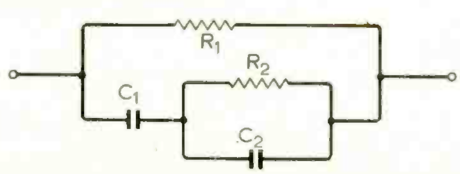
(C in microfarads, R in ohms)

From these expressions the values of components for the equalization networks may be derived starting with a suitable value of R_2 to set the sensitivity.

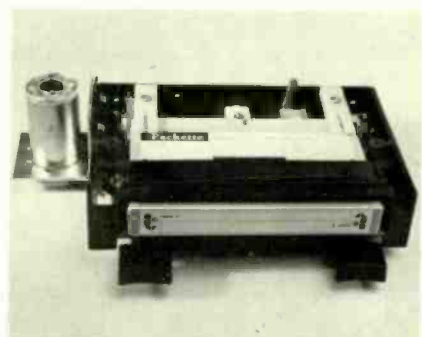


Standard R.I.A.A. curve for microgroove disc relay f_1 = 50.049 Hz (31 80 μs), f_2 = 500.49 Hz (318. μs) and f_3 = 2121.5 Hz (75 μs).

Equalization network



Cassette System for $\frac{1}{4}$-in Tape



The plastic chassis loaded with a tape Packette and fitted with a drive motor.

Tape Systems Ltd, of Egham, Surrey, have developed a mechanically simple yet robust tape transport system for use with cassettes employing $\frac{1}{4}$-in tape. Together these comprise the Packette System—Packette being the trade name of the new cassette.

Besides employing $\frac{1}{4}$-in tape with its inherent advantage over $\frac{1}{8}$-in tape with respect to mechanical strength, recording quality, alignment with the tape heads, and ease of manufacture, the Packette is edge driven. This action is achieved by building the pinch wheel into each Packette. There are both reel-to-reel and continuous-loop types.

The tape deck has a chassis of nylon-reinforced plastic and few moving parts. It can be operated in any position and be fitted with a variety of a.c./d.c. motors and tape heads to meet many intrumentation and audio requirements. The same deck can be driven at speeds down to 15/16 i.p.s. and wow and flutter can be as low as 0.1% at $1\frac{7}{8}$ i.p.s. Modified Marriott heads are employed for audio use—a composite erase record/play head-block has been developed for double track use such as in language laboratories where recordings are made on one track whilst a second track is in play-back.

The single drive motor employed runs at constant speed in the same direction for all operations—tape speed and direction changes are achieved by simple mechanical modules.

Of course there is no fundamental reason why traditional tape speeds should be employed in a new system—there simply has to be correct equalization for any speed chosen.

A Packette system has been developed for use in a language laboratory, and models are available from E. J. Arnold & Sons Ltd, Butterley Street, Leeds LS10 1AX.

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WW—101 FOR FURTHER DETAILS

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WW—102 FOR FURTHER DETAILS

Electronics in Civil Aviation

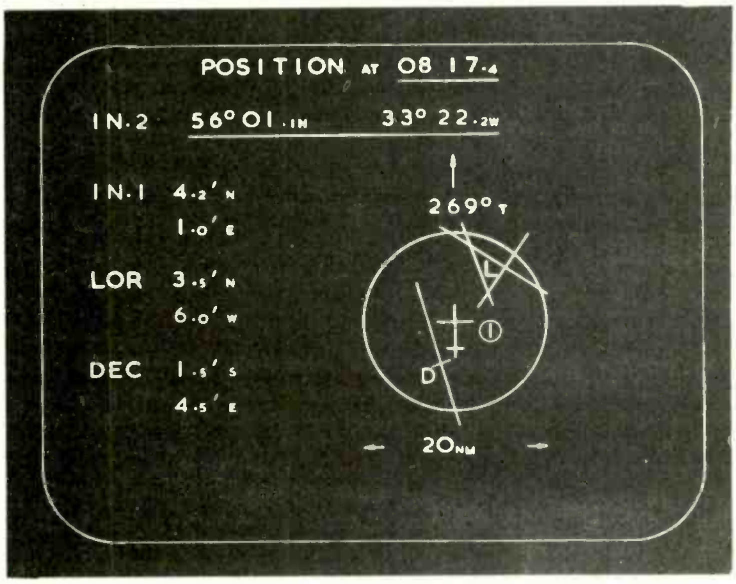
An impression of the current state of civil avionics obtained at a recent London conference

The devil we know is better than the devil we don't—and so say nearly all of us. This message was repeated over and over again in various ways by speakers discussing diverse aspects of electronics in civil aviation at the Royal Festival Hall, London, September 15th to 19th.

On the face of it one would think that it would not be beyond the capability of the electronics industry to provide civil aviation with all they need in the way of control, measurement and computing equipment. In fact if the electronics engineers were given their head and if the aviation boys took things at their face value a whole host of new electronic aviation aids would soon appear but, if this happened, chaos, collision and catastrophe would be the order of the day.

Revolutionary equipment could well, on paper at least, do away with all the known limitations of existing systems but such equipment would certainly introduce a number of unknown features which would lead to hazardous situations simply because these features are unknown. This has been proved in the past, as was pointed out in a paper by J. Benjamin of the Royal Aircraft Establishment, in military aviation where strategic necessity has led to radical change, sometimes with disastrous consequences.

Another important factor to be taken into account when considering change in civil aviation is that airborne equipment of the type we are considering requires large, very expensive, ground installations for support. Any change would mean that all the ground installations throughout the world would have to be replaced.



A possible solution to the problem of clearly presenting navigation information to the crew was suggested by J. G. Carr and F. S. Stringer and is shown above. The c.r.t. display shows the outputs of four navigation systems—two inertial navigators, Loran and Decca. The display graphically shows the positional information from the four equipments and shows how the outputs of three of the equipments differ from the one selected, which happens to be inertial navigator No. 2.

There is no question that a vast improvement must take place in the facilities available to civil aviation. However, this will be achieved by evolution and not revolution. Figures given by E. Davies, of Marconi, in a paper on surveillance radar showed that in the twelve months ended July 1968 the total aircraft movements (take offs or landings) at Heathrow, Gatwick, Luton and Stanstead was 400,000. During the same period another 700,000 movements were contributed by 26 other airports in the London area. The average movements for the period worked out at 125 per hour with peaks in the region of 250 movements per hour. According to P. G. Masefield, chairman of the British Airport Authority, the number of movements by 1980 will triple. This means 20 runways will have to run at a constant rate of 40 movements per hour.

To handle the necessary amount of traffic "all weather" operation will become essential and automatic landing will become routine even in extremely adverse weather conditions.

Civil aviation therefore has to find ways of handling all these aircraft in all sorts of weather. This will mean across-the-board improvements in airborne and ground installations with the lion's share of the problem on the heads of electronics engineers.

Automatic landing

The problem here is not one of accuracy, existing systems are perfectly adequate in this respect; it is not one of reliability, because reliability can be had at a price; it is the overall integrity of the system. Integrity is a word that was much bandied about at the conference. In this context it means that a system will operate correctly when required and that it will be known to be operating within its specified limits at any particular time and may therefore be trusted.

Consider a typical automatic landing installation. The well known, and established, instrument landing system (i.l.s.), operating in conjunction with heading information is responsible for bringing the aircraft in line with, and just over the threshold of, the runway. Being a radio system relying on radiated beams it is sensitive to interference and, on a number of airfields, it just cannot be installed because of the terrain.

In the later stages of the landing radio altimeters on board the aircraft play an important part. These can be sensitive to multi-path reflections and aircraft attitude.

The automatic pilot and automatic throttle used to carry out the landing contains tens of thousands of electronic components, scores of motors, servo systems, amplifiers, integrator and feedback loops. How can one be sure that this complex system is 100% serviceable? Is it sufficient to fit three of them and take the majority decision as being the right one? In this context the words fail-safe, fail-soft, fail-operative, fail-obvious, probability, comparator, monitor, duplex, triplex and duplicate monitored were repeated over and over again.

In most of the areas mentioned no real solutions to these problems exist as yet. In a paper by W. Hilton, of Sperry Gyroscope, a fail-obvious comparator for airborne systems was described which gave a warning if the monitored equipment or the comparator itself failed. With this system, if the comparator failed, the monitored equipment must also be considered to be unserviceable because the pilot, even if he knows that it is the comparator at fault, has no way of ensuring that the monitored equipment itself has not failed also. Even if the idea is extended indefinitely—a monitor to monitor the monitor, to monitor the monitor . . . there can still be no absolute certainty. The accepted thing is that the probability shall be that a system shall not fail more than once in 10^7 landings.

Will the designers have to take into account freak conditions? For instance an aircraft returning to an airfield at which a visual landing is impossible due to bad weather and when, for some reason, a diversion airfield is not available. In a case such as this a pilot would want to know the degree of unserviceability of his equipment in order to determine whether an automatic landing is a justifiable risk. Probably the only way of doing this would be to employ a large number of equipment measuring sensors controlled by a digital computer.

With the i.l.s. the picture is a brighter one. Some time ago the R.A.E. designed c.p.i.l.s. (correlation protected instrument landing system) which is now being developed and will be produced by the Plessey Company.

The system employs hyperbolic phase fields and correlation detection to generate guidance misalignment signals with inherent integrity and, with suitable choice of transmitter modulation, the system is compatible with existing v.h.f. instrument landing systems. The only additional airborne equipment consists of a microwave aerial and mixer unit which may be fed directly into the existing i.l.s. The idea therefore conforms to the rule of evolution rather than change, it provides the pilot with a choice of v.h.f. or microwave i.l.s., and overcomes many of the v.h.f. i.l.s. interference and site problems.

Air traffic control

The other area of great difficulty is in air traffic control. It is thought that large digital computers will be able to perform the necessary predictions and calculations for the safety of all aircraft in the controlled area. This will include handling emergency situations and taking into account the presence of military aircraft which, according to E. Davies, may suddenly change flight level at rates of up to 60,000 ft per minute.

The problem is in getting adequate information on all movements in the area so that the computers can be kept up to date on a rapidly changing situation.

In this field many improvements are required to radar systems. Airfield radar can be divided into two types; primary radar which is responsible for general surveillance and tracking, and secondary radar which consists of an airborne transponder that gives information on the aircraft carrying it when interrogated by a ground installation.

Primary radar needs to be of higher resolution to separate targets which are close together; higher scan rates must be achieved so that any new target may be quickly spotted; and dwell time on any particular target must be increased so that stationary clutter can be minimized and additional doppler information (velocity etc.) can be derived.

All these requirements are in obvious conflict and M. A. Radford, of Marconi, suggested that the solution may lie in the use of multiple receiver and electronic scanning techniques.

Secondary radar suffers from a variety of defects. One of these is difficulty in siting the aerial on the aircraft and even when two aerials are carried, contact is not certain due to the screening effect of the airframe. With present equipments the only information transmitted is aircraft identity and height.

Secondary radar however is rapidly increasing in importance and will eventually oust the primary radar from its premier position. C. Ullyatt, of R.R.E., says that primary radar will probably be used mainly to handle those aircraft which for some reason cannot take part in the secondary radar system, and for keeping track of airfield ground movements. Mr. Ullyatt gave a paper describing a new transponder which followed the law of evolution. Basically it consists of an auxiliary unit which can be fitted to, and addressed through, the existing transponder. The new equipment would be capable of transmitting a great deal of information and during an emergency could transmit the state of the aircraft systems to the ground.

Navigation

Extremely accurate navigation is essential to enable aircraft to operate in the fairly close proximity required if the number of movements predicted for the future is to be met. J. G. Carr and F. S. Stringer, of the R.A.E. (Mr. Stringer described hyperbolic navigation systems in our August issue), suggested at the conference that two or more current navigation aids could be operated under the direction of a management digital computer and explained how a Comet-4 was being modified to do research along these lines. In this system a highly accurate point position fixing aid is used with a long-term reference system so that the limitations of both are overcome.

Mr. Stringer suggested that the Kalman filtering technique could be used to great advantage now that digital computers of adequate capacity are available. Although such a technique is not liable to become economically attractive until storage becomes cheaper.

With the Kalman technique, a mathematical error model of each of the sensors is stored in the computer, the parameters of these models are adjusted throughout the flight every time a position comparison is made so that as time progresses the model becomes a closer approximation to the truth. The computer uses these stored values of error parameters to correct the navigation information to produce position data that is more accurate than any of the sensors could have achieved separately. In effect the navigation system is being continuously calibrated during the flight, and the longer the flight the more accurate the system becomes.

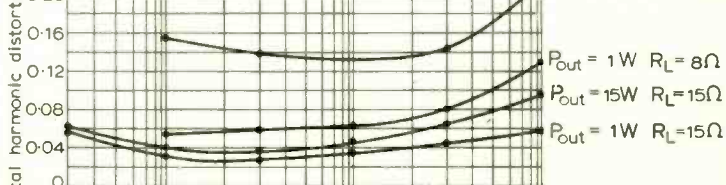
Civil aviation is rapidly approaching a point when far reaching decisions on electronic equipment for the next decade will have to be taken. We can only hope that the evolution of suitable equipment will not be overtaken by the demands on the airlines for more airborne seats.

Correction

"Low-cost 15W Amplifier" Oct. 1969.

The common emitter resistor R_6 in Fig. 1 should be $4.7k\Omega$ not $47k\Omega$.

Fig. 4, showing curves of t.h.d. against frequency for different powers and loads, was incorrectly annotated. The correct specifications are shown below.



Stuttgart Radio and TV show

Some highlights from the last German national exhibition

Good German citizens, and a good many non-Germans, flocked in their thousands to see the 26th German radio exhibition, the *Deutsche Funkausstellung*, which was held at Killesberg, just outside Stuttgart, from August 29th to September 7th. On the first three days, the Friday, Saturday and Sunday, 245,000 people attended the exhibition. Total attendance over the ten days that the exhibition was open was 703,000 which created an all-time record and exceeded all expectations.

Colour TV and hi-fi equipment were the principal attractions at the exhibition, coupled with a huge television studio, run by the first and second programme authorities A.R.D. and Z.D.F., which seated 1,400 people per performance. A clever idea here for people who could not get inside the studio was a travellator to convey them past the long observation window so that they all had a good view but were unable to loiter. High-quality speakers conveyed the sound to them.

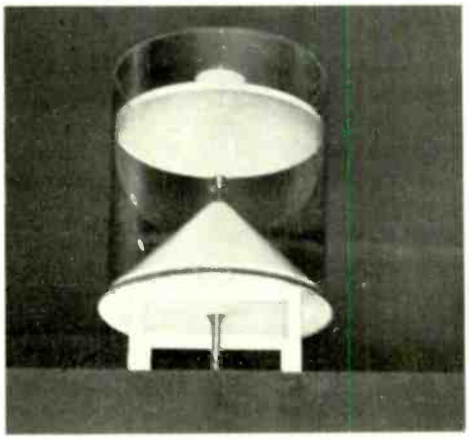
One of several large halls, in fact the major area of Hall No. 1, was occupied by various exhibits and demonstrations of the Bundespost, the German equivalent of our Post Office, who included among them an historical exhibit of television apparatus. There was the 30-line Nipkow mirror helix, an old 441-line receiver, and a 180-line or 441-line camera that was used during the Olympic Games in 1936, where Walter Bruch (now Prof. Dr. Bruch) inventor of the PAL colour system, was employed as a camera operator.

Probably the most significant exhibit, however, was the 12-GHz television broadcasting equipment, which was actually a working model, comprising transmitter, aerial, receiver dish and translator to Band IV and V channels. At present there are three television services available in Germany, and all the channels in Bands I, III, IV and V are apparently fully occupied by them.

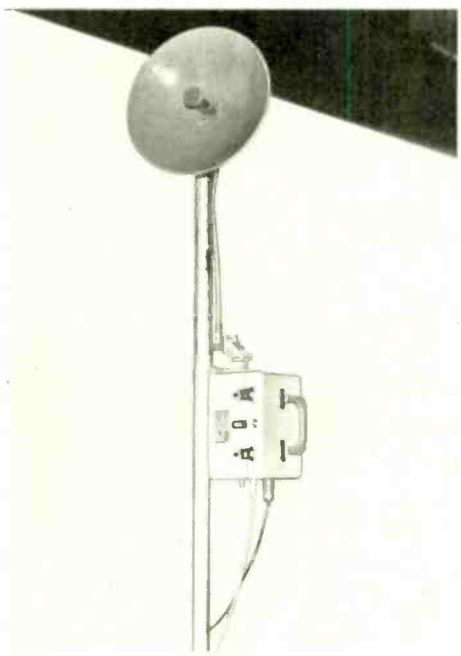
To make room for additional services, which will include an educational one, the Bundespost has been experimenting with still higher frequencies, around 12 GHz, actually between 2.5 and 2.7cm as was reported in *Wireless World* in July this year.

The exhibit showed the kind of equipment that would be used. The transmitter employs a conical aerial, with a reflector, which can be seen in the accompanying photograph, and has a circular radiation pattern in a horizontal plane. The reflector receives energy from a vertical horn projecting from the apex of the cone. Weather protection is provided by a transparent cover which encloses the whole aerial.

For reception a parabolic aerial is employed, as in the photograph, which is mounted on a mast together with a translator to convert the microwave frequency range to, say, u.h.f., so that it can be applied to a normal domestic receiver.



Transmitting aerial for the experimental television service on 12GHz.



Receiving paraboloid, with translator on the mast, for the 12GHz service.

In the experimental model shown the receiving aerial would cost about DM.200 (approximately £20), but the translator was estimated to cost about DM.8,000, which would render the system too expensive for any but the largest blocks of flats. It was expected, however, that by quantity production, using a quartz crystal controlled oscillator and a cavity resonator type of tuning system, the price could be reduced considerably. The system is envisaged for use only in the centre of a town which it could 'flood' with direct radiation. Its maximum radius of service is about 20km (about 12.5 miles).

Novel Car Aerial

One of the surprises among the commercial exhibits was a new type of car radio aerial called the Alpha 3 and shown by Hans Kolbe & Co. under their 'fuba' brand name (which they always spell with a small 'f'). It was designed by Hans Kolbe in conjunction with Professor Meinke, of the Institute for High Frequency Technique at Munich.

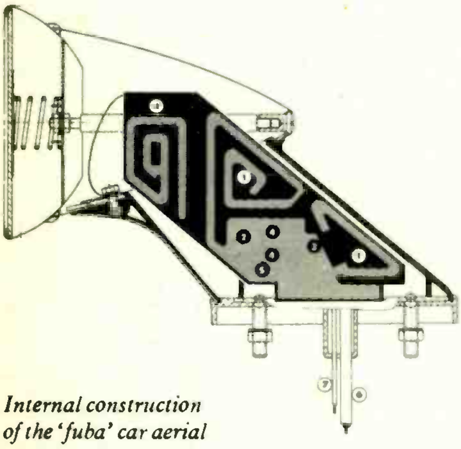
Incorporating a wing mirror, it is intended to be used as such. This alone is an asset today when vandals enjoy an orgy of snapping off telescopic aerials.

Inside the housing is a printed-circuit panel containing three aerial loops and two

Wing mirror car aerial introduced by Hans Kolbe.

transistor amplifiers, one for a.m. and the other for f.m. Even in car radios in Germany where there are some .000 v.h.f. stations it is necessary to make provision for f.m. reception, and this aerial system covers all a.m. broadcasting frequencies from 150kHz to 25MHz as well as the v.h.f./f.m. range in Band II.

The rim of the mirror forms part of the aerial pick-up system. It is made of rustless steel and is shaped to fit in its spring-loaded mounting as a ball joint, so that it can be adjusted in its application as a wing mirror.



Internal construction of the 'fuba' car aerial showing the printed circuit board.

Its internal construction can be seen from the accompanying illustration. The aerial loops, mirror rim and the electronic assembly form an integrated whole whose impedance matches the transistor input elements. The low impedance of the device helps to avoid interference pick-up. On v.h.f. the aerial loops form a bandpass circuit which rejects interference from transmissions outside the v.h.f. radio band, even though their field strength may be high. In the wideband a.m. coverage special design features are incorporated to prevent static interference and cross-modulation. The outputs of the two amplifiers are combined and matched to the coaxial cable. Also a protective diode is provided to by-pass static surges, which can wreck the input transistor in a car radio receiver.

Power supply to the amplifiers is taken via a separate lead from the car's electrical system, and the amplifiers will operate on 6V to 15V at 5-11mA.

The price of the Alpha 3 aerial in Germany is expected to be about DM.90 (say £9).

Cheaper V.T.Rs

Another surprise was the sudden appearance of video tape recorders by several manufacturers at the domestic-user level of about DM.2,000 (£200). Blaupunkt (a member of the Bosch Group and known in the U.K. as Blue Spot), Grundig, and Telefunken all showed prototypes, and Philips had two models, one (type LDL 1000) priced as low as DM.1,880.

Telefunken uses ½-inch tape on 18cm (about 7 inch) reels at 19cm/sec (about 7.5in/sec) giving a playing time of 60 minutes. It is said to be equally suitable for colour and monochrome recording, and the company hope with improved tape oxides to better the present 3MHz bandwidth.

Philips use ¼-inch tape, of which a length of 480 metres (a little under 1,600ft) will run for about ¾ hour. The instrument uses transistors throughout and operates from the mains. Of transportable proportions, it weighs 12kg (about 26½lb). Sound and synchronizing signals are carried on narrow edge bands.

Home Cine TV

Something more than a coincidence must have led NordMende to produce at the same exhibition as the series of domestic, or entertainment, video tape recorders their Colorvision equipment. This unit comprises a colour television receiver and an 8mm film scanner and reproduces the cine film on the screen of the TV receiver. The optics and film transport mechanism were developed in association with another company, Paillard S.A. (Bolex).

It is quite a domestic piece of equipment housed in a large console cabinet. The colour receiver occupies the left half of the cabinet and the film scanner, together with a separate tape cassette unit for the sound commentary, the right-hand half.

Advantages claimed for this method of reproducing cine film pictures are that it is silent in operation, does not require complete blacking-out of the room, provides the user with complete control through his TV receiver of such parameters as brightness, contrast and colour saturation, a still picture (it can hold one frame as long as required without any risk of overheating), it can be left ready for use in a living room without any need for elaborate setting-up procedure, and of course it provides the purchaser with a built-in 25-inch colour receiver.

The model on show was a prototype (but it was being demonstrated) and the price was not fixed, but it was believed it would be somewhere around DM.4,000 (about £400).

Full technical details are not available, but visible inspection showed that the film scanner employed a raster on the screen of a small oscilloscope and that the film passed through an optical lens system continuously, without a frame-by-frame gate. It is not clear, for instance, how the 18 picture-per-second sequence that they quote for the Super-8 film is synchronized with the picture frequency of the receiver; nor how the continuous film transport can be stopped to produce a still.

Philips domestic sound and vision recorder type LDL 1000.

From the film scanner the picture is broken up optically by dichroic mirrors into its red, green and blue components, which are then converted electrically into colour-difference signals prior to their application to the receiver. The sound commentary is quite independent, but it is incorporated in the same compartment as the film scanner.

All-embracing home entertainment

Another quite original idea shown by NordeMende was the Vario-Center, a fully comprehensive high-fidelity domestic sound and vision entertainment device in a severely contemporary but original styling. In appearance it resembled a large sphere with three slices cut off the sides to provide flat vertical surfaces, and a fourth slice off the top to present a flat horizontal surface.

On one of the vertical surfaces is mounted a NordeMende integrated stereo amplifier with a four-band a.m./f.m. tuner and control unit, with 30 + 30W continuous sine-wave output (model 8002/ST); on another surface is their model 8002/T4 tape recorder; and on the third the latest (hybrid) transistor 25-inch colour TV receiver. On the horizontal surface at the top is a Perpetuum Ebner PE2020 record player with a Shure M75MG cartridge.

Loudspeaker systems comprise two semi-spherical enclosures each with three bass, three middle and two tweeter units. They can each handle up to 50W.

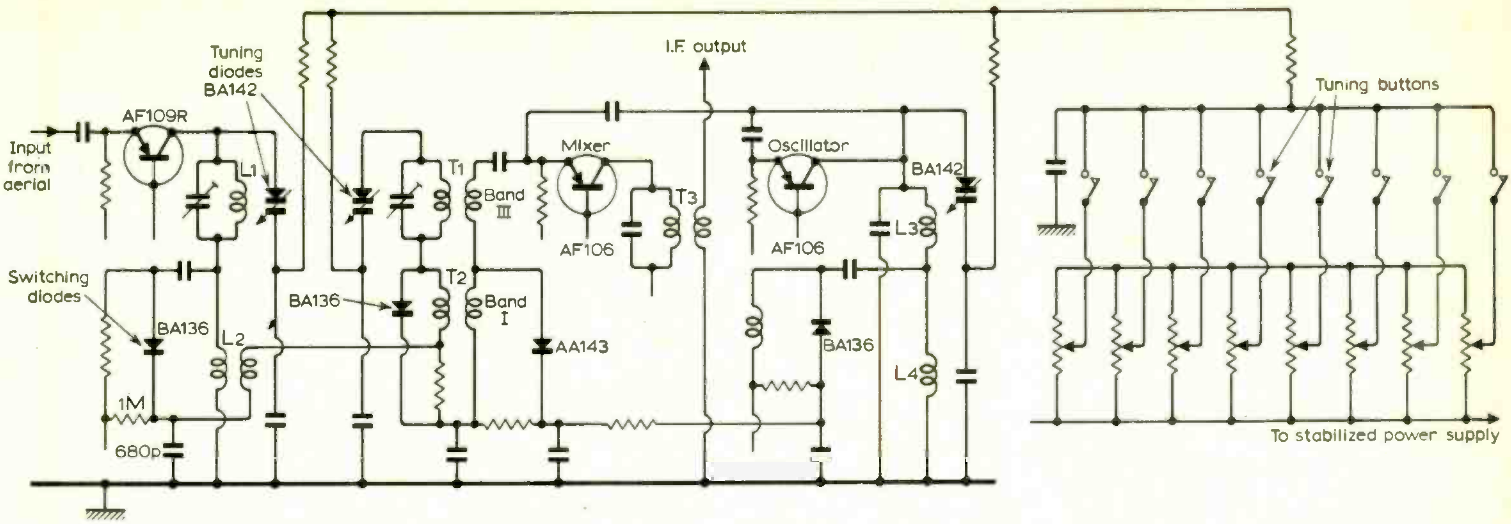
Electronic record players

Because the show was national, several importing companies held private shows in various parts of the town. One of these was held by Paillard-Bolex G.m.b.H., of Munich, who are distributors in Germany for the Swiss-made Thorens equipment.

They were showing an entirely new Thorens disc record playing deck (type TD125) with several interesting features. One feature is the shock-absorbent mounting for the turntable and pickup. Only the turntable and pickup, together with some electronic components are mounted on the chassis, and the whole chassis assembly weighs about 15lb. Its inertia, together with the springy suspension, enables quite violent vibrations to be absorbed.

The only link between the two, apart from the springy suspension, is the (10:1 ratio) drive belt, a soft slim rubber band which absorbs any vibration. No gears are employed, and there is no mechanical speed-change device. Driving power for the 16-pole

Thorens record player which features a shock-absorbent mounting for the turntable and pick-up.



Simplified diagram of the Blaupunkt v.h.f. television tuner using varicap diodes.

synchronous motor is derived from a 20W transistor amplifier driven from a Wien bridge oscillator, whose frequency determines the speed of the turntable in three steps for 16, 33 and 45 r.p.m. Rumble is claimed to be better than −68dB (DIN 45539 weighted standard).

For speed monitoring, stroboscopic markings for 50 and 60Hz mains on the underside of the turntable base are optically conducted to a window at which they can be compared with a neon lamp. A variable potentiometer provides ±2% correction. The deck can be operated from battery or mains.

Finally, a feature that can be seen in the Thorens photograph is a new style for switch knobs that was evident on quite a number of stands in the exhibition. This is the large flat type of knob seen in the foreground, which measures about 50 × 30 × 6 mm and looks like a bar of chocolate. The three seen here are slide-type controls for speed change, on/off and pickup raising and lowering.

In contrast to the entirely free suspension of the Thorens was that of Braun in their new PS 600 record player, which they cautiously state to be their first automatic player. This one lifts and lowers the pickup automatically, but it can also be adapted to change records. Its vibration-absorption is similarly effective, but to avoid the possibility of an oscillation being set up in the freely-floating system they have equipped it with critical hydraulic damping. Like the Thorens, too, this player has electronic control and electrical speed change.

Braun also introduced at the show a new type of loudspeaker cone which they call a 'Kalottenmembran'. Used as the middle-frequency unit in their 4-unit L 710 enclosure (two bass, one middle and one high-note) the new material permits a 'flatter' cone angle and thus provides a better 'spread' of sound in the upper frequencies.

Electronic TV tuning

Monochrome television was to be seen on every set-maker's stand, but colour was claiming the attention of both exhibitor and visitor. From the British observer's point of view the most interesting feature, both in colour and monochrome, was capacitance-diode tuning used by all but one manufacturer (Körting).

One of the great simplifications of the

Grundig all-band television tuner, with electronic tuning and band-switching, compared with a standard matchbox. It has no moving parts.

diode tuning technique is that once the circuits are set up and aligned, tuning of any number of stages can be effected by the adjustment of a single potentiometer. Press-button tuning is reduced practically to the need to switch a single low-voltage low-current d.c. line, each button being associated with its own potentiometer. As a result, remote control by a multi-way cable is simply an extension of the press-button unit on the set, and no motors are required.

Several manufacturers offered remote control, some by cable-less ultrasonic devices. Saba was actually demonstrating an ultrasonic remote control that changed programme and controlled colour saturation and volume. It was interesting to observe that all manufacturers included saturation adjustment on ther remote-control units, and some included contrast was well. These facilities of course require motors.

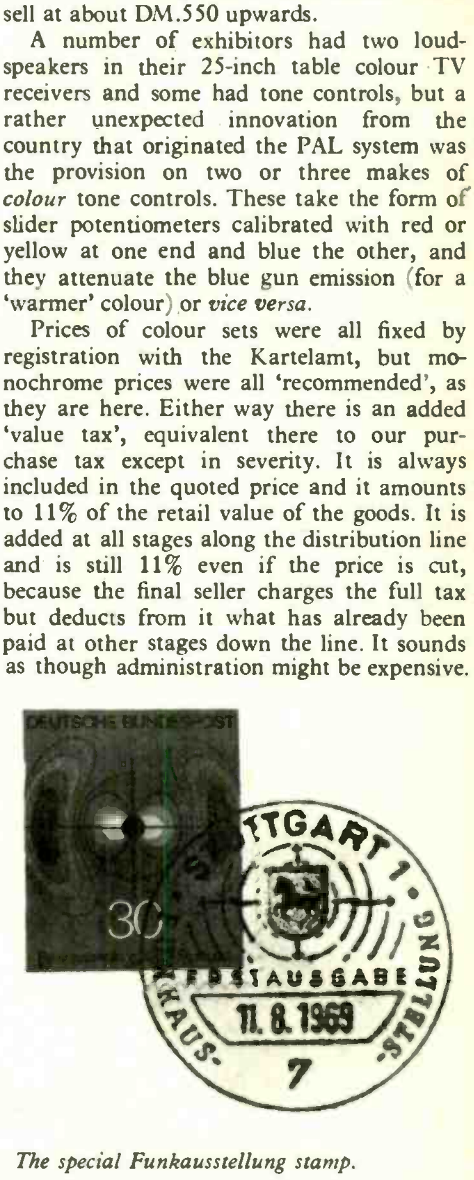
A simplified diagram of the Blaupunkt v.h.f. electronic tuner, shown in the accompanying drawing, which is representative of general practice in Germany. In addition to diode tuning it also incorporates diode band switching, and both tuning and band switching include the u.h.f. tuner, which is omitted from our simplified diagram.

Three circuits are tuned by BA142 diodes, as shown by the diode/capacitor symbols used in Germany to present a varicap diode. Band switching is effected by three BA136 diodes and an AA142 diode. On the right is shown the assembly of programme selector switches and potentiometers, of which there are usually six or seven, with a single lead between it and the tuner. Another lead would be necessary for band switching, of course, and that is controlled by an angular adjustment of the slider potentiometer shaft. Power supply for tuning is always derived from an integrated-circuit voltage-stabilizing circuit. Slide-type controls seem to have taken over from rotary knobs in most kinds of domestic equipment.

Prices in Germany for colour receivers range generally around DM.2,300 for a 25 inch table model, DM.2,000 for 22 inch and DM.1,700 for 19 inch. For monochrome 23 inch is the norm, and a table model would sell at about DM.550 upwards.

A number of exhibitors had two loudspeakers in their 25-inch table colour TV receivers and some had tone controls, but a rather unexpected innovation from the country that originated the PAL system was the provision on two or three makes of *colour* tone controls. These take the form of slider potentiometers calibrated with red or yellow at one end and blue the other, and they attenuate the blue gun emission (for a 'warmer' colour) or *vice versa*.

Prices of colour sets were all fixed by registration with the Kartelamt, but monochrome prices were all 'recommended', as they are here. Either way there is an added 'value tax', equivalent there to our purchase tax except in severity. It is always included in the quoted price and it amounts to 11% of the retail value of the goods. It is added at all stages along the distribution line and is still 11% even if the price is cut, because the final seller charges the full tax but deducts from it what has already been paid at other stages down the line. It sounds as though administration might be expensive.



The special Funkausstellung stamp.

News of the Month

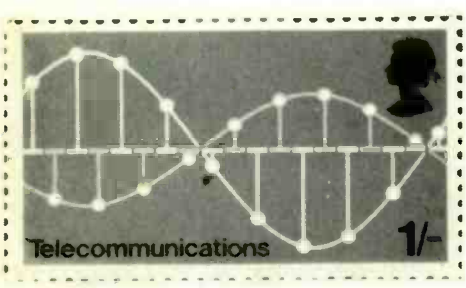
Register of engineers

The creation and administration of a composite register of "the engineering community" is foreshadowed by an announcement from the Council of Engineering Institutions. At a meeting of the Board on September 4th it was unanimously resolved that "the Council of Engineering Institutions will, in collaboration with other interested parties and subject to the agreement of the Privy Council, initiate the formation of an organization to create and administer a composite register covering the principal sections of the engineering community, currently chartered engineers, technician engineers, and engineering technicians".

A working party, consisting of one representative from each of the fourteen Institutions within C.E.I., which include the I.E.E. and I.E.R.E., under the chairmanship of Sir Arnold Lindley, has been set up to implement the resolution. The first duty of this working party will be to prepare a submission to the Privy Council to get agreement to such modifications to the C.E.I. Charter and By-Laws as may be necessary and then to determine which other interested parties should be invited to collaborate.

Aesthetics and electronics

The Marconi-Elliott Microelectronics factory at Witham, Essex, has won for the London architects Anthony B. Davies and Associates the gold medal award for industrial architecture made triennially by the Incorporated Association of Architects and Surveyors.



The sampling technique used in pulse code modulation, which was invented by Alec Reeves, of Standard Telecommunications Laboratories, Harlow, is symbolized on one of the four stamps issued to mark the establishment of the new Post Office Corporation.

Colour TV show

The colour television show organized by the B.B.C., I.T.A. and B.R.E.M.A. started its tour in Leicester on October 14th. The venues and dates for the exhibitions until the end of the year are: Stockport, Town Hall, Oct. 27-Nov. 1; London, Euston Station forecourt, Nov. 8-29; Birmingham, Mecca Ballroom, Dec. 5-10; Glasgow, McLellan Galleries, Dec. 16-20.

Incidentally, according to B.R.E.M.A., deliveries of colour receivers for August were 1,000 higher than for the same month of 1968 but the total of 60,000 for the first eight months of the year was 18,000 lower.

Technical design competition

Designers and technicians under the age of 35, who are still undergoing professional training or who have not worked professionally for more than two years, can take part in the competition for the Braun prize for technical design.

This competition which is to be held in 1970, is the second of its type. The first was held in 1968 when Germany and Japan won the major awards. The winning individuals or teams can receive up to DM 25,000 (=£2,500). To give some idea of the range of designs eligible, in 1968 122 projects were filed—from a cooking plate to a transportation system.

The competition is sponsored by Braun Aktiengesellschaft, 6242 Kronberg/Ts., Postfach 115 116, Germany, in co-operation with "Gestaltkreis" of the Federal Association of German Industries.

Airfield control radar

An X-band airfield control radar, called the ACR430, intended to meet the needs of small airfields has been introduced by Plessey Radar. The new equipment, which replaces the earlier ACR424 has a dual role in that it continuously radiates one beam for general purposes.

A single aerial reflector system fed by twin horns and dual transmitter/receivers provides the two-beam coverage. One horn illuminates the reflector to give a cosecant squared pattern for surveillance. The other horn partially illuminates the reflector producing a pencil beam with the accuracy required for surveillance radar approaches. Circular polarization is used to reduce the effects of precipitation clutter.

The output from a particular horn-transmitter/receiver combination can be switched to either or both displays which, together with the master control unit, can be up to 1,000 metres away from the aerial without the need for line amplification equipment. Two 300mm (12 inch) diameter displays provide selection of four range scales from 4 to 32 nautical miles.

European multi-role combat aircraft

A European company was set up, on the signing of an agreement in Munich recently, called Avionica Systems Engineering GmbH which will be responsible for planning the electronic systems for the European multi-role combat aircraft. The company will have its headquarters in Munich and will consist of members drawn from the following three companies: Elliott Automation and Advanced Military Systems Ltd [U.K.], Elektronik-Systems-Gesellschaft [West Germany], and FIAR-CGE and Selenia Industries Elettroniche Associate S.p.A. (Italy).

The new company will receive a contract for the electronic systems for the new aircraft from Panavia, which is also a consortium consisting of: the British Aircraft Corporation, Messerschmitt-Bolkow-Blohm and Fiat from the same three countries.

The Ferranti award

The British Computer Society has set up an annual award for the best candidate in its professional examinations.

The award, which is £150 donated by Ferranti, will be made by the council of the society on the recommendations of the chairman of the education board.

The first recipient of the award was Geoffrey Hollis who is a computer systems analyst with the Gulf Oil Company.

Solar flare early warning installation

A system of 24-hour forecasts of the best frequencies to use in the shortwave band has been worked out by Swedish Telecommunications Administration. This will make use of a telescope installed for this purpose on the roof of a building at Farsta outside Stockholm. The telescope will be used to register solar flares and provide an early warning of disturbance to radio communications.

Tape player for colour

Lasers and holographic techniques have been employed by R.C.A. to play back, through a colour television set, full-colour programmes recorded on very cheap transparent plastic tape. A laboratory model of the SelectaVision tape player system was recently unveiled in America and is expected to be on sale to the public in the early 1970s. The cost should be about $400 for the player and less than $10 for a half-hour recorded tape. The system is claimed to be as easy to operate as a record player.

"The engineer is a woman"

In an effort to encourage women to enter the engineering professions the Ministry of Technology has produced a film called "The Engineer is a Woman". In the film five women from mechanical, civil, electronic and electrical engineering, explain how and why they became engineers. The film is intended for 13- to 18-year-olds and can be obtained free of charge for non-theatrical use from: The Central Film Library, Bromyard Avenue, Acton, London W.3.

Semiconductor plant expanded

The Ferranti semiconductor assembly plant at Ormsgill, Barrow-in-Furness, is to be doubled in size to over 50,000 sq.ft. By about mid 1970 the plant will be capable of assembling more than 20 million semiconductor components per year from material processed at the "parent" plant at Gem Mill, Chadderton, Oldham.

Data book demise

After being well known to engineers for over 30 years the Mullard Data Handbook, which consisted of a large number of black loose leaf folders, is to be discontinued. In its place three multi-part books are being prepared which will list data in the same format as before, on Mullard's design range of components.

Book one (blue cover) of the new series will cover semiconductor devices and integrated circuits and will be divided into six parts. Book two (orange cover) will deal with valves and tubes and will have five parts. Book three (green cover) will be in three parts and will provide data on components and materials.

Users who took out new subscriptions to the original handbook service during or after May 1968 will receive equivalent replacements from the first set of the new publication free of charge.

The fourteen parts will cost 12s each and should be available between now and January 1970, depending on the part required. Every year each part will be up-dated and reprinted and will be available at the same price; 12s. Orders for the new handbook should be sent, with remittance, to Central Technical Services, Mullard House, Torrington Place, London W.C.1.

Operational Amplifiers—Pt. 10

We regret the omission from this issue of the concluding instalment of the series of articles on operational amplifiers by G. B. Clayton.

Mini-computer

A physically small computer, known as the 18C, is being developed by Arcturus Electronics Ltd, with the backing of the National Research Development Corporation. It uses medium scale i.cs and has a 16-bit word length. Parity checks are built in. Data can be manipulated between several registers without returning to the main memory. It has a multi-register configuration—two registers may be used as index registers. The memory may vary in size from 256 to 32,000 words. Production is to begin soon and the 18C will be available in a desk-top console on a seven-inch tall standard rack-mounted package. Both versions will hold up to 8,000 words of memory or interfaces for peripheral devices. It is expected that the selling price with 4,000 18-bit words of memory and a Teletype ASR33 will be under £4,000. A system with 256 words of memory could, in quantity, sell for under £2,000.

Portable radio receives weather broadcasts

Zenith Radio Corporation have produced an a.m./f.m. portable radio with all the usual facilities plus a pre-tuned channel of 162.55MHz. On this frequency there are almost continuous broadcasts in America giving information on local weather and water conditions, so the radio should be popular with all those who enjoy "messing about in boats". The price in the U.S.A. will be just under $ 50.

Satellite link for Indonesia

Indonesia's new communications satellite ground station will link the country with the U.S.A., Europe, Japan, Australia, Hong Kong, Singapore and Malaysia. The station is located in Djatiluhur, Java, approximately 100km from the capital and was built by the defence communications division of International Telephone and Telegraph Corporation. It is equipped to provide a variety of international communication Services—telephone, telegraph, facsimile, leased channel service, alternate voice-data and both colour and monochrome television.

I.E.E.-I.E.R.R.E. liaison

For some time there has been gradual drawing together of the I.E.E. and the I.E.R.E. and many joint meetings and conferences have been arranged. Now a joint liaison committee has been set up "To examine, and to report on, the advantages, disadvantages and problems of possible methods of combining the activities of the two institutions in a manner which would be in the best interests of the members of both institutions, and to make recommendations for the closer working together of the two institutions."

A panoramic view of the "largest semiconductor factory in Europe"; Mullards at Southampton. With almost 400,000sq.ft. of floor space and a staff of 3,000 Mullards are endeavouring to obtain a larger share of the world's semiconductor market. Dr. F. E. Jones, managing director of Mullard, has predicted that by 1980 the market for transistors will be 16,000M units and for integrated circuits 8,000M units, requiring over 1,000 tons of silicon a week. Mullard have other semiconductor plants at Stockport and Blackburn and are building another at Thornaby in Yorkshire which should start production at the end of the year and will eventually have a floor area of 200,000sq. ft.

Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

The B.B.C. should think again

Now I have heard everything! Twenty years after implementing the Copenhagen Wavelength Plan, nearly fifteen since v.h.f. broadcasting was begun, and just at the time when this service has reached the remotest parts of the Kingdom, the British Broadcasting Corporation is "prepared to consider" reallocating the medium-frequencies! Why? Where is the technical and economic sense in this?

Do the B.B.C's engineers really think that they can hoodwink the public at large into believing that by transmitting Radio 1 on two medium-frequencies to cover the country, all the interference problems will disappear overnight? This reallocation would end the daytime distortion caused by interaction between the ground-waves of adjacent transmitters using 1214kHz, but it will certainly do nothing to overcome the night-time fading and the ear-splitting beat interference from the Albanian station at Scutari. Neither is 908kHz going to be satisfactory with the East German Burg transmitter occupying this channel.

Radio 1 is supposed to be a national programme, so surely it should take its place alongside Radios 2, 3 and 4 *on v.h.f.* where the service coverage extends—potentially—to 99.7% of the population. If money is not available to establish a complete nationwide Radio 1 v.h.f. network, then I think that the B.B.C. should be required to give an undertaking that all the proposed local stations should carry it at least during the evening periods when the medium-frequency transmissions are subject to fading and foreign interference.

Again, why bother at this time to improve Radio 4 m.f. coverage when that achieved on v.h.f. will still be better by between one and two per cent of the population?

In proposing to reallocate and improve m.f. reception and thereby continue the side-by-side duplication of three programmes on two entirely different transmission systems, the B.B.C. is going to leave itself and we listeners in as big a muddle as ever. V.H.F. receiver sales will be retarded and a useful opportunity to work out with fellow E.B.U. Members a phased close-down of non-essential transmitters lost.

If the B.B.C. is still staffed by competent professional broadcasters and engineers, why do they not put forward a bold, imaginative *Plan* for the seventies rather than palliatives more suited to the fifties? This, sir, is a sincere plea to ask the B.B.C. to think again.

AUSTIN UDEN,
Aylesbury,
Bucks.

Logic Display Aid

During the building and testing of the *Wireless World* Logic Display Aid, which is an extremely useful and clever device for the laboratory, we have found a number of errors.

The first anomaly is on page 258 of the June issue and concerns component values in the dian circuit. Resistors $RV_{5\,(12)}$ and $RV_{7\,(14)}$ in the circuit are of 500 Ω but were found to be too low in value to reduce the current sufficiently to control the output voltage to the required level. Actual measured values in the boards built were $RV_{5\,(12)}$ 3.6k Ω and $RV_{7\,(14)}$ 1.56 Ω, but 10k Ω components were used as these were available at the time.

The multivibrator, IC6/B2 on page 311 July issue was found to run at about 12kHz with the capacitors of the shown value. Using 0.022μF raised the frequency to about 24kHz which was considered to be satisfactory.

An error is to be found on page 377 of the August issue, Fig. 62. Pin 5 of IC2 should go to pin 16 socket 7 and not 17 as shown.

When construction had reached board 8 it was found that in the assembly a ZN330E was fitted for IC4 as in the component list, but a ZN362E was needed. The component list states one too many ZN330Es and one too few

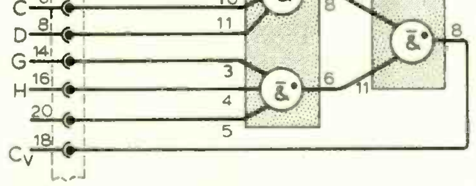


Fig. 1

ZN362E. The ZN330E was used in position 4 on board 8. The extra gate needed was found on board 8, IC5, the wiring of which is shown in Fig. 1.

Fig. 64 also has an error; pin 1 and pin 12 of IC3 should go to pin 8 of IC4.

On page 419, Fig. 66, pin 8/B2 should be relabelled pin 23/B2. The K signal comes from P9/B8 not P5/B6 and the T signal from P5/B8, not P9/B6.

A different arrangement for the video was employed as shown in Fig. 2. This provides bright-up pulses only when clock pulses and video are present, completely eliminating any

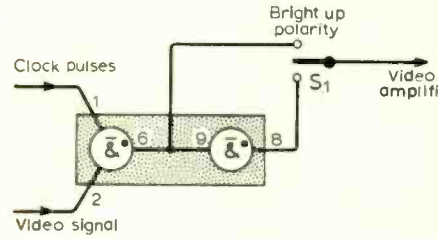


Fig. 2

fly back signals. The second gate was used as an inverter so providing positive or negative bright-up as this may be required for future use in the instrument built. Also a more sophisticated video amplifier was used, as a circuit board was salvaged from a project abandoned some time ago.

H. J. BACON,
Barking Regional College of Technology.

The author replies:

I am much indebted to Mr. Bacon for taking the trouble to note the errors in the article. This will make life easier for other constructors. His idea of providing a switch to select either positive or negative going bright-up pulses is a good one. Yet another way of obtaining satisfactory video blanking will be described in part 8 of the series of articles as the original blanking circuit did not perform very well with some oscilloscopes.

I would be very pleased to hear from others who have used the display aid for teaching as it would be useful to have an assessment of the instrument's value as a teaching aid and to hear of the students' reaction to it.

BRIAN CRANK.

F.M. receiver bandwidth

It is disappointing to find Mr. L. Ibbotson stating, in his otherwise informative contribution, that something like 180kHz i.f. bandwidth will provide 15kHz audio bandwidth when a maximum frequency deviation of 75kHz is employed (*W.W.* June 1969, "Test Your Knowledge", Q.9).

The i.f. bandwidth (for a single sinewave tone) is determined by the Bessel expansion of the equation for the modulated wave:

$$e = E\ \sin(\omega_c t - m \cos \omega_m t) \text{ i.e.}$$

$$e = E\ [\ J_0(m) \sin \omega_c t - J_1(m) \cos(\omega_c \pm \omega_m)t - J_2(m) \cos(\omega_c \pm 2\omega_m)t + \ldots \text{ etc. to infinity.}$$

$J_n(m)$ is the Bessel coefficient of the first kind, order n and argument m

$$\text{modulation index} = \frac{\text{deviation frequency}}{\text{modulating frequency}}$$

the standard convention is that the significant sidebands are all whose amplitude is greater than 1%.

In the case quoted, the mod. index = 75/15 = 5, and reference to a table of Bessel Functions will show that J_8 (5) is the last order of argument 5 which is greater than 1% (it is 1.841%, whereas J_9 (5) is 0.552%). Hence there are 8 pairs of significant sidebands.

The bandwidth = 2 × n × mod. freq., where n is the number of pairs of sidebands. With 8 pairs,

bandwidth = 2 × 8 × 15kHz = 240kHz.

From above it will be seen that if the i.f. bandwidth is only 180kHz, then mod. freq. =

$$\frac{180}{2 \times 8}\text{kHz} = 11.25\text{kHz}.$$

A listening comparison will quickly demonstrate the validity of the foregoing, the 'rule of thumb' sets really are disappointing. One such may be the 'F.M. Tuner Using Integrated Circuits' described in the same issue. If its bandwidth (3dB down) is in fact 160kHz, then it will have an audio bandwidth of only 10kHz.

L. E. WAUGH,
New Malden,
Surrey.

The author replies:

I agree with the result quoted by Mr. Waugh that if we wish to include all side frequencies with an amplitude greater than 1% of the unmodulated-carrier amplitude, then for a modulating frequency of 15kHz and a maximum deviation of 75kHz an i.f. bandwidth of 240kHz is required. I do not agree, however, that this is the standard convention. Some authorities, it is true, claim that all side frequencies with amplitudes greater than 2% of the unmodulated-carrier amplitude should be included—this would require the inclusion of 7 pairs of side frequencies and hence a bandwidth of 210kHz.

I do not agree that restricting the i.f. bandwidth to 180kHz will restrict the received audio bandwidth to 11.25kHz; f.m. does not work that way. If an audio signal with components up to 15kHz is radiated, then the same range of audio signal components will be received—together with an amount of nonlinear distortion products determined by the degree by which we restrict the i.f. bandwidth.

L. IBBOTSON.

Listener fatigue and ultrasonics

In an article in the April, 1969, issue Mr. Linsley Hood suggested that "listener fatigue" may be due to the ability of many transistor amplifiers to give large power outputs at supersonic (ultrasonic) frequencies which cause a response in modern high-quality speaker systems.

I have been carrying out experiments deliberately feeding "white noise" through a high-pass filter to Mr. Linsley Hood's class A amplifier which was coupled to a commercial three-speaker high-quality reproducing system. This arrangement was found to be capable of producing a vague feeling of discomfort over a period of some hours whether or not normal programme material was being handled.

Further experiments with specific ultrasonic frequencies indicated that, with my apparatus, the discomfort was noticeable only at fairly high power levels (3W or more), and at frequencies just out of audible range (20-25kHz).

Other evidence on this subject has been obtained from users of high-powered ultrasonic cleaning equipment, who report vague feelings of discomfort and a desire to move away when working in the vicinity of such apparatus.

Bearing in mind that, although normal programme material may not contain appreciable signals at ultrasonic frequencies, such unwanted signals can arise in equipment; there seems to be a strong argument for always using a steep-cut low-pass filter circuit with high-quality amplifiers.

The extra realism or "presence" sometimes claimed for apparatus having a response far beyond the sonic spectrum may in fact be a very mixed blessing.

NORMAN W. VALE,
Mickleover,
Derby.

Second-order active filter

I would like to correct various errors which crept into my note 'A Simple Second-Order Active Filter' (*Wireless World*, April 1969, p. 185).

The formula quoted was derived using a high gain infinite input impedance amplifier; it should have been

$$\frac{e_o}{e_i} = \frac{-1}{1 + \alpha s\tau + (s\tau)^2}$$

where $\tau = RC$ and the 3dB frequency is given by

$$w_c = \frac{1}{\tau}.$$

The degree of peaking is governed by choice of α, with critical damping (no peaking) for $\alpha = 2$. However, critical readers will have noticed that my values for

$$c_s \left(= \frac{\alpha c}{3}\right)$$

for the practical responses given, do not agree with the theoretical transfer function. This is due to the finite input impedance of the transistor pair. This does not detract from the utility of the circuit however. Better agreement would be obtained by reducing both R and R_c (33k) and increasing C.

JOHN FIRTH,
Ottawa,
Canada.

Operational amplifiers

Your August, 1969, issue includes Part 7 of the series of articles on operational amplifiers by G. B. Clayton which contains two points on which I would like to comment. The first concerns the circuit diagram under the heading 'Monostable Multivibrator (1)'. If this diagram is correct the circuit cannot work in the manner described by the author, for a negative pulse cannot be applied to terminal A from the input point labelled 'trigger'. If, on the other hand, diode D_2 is shown the wrong way round, the waveform labelled eA will have a positive level, in the stable state, whose value depends partially on the value of the unlabelled resistor adjacent to D_2 on the figure.

The other point worth a comment concerns the section 'Regenerative Comparator'. The author's illustration of a *rectangular* hysteresis loop illustrates a common situation in which the loop gain is high for all values of output p.d. e_o except those very close to the saturation values. But this is a particular case. Regenerative circuits such as these reach their threshold levels when the loop amplification reaches unity, and for small values of the feedback ratio β the switching points can occur at values of e_o that are considerably less than the saturation values. There is a further comment worth making in relation to this situation. If integrated circuit operational amplifiers are used as regenerative comparators with small hysteresis, as required in many applications, it will be found that the elimination of high frequency parasitic oscillations becomes a very difficult problem indeed. It may become necessary then to use two stages. The first stage is a non-regenerative comparator with the required degree of amplification obtained by negative feedback and the second stage is a regenerative comparator with ample hysteresis and well-defined threshold levels.

H. SUTCLIFFE,
Professor of Electronic Engineering,
University of Salford.

The author replies:

I would like to thank Professor Sutcliffe for his comments. The circuit diagram under 'Monostable Multivibrator (1)' is in error, the diode D_2 has been shown the wrong way round. The positive level of the waveform e_A shown in the text as $\beta V_o^+{}_{max}$ will, as Professor Sutcliffe points out, be partially dependent on the value of the unlabelled resistor, the effect is small however if as I had assumed (but neglected to state) the value of R_1 is considerably less than the value of the unmarked resistor.

Regarding his second comment, the use of low β and hence small hysteresis is, I would think, likely to give rise to parasitics at switching in any form of regenerative comparator, whether using i.c. op. amps or not. I would therefore consider the case discussed in the text as being the usable form of a regenerative comparator circuit although it is strictly a particular case. Professor Sutcliffe's comment will make readers aware of the difficulties of using small hysteresis with regenerative comparators.

G. B. CLAYTON.

More "Letters" are on p.535

Personalities

This year's I.E.E. Faraday Lecturer is **J. H. H. Merriman,** C.B., O.B.E., M.Sc., A.Inst.P., F.I.E.E., a director of the new Post Office board. Mr. Merriman, who is 54, and a physics graduate of the University of London, joined the Post Office Research Station, Dollis Hill, in 1936. Six years ago he became assistant engineer-in-chief of the Post Office, and in 1965 deputy engineer-in-chief. Two years later he was appointed to the new post of director of engineering and in August 1967 he became senior director: development. He was recently appointed member for technology of the board of the new Post Office Corporation. Last December Mr. Merriman accepted the invitation to become visiting professor in the department of electronic science and telecommunications at the University of Strathclyde, Glasgow.

John A. Saxton, D.Sc., Ph.D., the new chairman of the Electronics Division of the I.E.E., is director of the Radio & Space Research Station at Ditton Park, Slough, Bucks. Dr. Saxton, who is 55, was, until his appointment to the Research Station in 1965, director of the U.K. Scientific Mission in Washington, D.C., and scientific attaché at the British Embassy there. He was for a time on the staff of the college before joining the Radio Division of the National Physical Laboratory, and in March last year he accepted a visiting professorship in physics at University College, London.

Donald G. Fink, general manager of the Institute of Electrical and Electronics Engineers, New York, has received the Outstanding Civilian Service Award of the United States Army Electronics Command "For his outstanding and dedicated service since 1963 as a member, vice-chairman, and chairman of the United States Army Electronics Command Electronics Advisory Group, Fort Monmouth, New Jersey, which has materially assisted in the advancement of the systems concept in tactical communications and resulted in great benefits to the Electronics Command and the Army".

Sir Raymond Brown, O.B.E., Comp.I.E.R.E., has relinquished his appointment as Head of Defence Sales of Her Majesty's Government, which he had held for over three years, and has rejoined Racal Electronics Ltd as president. Sir Raymond, who, until his Government appointment, was chairman and managing director of the company of which he was co-founder, was knighted in this year's Birthday Honours. **E. T. Harrison** continues as chairman of the board and chief executive.

Bryan L. H. Wilson, M.A., A.M.Inst.P., has become chief scientist at the Allen Clark Research Centre of The Plessey Company, at Caswell, Northants, which he joined in 1953 and where he has been leader responsible for solid-state research since 1963. He is a graduate of Jesus College, Cambridge, where he took the natural sciences tripos. Much of Mr. Wilson's early work was concerned with the development of silicon integrated circuits. Subsequently, his activities have included the development of photocells and thermoelectric materials.

C. R. Knowles, M.A., is appointed chief engineer, and **S. Woodcock,** B.Sc., products manager responsible for selling and marketing in the components group of Ferranti's Electronic Display Department. The components group manufactures cathode-ray tubes (and associated coils), valves and photon devices. Mr. Knowles, who is 32, graduated in natural sciences from Jesus College, Cambridge. He joined Ferranti Ltd in 1961 as a development engineer in the cathode-ray tube laboratory. He became chief development engineer for valves in 1967 and was made assistant works manager in October of that year. Mr. Woodcock, after military service in the Far East, graduated from Leeds University in 1950 and joined Ferranti in 1951 as a member of the physical laboratory. He worked initially on the development of the aluminizing process for TV picture tubes and on phosphor screens, but later switched to work on industrial and radar tubes. Since 1966 he has been chief engineer, c.r.t. development.

Arthur I. Llewelyn, O.B.E., B.Sc., has been appointed director of the Ministry of Technology's Computer Aided Design Centre, Cambridge, which began operating earlier this year, and aims to develop the application of c.a.d. techniques in industry in co-operation with Cambridge University. Mr. Llewelyn, after studying at the University of Wales Engineering Department, Cardiff, joined Bawdsey Research Station at the outbreak of war where he was concerned with the early developments of radar, and later was responsible for early airborne pre-control and navigational-computing systems. In 1960 he took up an appointment with NATO as scientific adviser to the Allied Air Forces Central Europe. Mr. Llewelyn returned to the U.K. in 1965 and joined the Ministry of Technology and has latterly been head of the Computer Advisory Service.

This year's recipient of the David Sarnoff Gold Medal of the American Society of Motion Picture and Television Engineers is **Peter C. Goldmark,** B.S., Ph.D., president and director of research of C.B.S. Laboratories, Stamford. He started his professional career with Pye Radio in Cambridge, where in 1935 he was in charge of television engineering. Dr. Goldmark, who was born in Budapest, Hungary, received his doctorate in physics from the University of Vienna, and after service with Pye went to the United States and joined the Columbia Broadcasting System as chief engineer in 1936. In addition to his position in C.B.S. which he has held since 1954 Dr. Goldmark is a visiting professor in medical electronics in the Department of Radiology at the University of Pennsylvania Medical School.

W. Roy Thomas, F.I.E.E., aged 51, is appointed group technical executive of Plessey Electronics Group where he will be responsible for co-ordination of all research and development work for the research centres, at West Leigh and Roke Manor. Mr. Thomas had been with Elliott-Automation since 1952 where latterly he was group chief scientist, a director of Elliott Space & Weapon Automation Ltd and E A Radar Systems Ltd and chairman of Elliott Electronic Tubes Ltd. From 1939 to 1952 he was with the Royal Aircraft Establishment, Farnborough, where he was concerned with work which culminated in the design of the TRIDAC three dimensional missile-aircraft simulator. At Elliotts he was responsible for the development of FACE, the field artillery control system using the 920B computer. Latterly Mr. Thomas co-ordinated the activities of the six research laboratories of Elliott Automation concerned with advanced techniques in computers, avionics, radar, optoelectronics microcircuits and space. Mr. Thomas is chairman of the joint E.E.A./S.B.A.C. avionics research committee for guided weapons, space and electronics. He is also the U.K. representative on the organizing executive committee of EUROSAT.

Frank H. Taylor, F.I.E.E., has been appointed a senior principal research engineer at Standard Telecommunication Laboratories, Harlow, Essex, which he joins from S.T.C's Radio Products Group, New Southgate. Mr. Taylor had been technical manager and systems manager for the group's aviation and communications business.

P. J. Allin, B.Sc., A.M.I.E.E., aged 28, has joined Intercontinental Systems Inc. (UK) Ltd, of Woking, as terminal systems engineer. Mr. Allin obtained his degree in electronic engineering at the City University (formerly Northampton College) after which he spent six years at the Central Electricity Research Laboratories in Leatherhead. Since 1966 he has been with Cable and Wireless as an electronics designer.

R. O. K. Turvey, B.Sc.(Eng.), M.I.E.E. has been appointed general manager of Cole Electronics' manufacturing division (formerly known as C. A. Cook Ltd.) at Wickford, Essex. Mr. Turvey held previous appointments as chief engineer of the Transmission Division of A.E.I. Woolwich and as manager of the Terminal Equipment Department of Submarine Cables Ltd.

C. P. Crompton, M.I.E.R.E., who joined Orbit Controls Ltd, of Cheltenham, as a senior project engineer on its formation 18 months ago, has been appointed chief engineer. Mr. Crompton, who is 41, previously held senior engineering posts with Advance Controls Ltd., Racal Communications Ltd., and the Sperry Gyroscope Co.

The appointment of **Elvin F. Collins** as electronics production manager is announced by Solartron Electronic Group, Farnborough. He succeeds **Dennis Burton,** recently appointed director of production. Mr. Collins, aged 38, has been with Solartron for eleven years, latterly as product manager for digital instruments. Prior to joining Solartron he worked as a test gear engineer with the Ministry of Supply.

G. W. Mackenzie, M.I.E.R.E. has been appointed by the B.B.C. Head of Enginering, Northern Ireland. He joined the Corporation in 1941 at the Edinburgh studio centre. In 1954 he became a lecturer in the Engineering Training Department where, since 1963, he has been head of the technical operations section.

T. Aspin has been appointed technical manager of the Industrial Electronics Division of Mullard Ltd and becomes a director of Associ Semiconductor Manufacturers Ltd and of the Mullard Radio Valve Company Ltd. Mr. Aspin joined Mullard in 1946 and since 1966 has been general product manager of the company's Consumer Electronics Division.

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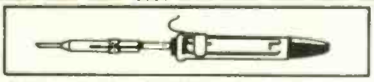

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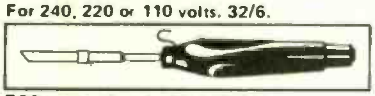

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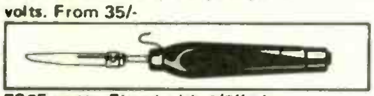

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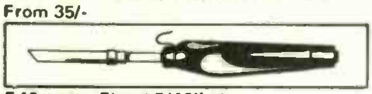

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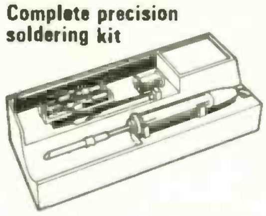

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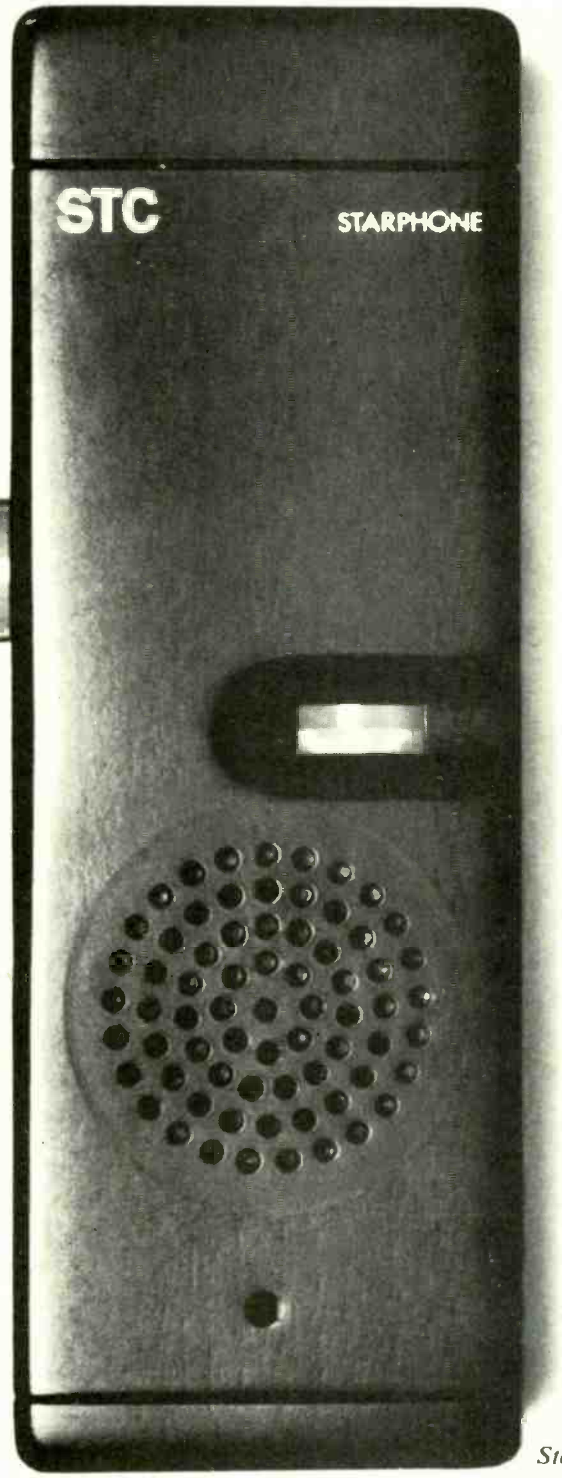

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Active Filters

4. Basic theory: Active circuits

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

:he essence of active-filter design is ·ealisation of 2nd-order response with ? factor > ½ without using both capacit- ance and inductance. Three simple -eedback loops are analysed: (1) two ags and negative gain, (2) a lag-lead -network with positive gain, (3) a -balanced parallel-T network and -negative gain; and the basic relation- ships between available gain and maxi- num Q are derived. An abstract discussion of sensitivity to variations -n amplifier gain and in passive com- -ponent values is also attempted.

:st-Order networks

-We have seen in Part 2 that the two 1st- ·rder transfer functions $1/(1 + pT)$ and $T/(1 + pT)$, can be realised with *CR* etworks; and it follows that any transfer .nction that can be reduced to a product of st-order factors can in principle be realised y a *CR* network (though buffer amplifiers nay be very helpful in a practical situation). -There is no active-filter problem.

-nd-Order networks

For a 2nd-order transfer function, for xample

$$1\Big/\left(1 + \frac{1}{q}pT + p^2T^2\right),$$

-he condition of $q = \frac{1}{2}$ marks a dividing line: when $q < \frac{1}{2}$ passive *CR* realisation is possible, but when $q > \frac{1}{2}$, not. (The condition $q < \frac{1}{2}$ is, of course, covered by the paragraph above, since then the transfer unction may be resolved into two real 1st-order factors.) The limitation can be emoved, however, by the use of gain and eedback.

For the basic system with 100% feedback shown in Fig. 1(a)

$$\frac{V_{out}}{V_{in}} = \frac{\mu}{1-\mu} \qquad (1)$$

If, therefore, as in Fig. 1(b),

$$\mu = \pm AF(p) = \pm AF_1(p)/F_2(p),$$

where $F_1(p)$ and $F_2(p)$ are the numerator and denominator respectively of $F(p)$,

$$\frac{V_{out}}{V_{in}} = \frac{(\pm A)F_1(p)}{F_2(p) - (\pm A)F_1(p)} \qquad (2)$$

The aperiodic gain constant is written $(\pm A)$ so that A may be a positive quantity whether the amplifier gain is positive or negative. In general this simplifies the labelling of diagrams and discussion of changes in the magnitude of A. In addition in the following analysis, to emphasise the difference and to avoid confusion when making comparisons, A is used when the gain factor is negative and K when it is positive. Three circuit configurations will be analysed:

1. A two-lag network and negative gain,
2. A lag-lead (1st-order band-pass) network and positive gain,
3. A balanced parallel-T network and negative gain.

*Royal Radar Establishment

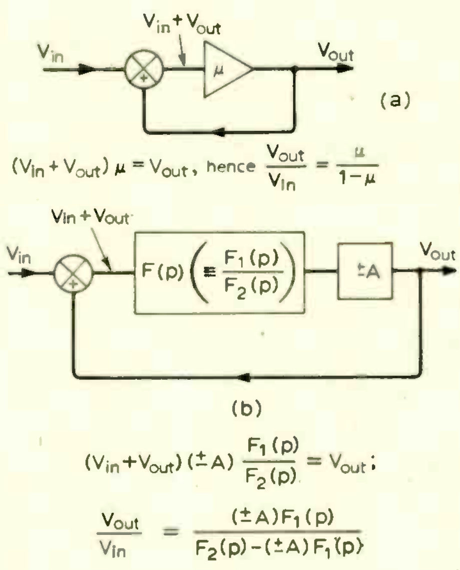


Fig. 1(a). Schematic of active feedback system; (b) the same in which μ is arbitrarily divided into a frequency-dependent factor and an aperiodic factor.

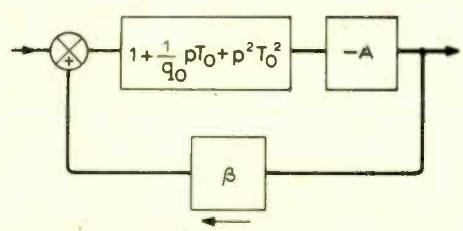


Fig. 2. A basic method of increasing Q factor.

Two lags and negative gain

The transfer function of a two-lag network may conveniently be written as shown in Fig. 2, so that q_0 and T_0 are the initial values of q and T for the system; i.e., the values before feedback is applied. By setting $\beta = 1$ the system becomes of the same form as Fig. 1, and by substituting in equn. (2)

$$F_1(p) = 1,\ F_2(p) = 1 + \frac{1}{q}pT_0 + p^2T_0^2,$$

the loop-closed transfer function is obtained as

$$\frac{V_{out}}{V_{in}} = -\frac{A}{1 + \frac{1}{q}pT_0 + p^2T_0^2 + A}$$

$$= -\frac{A}{A+1} \times \frac{1}{1 + \frac{pT_0}{q_0(A+1)} + \frac{p^2T_0^2}{A+1}} \qquad (3)$$

Comparison with the standard form for a 2nd-order denominator, $1 + pT/q + p^2T^2$, then gives

$$T = T_0/(A+1)^{\frac{1}{2}} \qquad (4)$$

and

$$q = q_0(A+1)^{\frac{1}{2}}. \qquad (5)$$

Thus, remembering that the nominal cut-off or undamped resonant frequency $\omega_c = 1/T$, we find that the application of feedback multiplies both ω_c and q by $(A+1)^{\frac{1}{2}}$. The effect is shown in Fig. 3, although these curves are drawn for the situation where A is constant and the varying parameter is the feedback fraction β. By substituting $1/pT$ for pT, or otherwise, the corresponding results for a loop containing two leads are found to be that q is multiplied and ω_c is divided by $(A+1)^{\frac{1}{2}}$.

Generally the dependence of cut-off frequency on amplifier gain is undesirable in a practical circuit. But there are ways of reducing it to a second-order effect, for example by combining the amplifier and one of the lags into a feedback integrator; and the relation between q and loop gain, equn. (5), still applies.

When

$$A \gg 1,\ q = q_0A^{\frac{1}{2}} \text{ approx.}, \qquad (6)$$

from which the sensitivity of q to small changes in zero-frequency gain, A, is obtained as

$$\frac{\Delta q}{q} = \frac{1}{2}\cdot\frac{\Delta A}{A}. \qquad (7)$$

This is a satisfactory result to the extent that there is no magnification of errors, and one would expect that in a practical circuit A would be stabilized by using an amplifier of much higher gain, say A_0, reduced to the required gain A by negative feedback—

$$A = \frac{A_0}{1 + A_0\beta}, \qquad (8)$$

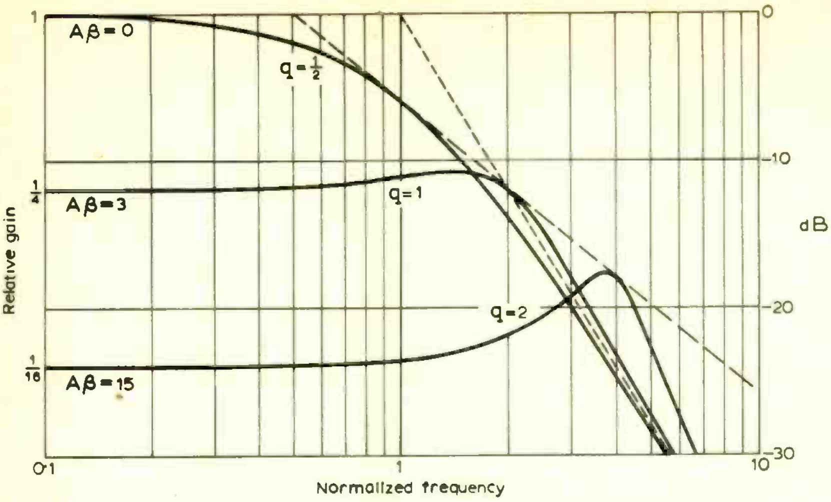


Fig. 3. Showing the effect of negative gain and feedback on a two-lag network. A is constant, β varies.

Black's formula, which may be rearranged to

$$\frac{1}{A}=\frac{1}{A_0}+\beta. \qquad (9)$$

Thence, by differentiation, if β is constant

$$\frac{\Delta A}{A}=\frac{\Delta A_0}{A_0}\cdot\frac{A}{A_0}, \qquad (10)$$

which is the well-known result for a negative-feedback system, viz. relative changes in closed-loop gain are proportional to relative changes in open-loop gain multiplied by the ratio closed-loop gain to open-loop gain (i.e., the ratio of required gain to available gain). Thus, in principle, by making A_0/A large enough the dependence of A on A_0 can be reduced as much as may be desired. It is to be expected, however, that in practice when $A_0/A \to \infty$ it will be found that A is affected by changes in β, and that equn. (7) becomes effectively

$$\frac{\Delta q}{q}=-\frac{1}{2}\cdot\frac{\Delta\beta}{\beta} \qquad (11)$$

This result also is satisfactory, as it again shows that the circuit does not exaggerate changes in component values.

Because for a passive *CR* network $q_0 \not> \frac{1}{2}$, and often because of practical constraints is considerably $< \frac{1}{2}$, equn. (5) shows that even for a moderate value of q (say $q = 5$) a quite high minimum value of A is needed. Consequently in a "designable" circuit, where a higher intrinsic gain will be used than the minimum needed, the gain used may be of the order 1,000 or more. This may seem a high price to pay. Nevertheless the two-lag loop (if the high-pass equivalent is included) is the basis of all the preferred methods of realising active filters—because of the low sensitivity to errors in component values. This low sensitivity derives from the fact that if A is a real number; i.e., shows no appreciable phase shift over the band of frequencies for which the magnitude of the loop gain is $\geqslant 1$, the system is essentially stable no matter what variations there may be in gain or in component values. This is made clear by the Nyquist plot for the ideal loop. Each lag contributes a maximum phase shift of 90°, and together they give a cardioid-shaped curve as shown in Fig. 4. The curve does not cross the horizontal axis, the limiting phase shift being 180°, and so can never encircle the point 1, j0.

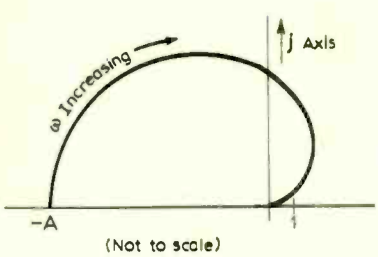


Fig. 4. Nyquist plot for feedback loop with two lags and negative gain.

The results of this analysis of the two-lag loop are summarized in the block diagrams of Fig. 5, which can be useful as the starting point for some practical designs, particularly of bandpass filters using the low-pass to bandpass transformation rules.

Equns. (4) and (5) give the initial value T_0 that must be chosen to give a closed-loop value T as

$$T_0 = qT/q_0, \qquad (12)$$

and the value of gain, A, required to raise q_0 to q as

$$A = (q/q_0)^2 - 1. \qquad (13)$$

These results are incorporated in Fig. 5(a). When the passive network can be represented as two equal isolated lags, Fig. 5(b), $q_0 = \frac{1}{2}$, and $q/q_0 = 2q$. Consequently $T_0 = 2qT$, and $A = 4q^2 - 1$. Where there are two unequal lags, they may be multiplied together and treated as case (a). Since q_0 will be $< \frac{1}{2}$, A will be greater than for case (b).

The discussion of two simple lags and gain may appear to be an out-of-date approach when it is already known that many practical circuits are going to be built around high-gain operational amplifiers used as integrators. But loop gain is of such fundamental importance to the design of an active filter, that it is always necessary at least to know that enough has been provided to satisfy a given specification. A high-gain integrator is easily shown to be equivalent to a lag and gain, and the results of this section will be found to provide a unified basis for the analysis of a wide range of problems.

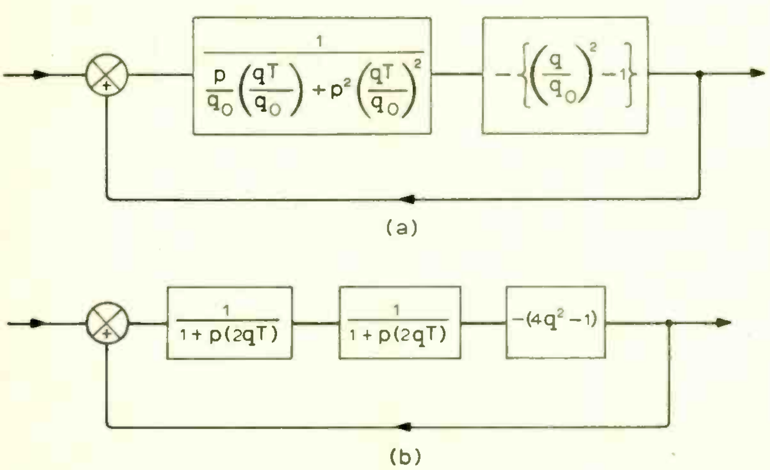


Fig. 5. Block diagrams for synthesis of feedback loops containing two lags, or their analogue (two leads, or two "tuned circuits").

A lag-lead network, or network with "tuned-circuit" response

The transfer function for tuned-circuit response, with centre frequency $\omega_0 = 1/T$, Q factor q_0, and normalized to unity gain at the centre frequency is

$$\frac{\frac{1}{q_0}pT}{1+\frac{1}{q_0}pT+p^2T^2}$$

Except that the gain at the centre frequency is always less than unity, the transfer function of a passive *CR* lag-lead network is of the same form and may be represented as in Fig. 6, $k < 1$. (See Part 3, equn. (23) and Table 1.)

Substitution in equn. (2) gives for the transfer function with the feedback loop closed:

$$\frac{V_{out}}{V_{in}}=\frac{\frac{kK}{q_0}pT}{1+\frac{1}{q_0}pT+p^2T^2-\frac{kK}{q_0}pT}$$

$$=\frac{\frac{kK}{q_0}pT}{1+\frac{1-kK}{q_0}pT+p^2T^2} \qquad (14)$$

This shows that the feedback leaves the centre or resonant frequency unaltered (which was to be expected from consideration of symmetry), and increases the Q factor [if $0 < kK < 1$], since now

$$q = q_0/(1 - kK). \qquad (15)$$

Clearly as $kK \to 1$ the increase in q becomes very great, and when $kK > 1$ the Q factor becomes negative and the circuit will oscillate. The system is, in fact, equivalent to the familiar application of "reaction" to a tuned circuit in a simple radio receiver. As a method of increasing Q factor, and gain at the centre frequency, the system is very effective, but likely to be tricky unless means can be found to stabilize the performance.

The sensitivity to small relative changes in loop gain is easily derived from equn. (15) by differentiation and substitution as

$$\frac{\Delta q}{q} = \frac{\Delta(kK)}{kK}\left(\frac{q}{q_0} - 1\right). \qquad (16)$$

When $q \gg q_0$ relative changes in loop gain are exaggerated by the factor q/q_0 approximately, and this is a useful warning if q_0 and k may be taken as constant and K is the factor most susceptible to uncontrolled changes.

The same conclusion can be deduced from the Nyquist plot, which, as shown in Fig. 7, is a circle passing through the origin, the diameter OD representing kK the loop gain at the centre frequency. When $q/q_0 \gg 1$, OD $\to 1$, since as equn. (15) tells us, $q/q_0 = 1/(1 - \text{OD})$. Small changes in OD then give much greater relative changes in the gain margin $(1 - \text{OD})$ and consequently large changes in performance over a band of frequencies corresponding to a section of the plot centred on the point D; i.e., at and around ω_0.

However, when a gain factor critically affects performance, the factor and consequently the performance may (and should) be stabilized by feedback, as is well known (see equns. (8), (9), et sequ.). Then $K \to 1/\beta$ very nearly, and β is typically determined by two resistors as shown in Fig. 8, so that

$$K = 1/\beta = (r_1 + r_2)/r_1, \qquad (17)$$

and the sensitivity of K to changes in r_1 and r_2 is given by

$$\frac{\Delta K}{K} = -\frac{\Delta r_1}{r_1}\left(1 - \frac{1}{K}\right) \qquad (18)$$

and a similar expression (without the prefixed minus sign) for $\Delta r_2/r_2$.

When $K \gg 1$ changes in r_1 and r_2 cause proportional changes in K, and so, because of the magnification of errors in K shown by equn. (16) for $q \gg q_0$, working in this region necessitates holding $(r_1 + r_2)/r_1$ to a much tighter tolerance than the required tolerance on q. Even when $K = 2$, $(r_2 = r_1)$, changes in either resistance cause changes in K which are relatively only half as great. Admittedly accurate and stable resistors are not difficult to come by, but as a general principle it is preferable to avoid this region. When $K \to 1$, $(r_2 \ll r_1)$, the sensitivity of K to changes in r_1 and r_2 becomes very small; and of great interest is the limiting condition when 100% negative feedback is applied, then $\beta = 1$, r_2 disappears, and $K = A_0/(A_0 + 1)$, thus $K \to 1$ as $A_0 \to \infty$ and does not depend on the accuracy of any component. Performance is still affected by k and q_0, and as these are in general mutually dependent, the system will now be analysed explicitly as a loop containing a lead-lag network.

If the frequency-dependent network can be represented by the lead-lag transfer function

$$\frac{pT_2}{1 + pT_2}\cdot\frac{1}{1 + pT_1} = \frac{pT_2}{1 + p(T_1 + T_2) + p^2T_1T_2}$$

$$k = \frac{T_2}{T_1 + T_2}, \text{ and } q_0 = \frac{\sqrt{T_1T_2}}{T_1 + T_2} \qquad (21), (22)$$

Hence, substituting in equn. (15), we find

$$q = \frac{\sqrt{T_1T_2}}{T_2(1 - K) + T_1} \qquad (23)$$

$$= \frac{1}{x(1 - K) + \dfrac{1}{x}}\left[\text{where } x = \sqrt{\frac{T_2}{T_1}}\right]. \qquad (24)$$

When $K < 1$, this expression is of a familiar form and gives

$$q_{max} = \frac{1}{2\sqrt{1 - K}} \qquad (25)$$

when the ratio of time constants

$$x^2 = \frac{1}{1 - K} \qquad (26)$$

Thus when $K = \frac{3}{4}$, $q_{max} = 1$; $K = \frac{15}{16}$, $q_{max} = 2$; $K = \frac{63}{64}$, $q_{max} = 4$; etc. This behaviour is shown in the lower and right-hand half of Fig. 9.

When $K = 1$, there is no maximum and

$$q = x = \sqrt{\frac{T_2}{T_1}} \qquad (27)$$

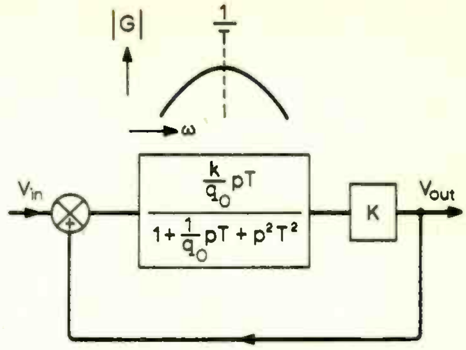


Fig. 6. Positive gain and a network with "tuned-circuit" response, given by equn. (14).

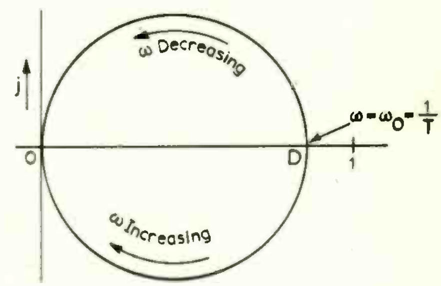


Fig. 7. Nyquist plot for positive-feedback loop containing lead-lag network.

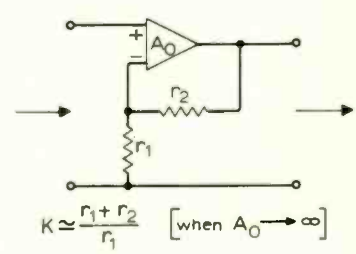


Fig. 8. Positive-gain amplifier with gain stabilized by feedback.

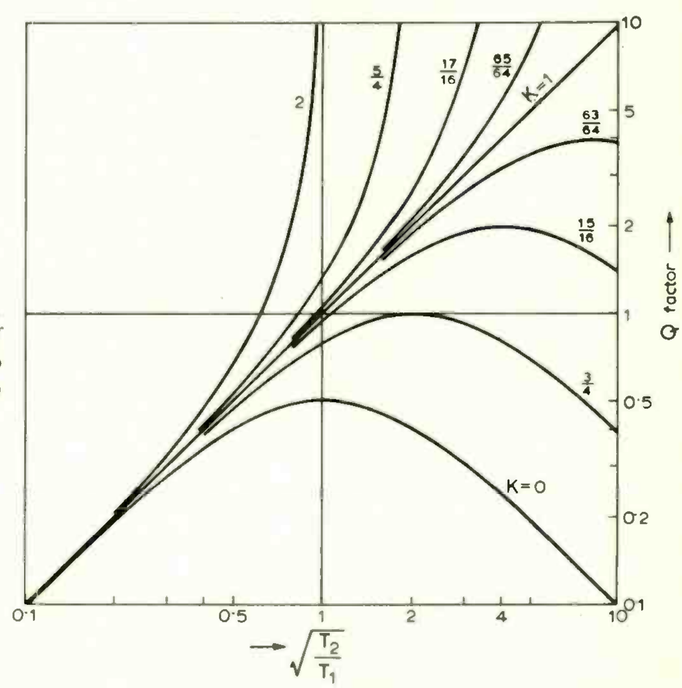


Fig. 9. Illustrating equn. (25). Shows the effect of the gain K and the ratio T_2/T_1 on a lead-lag loop with positive gain.

As already mentioned we can make $A \rightarrow 1$ very closely by applying 100% negative feedback to a high-gain amplifier, as for example by the emitter-follower connection. Provided that the Q factor aimed at is not too close to q_{max}, as given by equn. (25), performance depends almost only on the ratio of the two time constants. The information about q_{max} contained in equn. (25) is perhaps easier to interpret if we substitute $A_0/(A_0 + 1)$ for K [where A_0 = internal gain]. The equation then becomes

$$q_{max} = \tfrac{1}{2}\sqrt{(A_0 + 1)}. \qquad (28)$$

This result is the same as that deduced for two lags and negative gain, equn. (5), when $q_0 = \frac{1}{2}$ (the maximum possible value), and $A = A_0$ (the full internal gain of the amplifier); and the identity demonstrates that in circuits which do not exaggerate the effect of component tolerances as q is raised there is no substitute for amplifier gain.

When

$$K > 1, q = \infty \text{ when } x^2 = 1/(K-1). \qquad (29)$$

This is shown by the curves in the upper and left-hand part of Fig. 9. By choosing K correctly high Q factors can be obtained with any value of T_2/T_1. But in general in this region, except close to the diagonal representing $K = 1$, it can be seen from the shape and spacing of the curves that high values of Q factor are obtained at the expense of high sensitivity to both K and the ratio T_2/T_1; i.e., the familiar disadvantages of positive feedback appear.

Active filters using a balanced parallel-tee network

It has been shown in Part 3 that the parallel-tee network consist of a low-pass network and a high-pass network connected in parallel; and also that if the input voltage is introduced at the foot of the tees band-pass response is obtained and the network may be analysed as a lag-lead network and a lead-lag network in parallel. The existence of these parallel paths gives the parallel-tee network some special properties which can be useful. But, in general, filter circuits using the parallel-tee network contain, from one point of view, redundant components; i.e., they contain more components than the minimum necessary to obtain the specified order of response. Synthesis and analysis depend on the assumption that the six components of the network are accurately matched. Such circuits therefore fall outside the main theme of this series. They do, however, show a very modest gain requirement for a given Q factor compared with the two-lag loop. It is of interest, therefore, to derive the relation between q and available loop gain for the feedback system shown in Fig. 10(a). The notion behind the setting up of such a system is, of course, that as feedback is increased the response at high and low frequency is depressed and the -3/dB points move closer together.

The effect is shown in Fig. 10(b), which is drawn for the situation where A is constant and the feedback fraction β is the parameter which is varied. The figure has been drawn for $q_0 = \frac{1}{2}$, the greatest value that can be obtained from a passive CR network: in practice q_0 is likely to have a lower value, say $\frac{1}{4}$ (see Part 3).

By setting $\beta = 1$, so that the zero-frequency loop gain is simply $= -A$, and substituting in equn. (2), we find

$$\frac{V_{out}}{V_{in}} = \frac{-A(1 + p^2T^2)}{1 + \dfrac{1}{q_0}pT + p^2T^2 + A(1 + p^2T)^2}$$

$$= -\frac{A}{A+1} \times \frac{1 + p^2T^2}{1 + \dfrac{1}{q_0(A+1)}pT + p^2T^2}, \qquad (30)$$

which shows that

$$q = q_0(A + 1) \qquad (31)$$

or

$$q \simeq q_0 A, \text{ when } A \gg 1. \qquad (32)$$

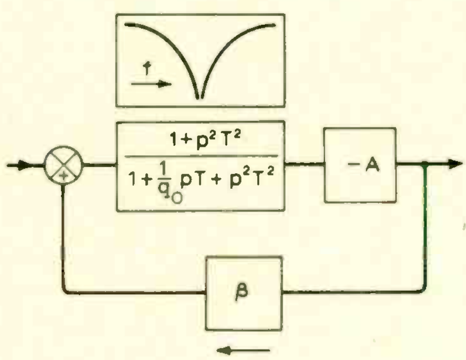
Thus $q/q_0 \propto A$, and consequently for $q/q_0 \gg 1$ a much smaller value of A is required than in a two-lag loop (where $q/q_0 \propto A^{\frac{1}{2}}$).

The linear relationship between q and A gives

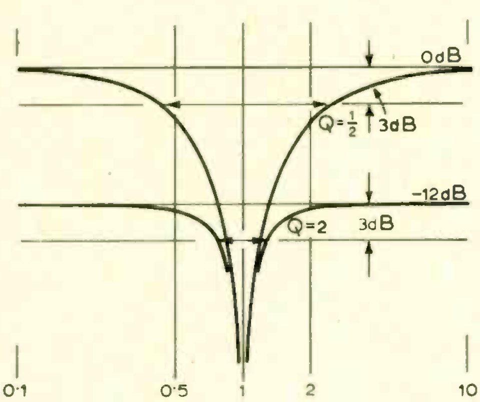
$$\frac{\Delta q}{q} = \frac{\Delta A}{A} \qquad (33)$$

or

$$\frac{\Delta q}{q} = \frac{\Delta q_0}{A_0} \cdot \frac{A}{A_0} \qquad (34)$$



(a)



(b)

Fig. 10. (a) Feedback loop containing parallel-T network. (b) Shows increases in Q factor by application of feedback.

when A is obtained from an amplifier of high gain, A_0, to which additional negative feedback is applied.

It can hardly be emphasized too strongly, however, that performance is sensitive to unbalance in the parallel-T network, and that consequently errors in component values can easily invalidate the results derived above.

Loop gain and through gain

It is the nature of the closed feedback loop that determines the inherent characteristics of the resulting resonant circuit, viz. the undamped resonant frequency and the Q factor, which manifest themselves in the denominator of transfer functions of the type $F(p) = V_{out}/V_{in}$. It is, of course, often possible to enter or leave the circuit in several ways, and this gives a choice of numerator functions. But provided all voltage sources are of effectively zero internal impedance so that they do not alter the impedances of the branches into which they are introduced, and that all output voltages are observed without adding any appreciable shunt admittance,* the denominator of $F(p)$ is invariant, being a reflection of the natural motion of the circuit (i.e., of the way in which transients decay).

In simple cases the nature of the transfer functions obtained from the various possible connections can often be predicted from inspection of the circuit. Thus, for example, in Fig. 11(a) for an input V_1 there is a two-lag network between input and output, and the response is low-pass. For an input

*There are parallel arguments for current sources and current outputs.

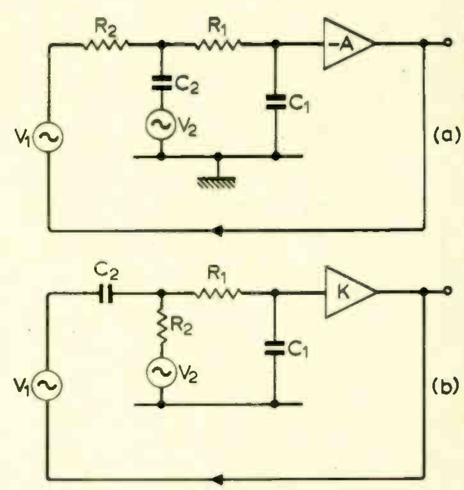


Fig. 11. Showing how a change in the position of the input can convert a low-pass filter to band-pass and vice versa.

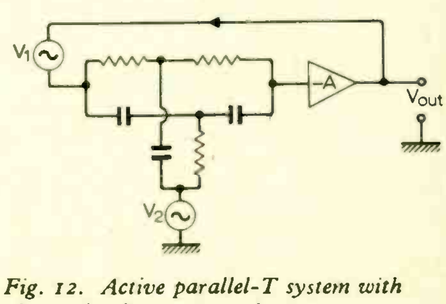


Fig. 12. Active parallel-T system with alternative input connections.

V_2 there is a lead-lag network between input and output, and the response is simple band-pass (or "tuned-circuit"), with (of necessity) T ($= 1/\omega_c$) and q the same as for the response to V_1. Similarly in Fig. 11(b) for an input V_1 there is a lead-lag network between input and output, and the response is simple band-pass: for an input V_2 there is a two-lag network between input and output, and the response is low-pass. These properties are not peculiar to active networks, and examples of the multiple responses that can be obtained from a passive network have been given in Part 3.

For each circuit, if one transfer function is known, simple reasoning will lead to the others. Thus we already know that for Fig. 10(a) the transfer function for an input V_1 is, using equn. (3), and in Part 3 equn. (3) and Table 1

$$\frac{V_{out}}{V_1} = -\frac{A}{A+1}\cdot\frac{1}{1+pT/q+p^2T^2} \quad (35)$$

where

$$T = \sqrt{\frac{C_1C_2R_1R_2}{A+1}},$$

$$q = \frac{\sqrt{(A+1)(C_1C_2R_1R_2)}}{C_1R_1 + C_1R_2 + C_2R_2};$$

and we can derive the transfer function for V_2 from this equation by finding a relation between V_1 and V_2 and substituting.

V_1 can be replaced by a current source V_1/R_2 in parallel with R_2, and V_2 by a current source V_2pC_2 in parallel with C_2. The two current sources are effectively connected between the same two nodes (the output impedance of the amplifier being by definition zero) and so will give the same output if they are equal to one another, $V_1/R_2 = V_2pC_2$. Hence the wanted relationship is $V_1 = V_2pC_2R_2$, and the required transfer function

$$\frac{V_{out}}{V_2} = -\frac{A}{A+1}\cdot\frac{pC_2R_2}{1+pT/q+p^2T^2}; \quad (36)$$

For Fig. 10(b) we have, from equns. (14), (15), and Table 1 of Part 3

$$\frac{V_{out}}{V_1} = \frac{kKpT/q_0}{1+\frac{1}{q_0}(1-kK)pT+p^2T^2}, \quad (37)$$

where

$$k = \frac{C_2R_2}{C_1R_1 + C_1R_2 + C_2R_2},$$

$$\frac{1}{q_0} = \frac{C_1R_1 + C_1R_2 + C_2R_2}{\sqrt{(C_1C_2R_1R_2)}},$$

$$T = \sqrt{(C_1C_2R_1R_2)}$$

i.e.

$$\frac{V_{out}}{V_1} = \frac{KpC_2R_2}{1+\frac{1}{q_0}(1-kK)pT+p^2T^2}. \quad (38)$$

By the method of the previous paragraph we then find $V_2 = V_1pC_2R_2$, and consequently

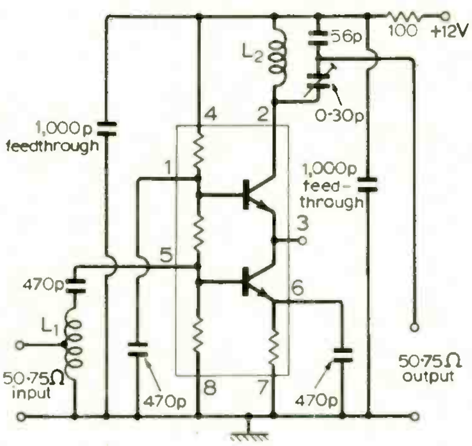
$$\frac{V_{out}}{V_2} = \frac{K}{1+\frac{1}{q_0}(1-kK)pT+p^2T^2}. \quad (39)$$

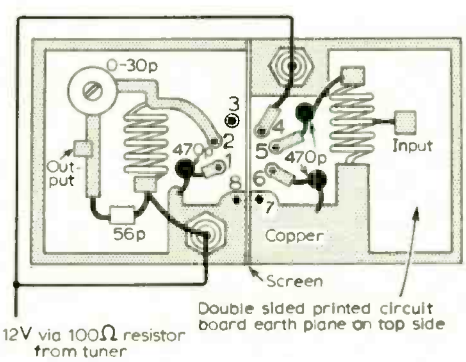
Superficially this l.p. transfer function suggests that gain is not stabilized by feedback. In a practical situation, however, we should have $K = A_0/(\beta A_0 + 1)$, where $\beta A_0 \gg 1$.

To keep the analysis as simple as possible Fig. 10(a) was drawn with the parallel-tee network in the forward path. To obtain "tuned-circuit" response the input, now called V_2, could be reconnected as in Fig. 19 (Part 3), leading to the arrangement shown in Fig. 12. Other examples of the multiple-response potentialities of one basic loop will be found in later parts.

R. F. amplifier for f.m. tuner

In reply to the letter in last month's issue regarding the problem of radiation from the local oscillator of the integrated circuit f.m. tuner described in the June issue, the author (G. J. Newnham), stated that a suitable r.f. amplifier was being prepared. Below we give the circuit diagram and layout he has supplied.





The 90MHz amplifier employs a 316-04 i.c. made by Marconi-Elliott Microelectronics. Both coils consist of five turns of 18 s.w.g. (0.3in diameter, 0.25in long), and L_1 is centre-tapped.

BAILEY AMPLIFIER REPRINT

In our September issue we announced that the reprint of the articles by Dr. A. R. Bailey on his 20-W and 30-W amplifiers and pre-amplifier "will be on sale within the next month". We regret that plate-making and printing difficulties have seriously delayed publication. It now seems likely that the reprint will not be available until the end of November. We apologise to the many readers whose orders have not been executed.

New Books

Transistor Audio and Radio Circuits, from Mullard, is a manual of established and practical circuits for use by radio and audio service engineers, equipment manufacturers, students and home constructors. A wide range of circuits, from portable radio receivers to high-quality amplifiers is presented in detail and a chapter is devoted to test equipment. The chapter headings are: silicon and germanium transistors; basic h.f. circuits; basic a.f. circuits; radiograms, record players and portable radios; tape recorders; car radios; high-quality audio equipment; high-quality f.m. tuners; test equipment. Appendices cover biasing arrangements for h.f. circuits, B.B.C. test-tone transmissions, and six data charts and nomograms. Pp.205. Price 30s, (p. and p. 2s.) Mullard Ltd, Mullard House, Torrington Place, London W.C.1.

Servicing with the Oscilloscope, by Gordon King, presents the oscilloscope, from a practical standpoint, as a valuable aid to servicing and fault-finding in radio, television and audio equipment, including the latest stereo-radio and colour television circuits. The illustrations include many photographs of oscilloscope traces encountered when testing both faulty and correctly operating equipment. Pp.176 including a three-page index. Price 28s. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London W.C.2.

Hi-Fi and Tape Recorder Handbook, by Gordon J. King, is based on the author's previous book **The Practical Hi-Fi Handbook** published by Odhams Books in 1959 and now out of print. There are fifteen chapters written in a technically uncomplicated manner. The first chapter discusses special terms in the audio vocabulary—including decibel, phon, and harmonics—and explains the principles of recording and of stereophony. The rest of the book expands all these terms in relation to voltage amplifiers, valve and transistor power amplifiers, loudspeakers and disc and tape systems. The final chapter is on video tape-recording. Detailed circuits and photographs of commercial equipment are used in the discussions. There are two appendices—on amplifier specifications, and on test tapes and records—and a good index. Pp.304. Price £2. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London W.C.2.

Glide Path, by Arthur C. Clarke, recalls the struggles of a group of scientists, flyers and specially trained servicemen to perfect a radar talk-down system for planes during World War II. This novel is not prophetic, but documents a rapid and important technical development in communications. Pp.229. Price 30s. Sidgwick & Jackson Ltd, 1 Tavistock Chambers, Bloomsbury Way, London W.C.1.

Living with Hi-Fi

A wife's definition of 'tolerance'

by Heather Dinsdale

Although I have a great deal of sympathy for wives whose husbands seem to be married to a car, or a fishing rod, or a set of golf clubs, I claim a special consideration for those poor wives like myself whose husbands are dedicated to sound reproduction (I use the phrase advisedly) in any shape, form or size. To start with, all the work has to be done indoors; there is none of this banishing him to the garage, the river or the golf links. The

Husbands . . . dedicated to sound reproduction

hi-fi units invade the whole house, interconnected with long snake-like cables which are always placed just inside doorways for the unwary wife and children to trip over. The mess is not even confined to the visual senses; the most execrable sounds literally shake the house from time to time, especially when the baby has just been put to bed. This is all performed in the name of the great god hi-fi. ("I'm sorry, but the baby will just have to get used to it.")

The sheer size of the loudspeakers is another thing. Before we got married I was given my annual brainwashing at the Audio Fair, and I gradually learned that large loudspeakers sound better than small. My great mistake was to admit this. Now, my protests that we are being crowded out of house and home by bigger and bigger speakers are countered by impossible rationalizations. ("But you did say at the Audio Fair that those huge horns sounded very good.")

It is bad enough giving house room to completed hi-fi units; up to a point they have their uses for standing vases of flowers on, but the flowers mysteriously disappear shortly before the whole house shakes to the closing scene of "Götterdämmerung". (Presumably the vases would shatter if they were left in the room.) But those of you who think that I am being unreasonable have not had to live with an amplifier through all its stages from design and development to demonstration. There are, in fact, five distinct phases: design, development, testing, manufacture and demonstration.

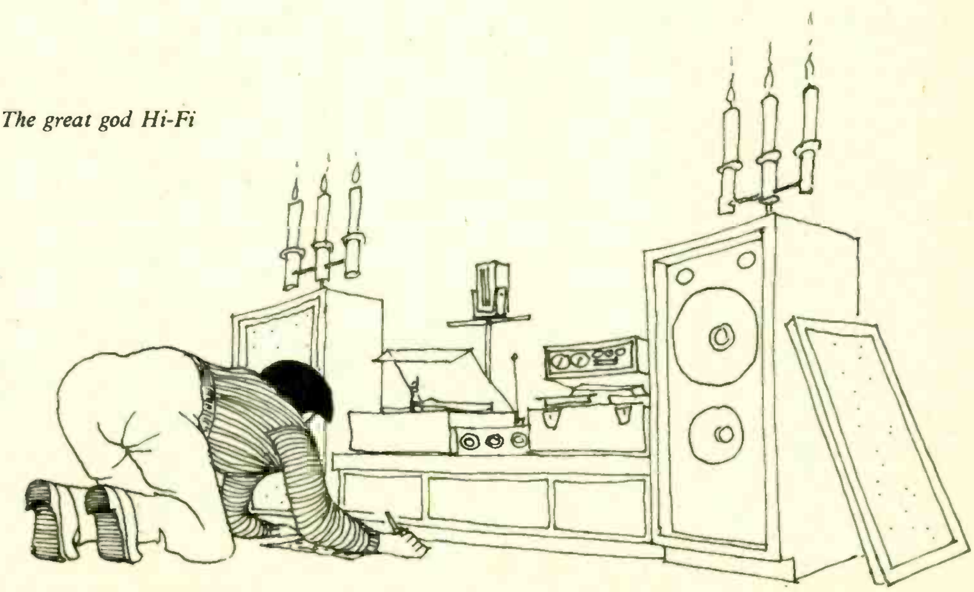
The design phase begins quietly. It is characterized by my husband developing an increasing absent-mindedness and loss of memory where household chores (e.g. washing-up) are concerned. For some reason this loss of memory does not apply to meal-times. Scraps of paper covered in hieroglyphics are left all over the house, and the slide-rule features prominently. The postman staggers up the drive laden with manufacturers' catalogues, and I find myself taking down meaningless telephone messages. Isn't it funny how the 'phone always rings while I'm feeding the baby; perhaps I ought to tell Mrs. Parkinson!

Testing

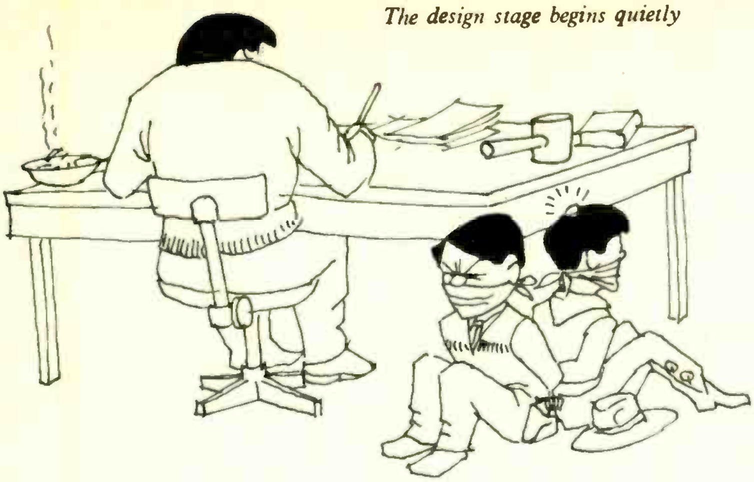
Once the design is completed, development can begin. This is normally done on the floor. I have carried out a careful research programme on the action of vacuum cleaners, and I can now report that resistors and transistors are always sucked up in preference to dirt and dust. ("Have you seen a thing looking like a little striped shrimp? It's gone where? But that was part of a matched set—took me hours. You'll have to empty the bag.") During the development phase, various instruments with small television screens appear and stand around the room. These offer infinite attraction to the children. ("Don't touch that—it's Daddy's. Yes, that's a green snake. No, you mustn't feed it.") I have discovered that there *is* a technique for getting solder out of carpets, but not for removing the actual burn mark. We have solved this latter problem by using a dark brown rug, and the smell of burning hair disappears quite quickly if you leave the windows open. At one time I got very upset when I thought he wanted to use the breadboard, but I know now that a breadboard is not a board, and has nothing to do with bread, either. Once the breadboard has been made, we start the testing phase. Previously, testing has consisted of making measurements on meters but now the ears are assaulted. Certain records have been earmarked *(sic)* 'demonstration quality' and these are played at varying volumes, with small modifications made to the amplifier between each test. I must admit that some of these records do sound extremely good—in moderation. Unfortunately, after it has been struck about 12 times in the hour, Donner's hammer (in "das Rheingold") seems to take up residence in my head. When we lived in a flat, the neighbours downstairs remarked one day on the apparent proximity of the railway station. I hadn't the heart to explain that we had recently invested in a Transacord recording of Pacifics (whatever they may be), and we were "just trying it out". It is, incidentally, an interesting and valuable fact that both our children enjoy very loud sounds, but it doesn't help in the subjective assessment of noise levels. ("But Darling, how can I hear if there is any hum or hiss if the baby's bawling in the background.")

When the tests have been finished we may go back to the drawing board, in which case the whole rigmarole I have described is liable

The great god Hi-Fi



The design stage begins quietly



to be repeated. Otherwise, we proceed to manufacture. I must admit that the units finally produced look quite presentable. Thank goodness that the breadboards don't last for ever!

Manufacture

Manufacture requires extensive use of the kitchen table for "metal bashing". ("Can't possibly use the garage—too damp and draughty.") The metal arrives as large sheets, and is first carefully marked out. Next the holes are drilled on the table or the floor as convenient, using a thick board as a back. ("I'm afraid the drill missed the board, Dear. I don't think the hole is too noticeable.") I once thought that drilling was the final operation, but no! Most of these little holes are pilots. Some of them have to end up square, and these produce the worst sound of all. A small vice is clamped to the kitchen table, and the small holes are opened out using hacksaws and files. The screeching sound is really dreadful. It fills the head, and seems to continue long after the work has been completed. A thin film of metal dust covers everything for days afterwards. After the holes have been cut, the metal is bent (blessed relief, this operation is silent), and we come to painting. Normally I quite like the smell of paint, but the crackle-finish paint with which all the metal work is treated has the most horrible odour. I was intrigued at the beginning to see whether the attractive crackle finish came straight out of the tin, and was disappointed to see that it looked just like conventional paint. Then the awful truth slowly dawned on me. The paint had to be treated in the gas cooker—my cooker—and despite my protests, the horrible smelly paint was bundled into the oven. I carefully examined the oven after the operation, and mercifully the smell had disappeared. The Sunday joint tasted just as good as ever the following day, so now we cure crackle paint quite regularly. ("Don't know what you were rabbiting about! It must be done in the oven, whether it smells or not.")

The little components are fixed on to printed circuit boards, which first have to be designed. After a roughly pencilled layout, adhesive black tape is carefully stuck in position, along with small circles and other rather rude-looking shapes. This process can be carried out anywhere, including railway carriages and even in bed. Unfortunately it leaves a trail of short black sticky pieces wherever it goes. Removing short pieces of sticky tape from the carpets is even more difficult than removing solder, and it is hard to keep the children away from it. Luckily, this phase does not last long, but when the boards come back, all cut and drilled, I must say goodbye to the kitchen table again. Soldering irons are very useful for determining the melting point of plastics. We soon discovered that plastic tablecloths melt easily and give off an obnoxious smell when burnt, and we now have a selection of household articles, including an alarm clock, a salad fork and a toy duck all with neat round holes depicting the path of the soldering iron.

If anyone asks me what is the most effective domestic missile, I reply without hesitation: wire ends from cutting resistor leads to size. The short wires boomerang back and forth across the room, and it is only by sheer good fortune that the whole family have not sustained serious injuries. The wires lodge in the most unusual places and continue to turn up months after the exercise in ballistic missiles has finished. I found many years ago as a child that the most effective way of locating dropped drawing pins is to crawl around on hands and knees. I can report with feeling that the best way of finding dropped wire ends is to sit on the upholstered furniture without too many clothes on.

This process can be carried out anywhere . . . even in bed!

Demonstration

When manufacture has been completed, we come to the final phase: demonstration. This resembles the earlier testing phase, but is more intensive. In addition, visitors turn up at the most unexpected times to "hear the new amplifier". We also have long listening sessions while minute adjustments are made. At about this time, I begin to think that perhaps it has all been worthwhile, because of the fine musical results. We have also met a number of interesting people and been in correspondence with many more.

I read once of some advice to young girls thinking of marriage: "Don't, but if you must, don't marry an engineer." If you marry an audio engineer, be prepared for a completely different way of life, governed by the everlasting search for better sound quality, in which all normal domestic planning is subordinate to loudspeaker positioning and the need to allow the designs to appear. In every engineer there is a designer trying to get out, and if you try to inhibit him, then sullenness sets in, leading to moroseness and maybe a lot worse.

Advice to young girls . . . don't!

I must conclude: he's been muttering for some weeks about designing a colour television set, and I am getting more and more worried about what this might entail. I might as well not bother; if he has decided to do it, then it must be done, and a mere wife is powerless to stop it. At least our test-cards will be in colour (I doubt if he will have time for actually watching programmes) and as the work proceeds the sound of metal-bashing, the smell of burning plastic, and the barrage of small wires will ensure that I know exactly what he is doing.

I wonder what the children will be when they grow up?

Transistor Distortion Characteristics

The performance of transistors in voltage amplifying circuits

by J. L. Linsley Hood

Developments in transistor manufacture have led to the ready availability of inexpensive devices. In particular, the planar silicon types (which are characterized by high gain, low leakage current, low noise and good high frequency characteristics) allow the construction of a.c. amplifying circuits having a performance which is better than all but the best of existing valve circuits.

Unfortunately, when transistors are used as voltage amplifiers the shape of the base voltage/collector current characteristics gives rise to waveform distortion, and the conditions which are most favourable for high stage gain and high input impedance (high collector load impedance, low I_c) are also those which lead to high levels of (predominantly second-harmonic) distortion.

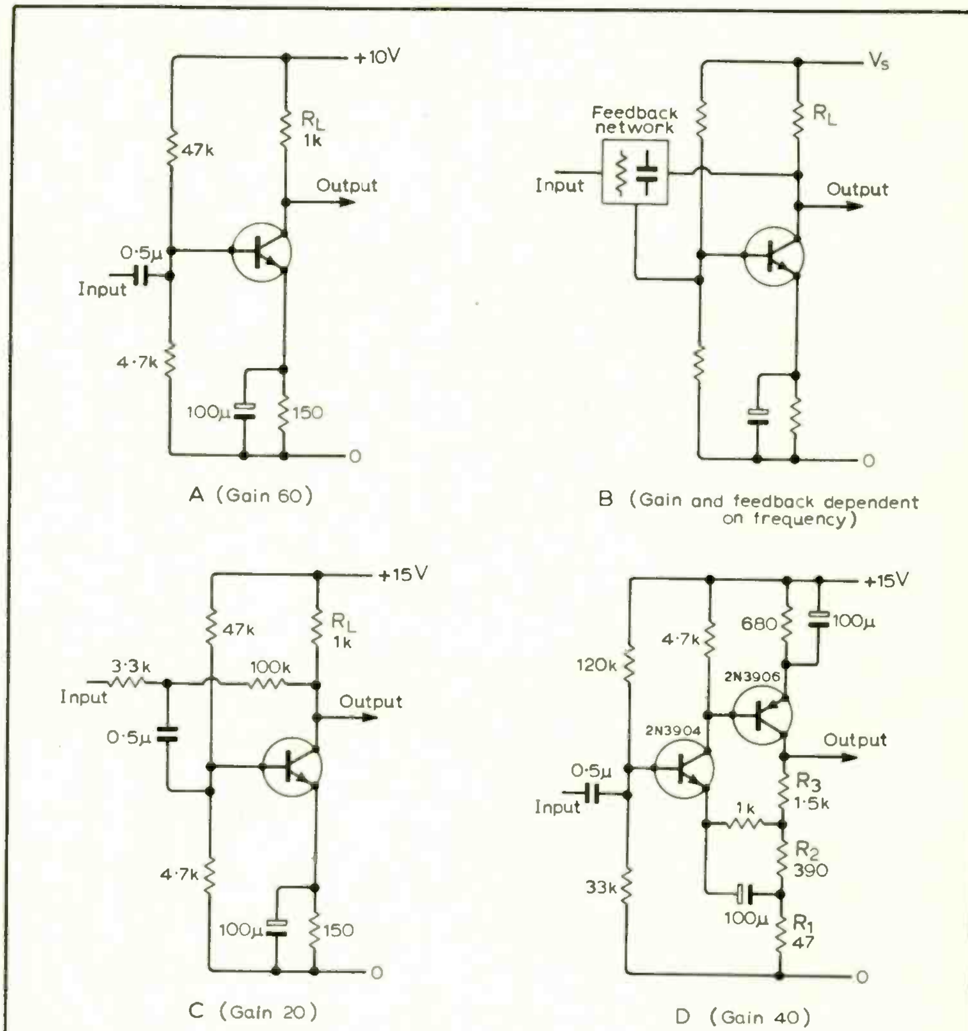
The performance of five different silicon transistor types is shown in Figs.1-3, and that of two germanium types in Fig.4, as measured at 1kHz using circuit A. In each case the actual value of the emitter bias resistor was adjusted so that the collector voltage was equal to half the supply voltage.

In general, the higher the current gain of the transistor, and the larger the collector load resistor, and the output voltage as a proportion of the supply voltage, the greater the total harmonic distortion. Also, as would be expected from the I/V curves, the silicon transistors gave higher distortion levels than the germanium types, and also, in the cases examined, had higher current gains.

No significant difference in performance was observed between different transistors of the same type having similar current gains, although those of planar construction gave a somewhat higher gain/distortion ratio than those with diffused junction.

This type of non-linearity is important, for example, in audio pre-amplifier tone control circuitry, where compensation networks in the negative feedback path are employed as in circuit B, to modify the gain-frequency characteristics. At the mid-point frequency of such an amplifier, the gain may be unity and the distortion factor consequently very low, but where the feedback is reduced in order to obtain, say, treble or bass lift, the output distortion will increase by the same amount.

Also, conventional audio power amplifiers may require an input signal of the order of 0.6–1.0V r.m.s. (equivalent to 1.7–2.8V peak to peak) and as can be seen from Figs.1-3, a simple transistor amplifier of the type shown



Voltage amplifying circuits referred to in the text.

Fig. 1. Curves of total harmonic distortion against output voltage for a Mullard n-p-n silicon BC109 with $h_{fe} \simeq 300$. *Circuit A.*

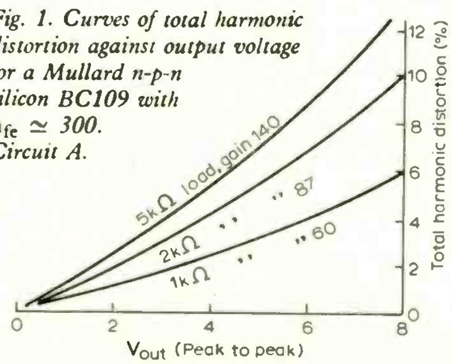
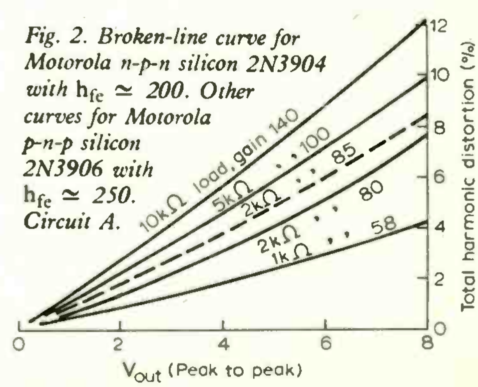


Fig. 2. Broken-line curve for Motorola n-p-n silicon 2N3904 with $h_{fe} \simeq 200$. *Other curves for Motorola p-n-p silicon 2N3906 with* $h_{fe} \simeq 250$. *Circuit A.*



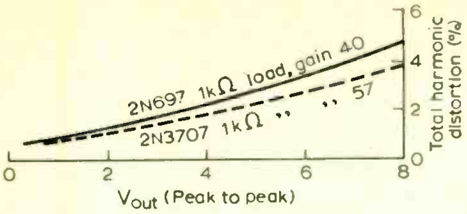
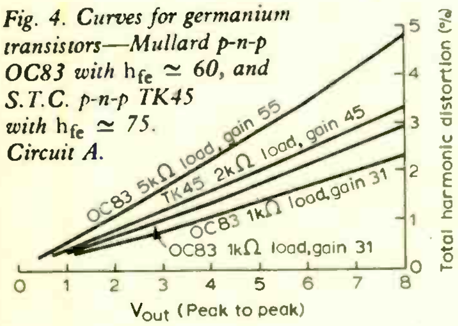


Fig. 3. Curves for Ferranti n-p-n silicon 2N697 with $h_{fe} \simeq 80$, and Texas Instruments n-p-n silicon 2N3707 with $h_{fe} \simeq 180$. Circuit A.

Fig. 4. Curves for germanium transistors—Mullard p-n-p OC83 with $h_{fe} \simeq 60$, and S.T.C. p-n-p TK45 with $h_{fe} \simeq 75$. Circuit A.



in circuit A would introduce 1–2% harmonic distortion. If 0.1% total harmonic distortion is the target figure, the largest output which could be obtained from such a circuit would be some 180mV peak to peak, equivalent to some 60mV r.m.s.

The use of negative feedback improves matters, but the reduction in distortion is accompanied by a reduction in gain. Using a higher supply voltage will increase proportionately the output signal voltage available at a given distortion level, and a single stage amplifier of this type, such as shown in circuit C, operating from a 15V supply rail and designed to have an output of 1V r.m.s. at 0.1% t.h.d., has a stage gain of only 4 or 5.

Since the reduction in the distortion is more nearly equal to the reduction in gain when the open loop gain is high, a better answer is to use a two-stage amplifier, such as that shown in circuit D. Here the output transistor is operated under favourable conditions, with a fairly low value of collector load resistance, and with an input circuit of fairly high impedance, while the input transistor is only required to deliver a small output voltage swing. The open loop gain of the circuit is approximately 8000, and the total harmonic distortion over the frequency range 20Hz to 20kHz is less than 0.04% at 8V peak to peak. Since the stage gain is determined by $(R_1 + R_2 + R_3)/R_1$, if R_1 is reduced the gain (and distortion content) will be proportionately increased. For example, if $R_1 = 20\Omega$, the stage gain will be 100, and the distortion factor at 8V peak to peak will be 0.1%.

The use of such a circuit as the final stage of an audio pre-amplifier* allows the preceding stages to operate at lower output voltage levels, with advantage in terms of harmonic distortion. Further, several such stages could be used in cascade, with passive *RC* or *LC* networks, for tone control purposes.

*Linsley Hood, J. L., "Modular Pre-amplifier Design", *Wireless World*, July 1969.

Announcements

"Sound 70 International" is the title being given to next year's exhibition of the Association of Public Address Engineers. It will not be held at Harrow as in the past but at the Camden Town Hall, Euston Road, London N.W.1, from 10th to 12th March.

The 1st International **Exhibition of Recreation and Leisure** will be held in Geneva, Switzerland from May 28th to June 7th 1970. The organizers are making a special feature of amateur radio activities.

The British Computer Society is moving its headquarters from Dorset Square to 29 Portland Place, London W.1.

"Talking About Colour Television" is the title of the latest filmstrip produced by the Mullard Educational Service. The film is intended for students with a working knowledge of monochrome television and is available, with a 54-page teacher's book, from The Slide Centre Ltd, Portman House, 17 Brodrick Road, London S.W.17.

RCA has announced plans to invest more than £375,000 in a new **plant in Jersey, Channel Islands**, as an improved base for expanding its commercial electronic products activities in Europe.

ITT Components Group Europe has opened a new branch office at 28d Glenacre Road, Cumbernauld, Scotland.

GNT Automatic A/S (has moved from St. Helens Place, London, to 10 College Road, Harrow, Middx. (Tel: 01-863 4378).

Guest Electronics Ltd., Nicholas House, Brigstock Road, Thornton Heath, Surrey, will in future be known as Guest International Ltd.

Davall Electronics Ltd, which was recently acquired by Erie Electronics Ltd, South Denes, Great Yarmouth, Norfolk, has been re-named Erie Controls Ltd.

Crouzet (England) Ltd, of Brentford, Middx, announce that they are changing their name to **Crouzet Ltd** and will shortly be adding aerospace electronics and process control equipment to their products.

Alfred Imhof Ltd have announced that conditional contracts have been exchanged whereby their parent company Parnell Investments Ltd will acquire the entire issued share capital of Bedco Ltd. There will be a single trading company called Imhof-Bedco Ltd.

Danish agents. SEMCO, of Copenhagen, have been appointed agents for components manufactured by Electrosil Ltd, Pallion, Sunderland, Co. Durham.

A Canadian company is being formed jointly by International Computers Ltd and International Management Associates. The company, International Computers (Canada) Ltd, will have exclusive rights to market the I.C.L. 1900 Series computers in Canada.

Technical Measurement Corporation (U.K.) Ltd, 14 Yeading Lane, Hayes, Middx, have been appointed **European distributors** for Nuclear Equipment Corporation, of California, manufacturers of solid-state detectors and preamplifiers, non-dispersive x-ray photon spectrometers and NIMAMP operational amplifiers for nuclear applications.

V-F Instruments Ltd, Gloucester Trading Estate, Hucclecote, Gloucester GL3 4AA, have been appointed exclusive U.K. agents for **Data Device Corporation**, of New York. The range of products manufactured by the American company includes: operational amplifiers, A/D converters, D/A converters, multiplexers, logarithmic modules and instrumentation amplifiers.

Racal Elektronik GmbH, 5300 Bonn, Adeuauerallee 89a, is a new company formed by the Racal Electronic Group in Western Germany.

The Beyer microphone company of Western Germany has formed a company in the U.K. for the distribution of its products. The new company, **Beyer Dynamic (G.B.)**, is operating from 1 Clair Road, Haywards Heath, Sussex.

The audio products of the **Pioneer Electronic Corporation** of Tokyo are to be marketed in Britain by the Hi-Fi Division of Shriro (UK) Ltd, 8 Bush Lane, Cannon Street, London E.C.4.

Celdis Ltd, Reading, Berks, have been appointed by General Instrument (UK) Ltd to market their range of semiconductors and tantalum capacitors.

An agreement has been signed between GEC-AEI (Electronics) Ltd of Stanmore, Middlesex, and Kollsman Instrument Ltd of The Airport, Southampton, for the manufacture and sale by Kollsman of various types of **induction digitizer**. These units, developed and patented by GEC-AEI Electronics, give a digital representation of the angular position of a shaft.

The Digital Systems Department of Ferranti Ltd has been awarded a contract by the Ministry of Defence valued at over £300,000, for the manufacture of **digital data link equipment** for the Royal Navy.

Plessey Radar has received orders valued at approximately £50,000 for the WF3 **windfinding radar** to be supplied to meteorological organizations in Australia, Ceylon, Pakistan and the U.K.

Pye TVT Ltd has installed an £8,000 **closed-circuit television** system for surveillance on the east and west towers of the Severn Bridge.

Redifon Ltd, Wandsworth, London S.W.18, has been awarded a contract for the manufacture and installation of **eleven ship radio stations.** Five stations are to be built for Canadian Pacific Steamships Ltd, the remainder for the Bibby Line and ACL, the Atlantic Container Line consortium. The company is also supplying £85,000 worth of radio equipment for twenty-six BP and Shell tankers.

Police walkie-talkies. Rank Telecommunications has received an order from the Metropolitan Police, valued at £122,000, for the supply of Mitre two-way personal radio transceivers.

Plessey Telecommunications Group has received contracts worth over £350,000 from the G.P.O. for eight **electronic telephone exchanges.**

The G.P.O. has awarded a contract worth almost £300,000 to Standard Telephones and Cables Ltd, for the provision of **a microwave radio system** to transmit bulk telephone traffic and television signals between Birmingham and Bristol.

Eastern Electricity have awarded a £0.5M contract to Ferranti for the supply of **telemetry/telecontrol equipment** to be used for the remote supervision and control of over 400 Eastern Electricity substations.

Circuit Ideas

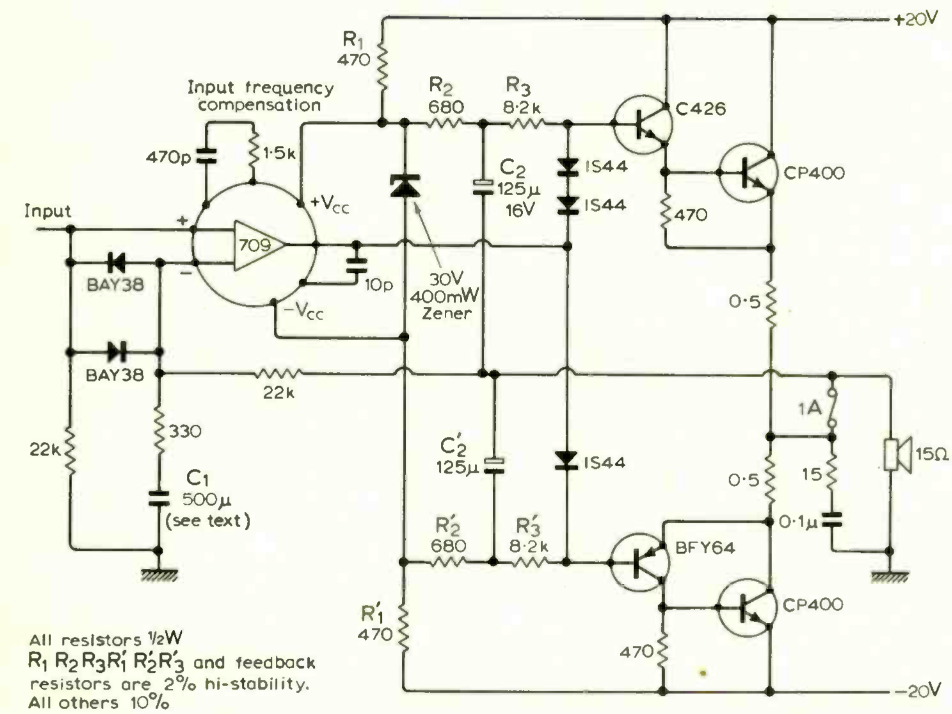
I.C. driver for power amplifier

By virtue of its very large input and output voltage ranges and excellent common mode rejection, i.c. type 709 may be made the basis of a power amplifier. Obtaining sufficient voltage swing to drive a complementary class B output stage, is achieved by complete exploitation of the bootstrap principle. Suppose that the op. amp. gives a maximum output swing $\pm V_o$ and will operate with a common mode input voltage in the range $\pm V_i$, both V_o and V_i being measured relative to the op. amp. power supply in the normal way. Both sides of the op. amp. power supply are bootstrapped in phase with the output in such a way that, when the output is at $+V_o$ the supply has been bootstrapped up by an amount equal to V_i so that the input is now at $-V_i$. Thus the total swing obtained relative to earth is $\pm(V_o + V_i)$. Typical values for a 709 running off ± 15V supplies are $V_o = 14$V and $V_i = 10$V, giving a total peak-to-peak swing of 48V which should increase to about 55V if the 709 is run at its rated limits.

This principle has been employed in the circuit shown. C_2, R_1, R_2 and the corresponding primed components cause the op. amp. power supply to be bootstrapped by about 40% of the output voltage, and the capacitors also provide a bootstrap for the drivers in the normal way. The d.c. voltage across the load is held by feedback to a few millivolts (the 709 input offset voltage) and the gain is such that 10W output is obtained from just under 200mV input. C_1 was a 500μF, reversible electrolytic, but 50μF would be adequate for normal audio purposes and it could probably be an ordinary, polarized component. Alternatively it could be omitted completely if one were prepared to tolerate a few tenths of a volt d.c. across the load or to trim the 709 offset voltage to zero. The diodes between the 709 inputs eliminate any possibility of latch-up occurring, and the frequency compensation components shown were found to give an adequate margin of stability in the circuit built. It was necessary to use a fairly low-impedance signal source (below about 5kΩ), otherwise strong high-frequency oscillation occurred, but this is thought to be a result of the particular circuit layout employed.

The 3dB points for the circuit given were at about 1·5Hz and 150kHz. Distortion was not measured, but it should be very low since the circuit has roughly 55dB of negative feedback at low frequencies.

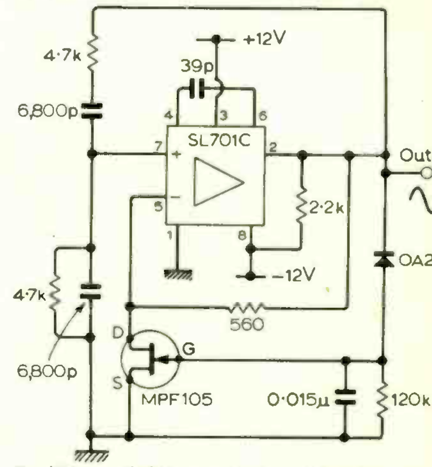
J. M. A. Wade
Cavendish Laboratory,
Cambridge



Power amplifier employing op. amp. type 709.

Constant amplitude oscillator

A stable sinusoidal output, independent of any change in supply voltage, can be obtained using the circuit shown below. The output from the wien bridge oscillator is fed back to the gate of the f.e.t. after rectification and smoothing. Since the drain-source voltage is much less than the gate-source voltage (negative), the dynamic resistance



Oscillator giving constant amplitude sinewave output with unstable supply.

of the f.e.t. varies linearly with the latter. Any variation in supply voltage, which apparently changes the output, will change the dynamic resistance of the f.e.t. keeping the output constant. The frequency of oscillation of the circuit shown is 5kHz. Variation in frequency is only 0·02% with a 30% change in supply voltage.

A. Basak
Chelsea College of Science & Technology,
London S.W.3

An invitation

If you have developed or happened upon an original circuit configuration to perform a simple or a complex operation, or have used standard components in an unconventional manner, we would like to hear from you. Send a concise description, in the form of a circuit diagram and notes, and we will consider its publication as a circuit idea. £5 is paid for each contribution published.

The way we make resistors is unique. To an extremely tough optical glass "heart" we fuse, molecule for molecule, an oxide film. At great heat. The result is an extra, diamond-like hardness and toughness that defies deterioration under the most adverse conditions . . . long after humidity, for example, has eroded the less robust types of film resistor. Electrosil resistors are virtually unaffected by thermal and mechanical shock, too. That's why they are specified more than ever today for the electronics industry, where high reliability is paramount.

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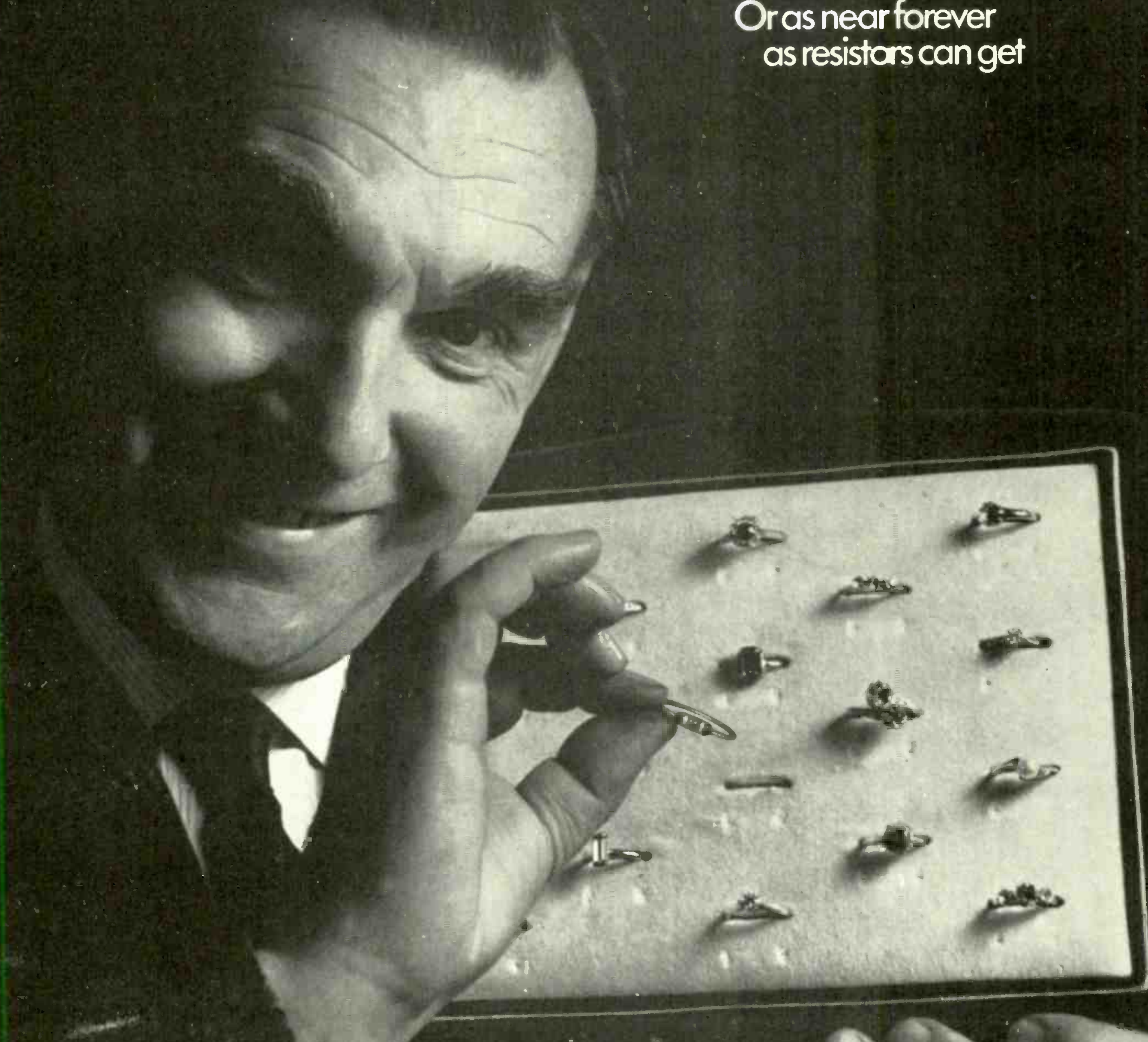
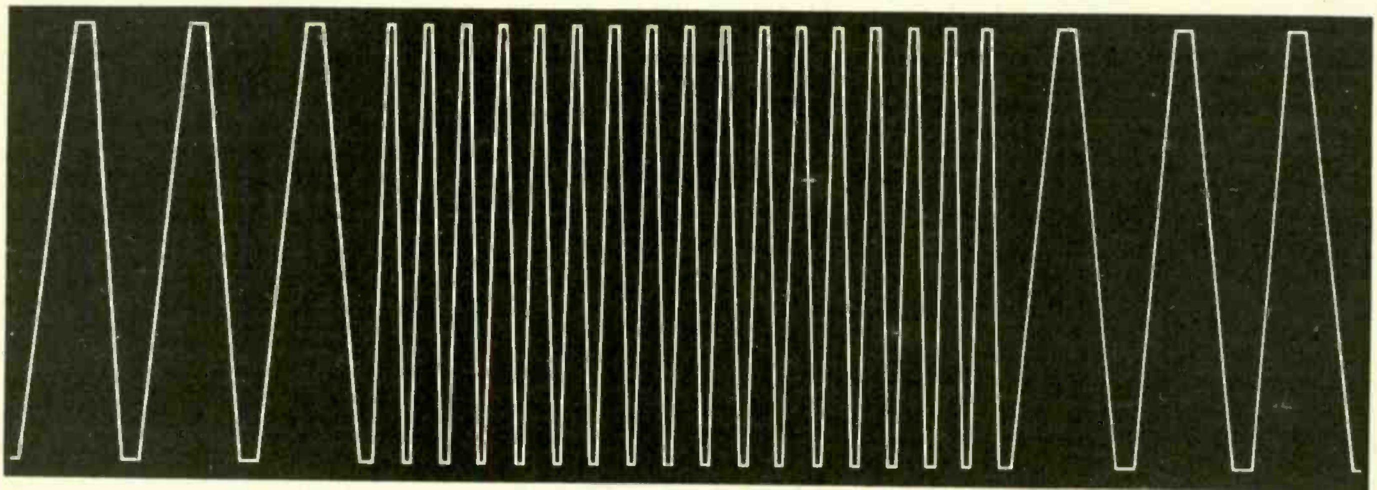


WW—105 FOR FURTHER DETAILS

Marconi LINCOMPEX...



Marconi radio terminal equipment

Marconi, foremost in the design of radio terminal equipment, have added to their already comprehensive range—Lincompex—the means of compensating for the variable characteristics of h.f propagation.

Lincompex

Developed from the original British Post Office design to give a service on h.f radio telephone circuits comparable with high-quality, long-distance cable. Improved service, fewer 'repeats' and greatly increased service hours make Lincompex the key to direct 'subscriber to subscriber' contact on long distance h.f circuits.

...the most advanced system available

- **SMALL SIZE**: Only one 7 in. shelf per channel.
- **LOW COST**: Introduction of new techniques has considerably reduced capital cost.
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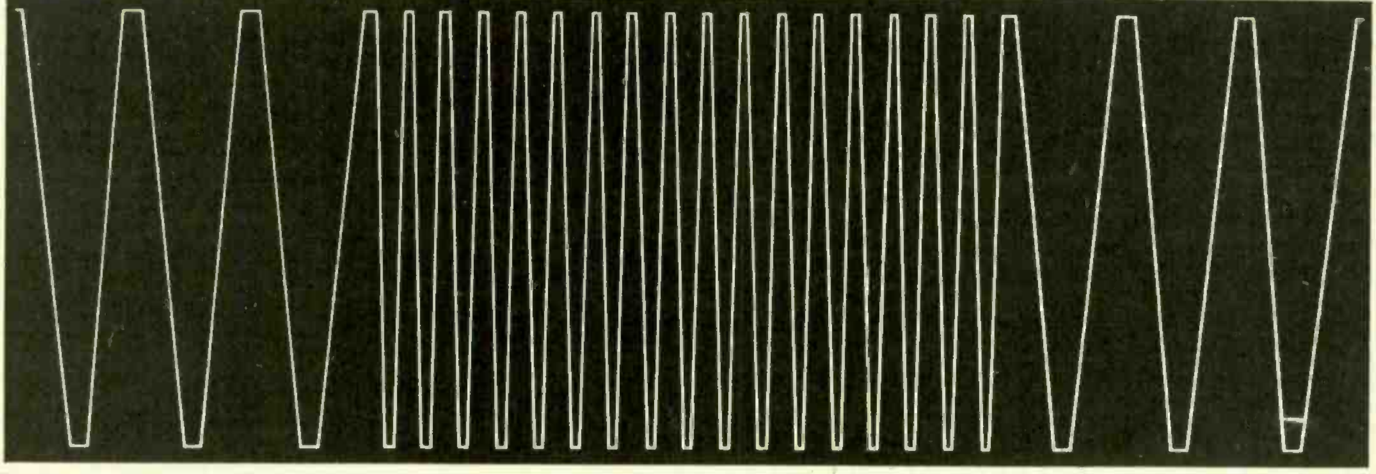
Marconi LINCOMPEX is designed for association with Marconi H5510 series of Terminal Equipments and built to maintain for years its designed performance.

Marconi Telecommunications Systems



The Marconi Company Limited, Radio Communications Division, Chelmsford, Essex Member of GEC-Marconi Electronics LTD/H84

Wireless World Logic Display Aid

7: Some more modifications and a description of the prototype

*designed by B. S. Crank**

This month sees the end of the description of the instrument. Next month's article, the last in this series, will be devoted to a few logic circuits that may be used with the instrument for instructional purposes. The last two possible modifications will now be described.

7: Enabling any display area to be switched to any mode of operation

This is an extension of modification 6 and the only requirement is that modification 4 should have been carried out. Four complete sets of control switches laid out as in the left hand side of Fig. 85 are incorporated. The switches are mounted in four rows, one row for each display area, and each row contains Venn, Truth, and Karnaugh control switches plus switches to control the content of the Truth table third column. The switches marked S_0 are pressed when it is desired to have no third column (two-variable Truth table) in any particular display area. The S_0 switches have no connections to them and therefore do not appear in any of the circuit diagrams, their sole purpose is to mechanically cancel the associated C = 0 and C = 1 switches.

Each row of switches fitted in this modification (do not confuse with modification 8 switches of Fig. 85) consists of two sets of three-button miniature radio switches, supplied by G. W. Smith, and as specified in the parts list for the basic instrument.

By gating the outputs of the bistables Q and W each row of switches is made operative for one display area only. The outputs of all the switches are then combined in gating to produce the control signals for the basic logic circuit. Fig. 86 gives the extra circuitry necessary.

The outputs of the bistables Q and W are combined in NAND gates 1, 3, 4, and 5 to produce signals corresponding to each display area. These outputs are the negative form of the required address signal ($\overline{Q}\,\overline{W}$, $Q\overline{W}$, $\overline{Q}W$, and QW). Each of these four signals is fed to a set of three mode control switches (Venn, Truth and Karnaugh). The output of all switches for the same mode (four each for Venn, Truth and Karnaugh) are combined in NAND gates 18, 20 and 21. For instance, all the Venn switches are connected to gate 18 to provide the V control signal for the main logic unit.

Imagine that the following switches are pressed, S_1, S_7, S_{13}, and S_{18}, and also imagine that both the X and the Y counter hold all zeros. The bistables Q and W will be reset so the $\overline{Q}$ and $\overline{W}$ lines will have a voltage upon them. Both inputs to gate 1 will therefore be UP and the output of gate 1 will be DOWN. Notice that the outputs of

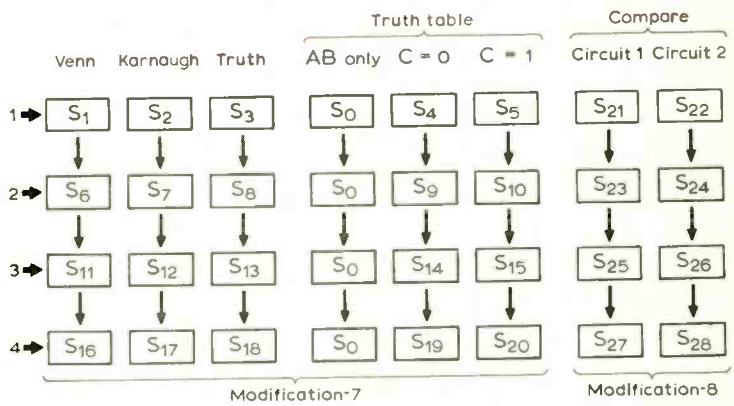


Fig. 85. Layout of the switches on the front panel.

gates, 3, 4 and 5 will be UP because at least one of their inputs will be DOWN.

The DOWN at the output of gate 1 will appear at the input of gate 18 via S_1 so that the output of gate 18 will be UP, switching the main logic unit into the Venn diagram mode of operation. The inputs to gates 20 and 21 will either be UP, or open, so that the outputs of these gates will be DOWN as will the T and K control signals. Notice that because the output of gate 18 is DOWN the output of gate 19 will be UP, switching both dians to the Venn operating mode.

Sixteen pulses from the clock generator will trace the first column of dots in display area 1. The sixteenth pulse will set bistable Q and bring the beam in the c.r.t. to the top-left-hand dot of display area two. Now the Q and $\overline{W}$ lines will be UP.

The output of gate 3 will go down and the outputs of gates 1, 4 and 5 will go UP. The output of gate 18 will go DOWN and the output of gate 19 will go UP. The V control signal will therefore also be DOWN and the dians will be switched to the Venn/Karnaugh mode.

The DOWN at gate 3 will be relayed via S_7 to gate 20 and the K control signal will go UP switching the main logic unit to the Karnaugh map mode of operation. All other outputs of this circuit to the main logic unit will be DOWN.

Fifteen more pulses from the clock generator will trace the first column of dots in display area 1. The sixteenth next pulse will set the first bistable in the X counter (E) and reset the Y counter to all zeros. $\overline{Q}\,\overline{W}$ will now exist and the main logic unit will be switched to Venn operation (gate 1, 5, and gate 18/19) in the same way as before. The second column of dots will then be traced out, first in display area number 1 and then in display area number 2

* assistant editor, *Wireless World*.

with a change-over to Karnaugh operation in between.

This process will repeat itself sixteen times with the main logic unit being switched from Venn to Karnaugh operation as the dot passes out of display area 1 into display area 2. After the sixteen repetitions the beam will be at the bottom right-hand corner of display area two (having scanned both display areas one and two), 512 clock pulses will have been generated, the X and Y counter will be in the following state ABCDQEFGH$\overline{W}$ and the main logic unit will be in the Karnaugh mode of operation.

One more clock pulse will drive the counter to $\overline{A}\,\overline{B}\,\overline{C}\,\overline{D}\,\overline{Q}\,\overline{E}\,\overline{F}\,\overline{G}\,\overline{H}$W and place the spot at the top left-hand corner of display area number three. $\overline{Q}$W now exists. Gate 4, S_{13} and gate 21 will cause the main logic unit to be switched to the Truth table mode. When display area number four is reached QW will exist and gate 5, S_{18} and gate 21 will keep the instrument in the Truth table mode. After 512 more clock pulses both display areas three and four will have scanned and the process will repeat itself starting with display area number one again.

At the same time as all this was going on the output variables of the instrument, as decoded by the various variable forming logic circuits and controlled by the V, K, and T control signals derived from Fig. 86, were being fed to some sort of external logic circuit. The output of this logic circuit was being used to intensity modulate the c.r.t. beam either directly or via the 1 and 0 character generators as dictated by the V, K, and T control signals.

From the above description it can be seen how any of the display areas could have been switched to any of the operating modes if desired. If, for instance, S_2, S_7, S_{12}, and S_{17} had been pressed, all four displays areas would operate in the Karnaugh map mode. If the buffer stages only of Fig. 84 were incorporated then a six variable Karnaugh map would result. It is advised that these stages be added with this modification because of the greater flexibility afforded.

Having described the circuitry required to produce the V, K and T control signals it is now necessary to have a look at the third column of the Truth table and the Truth table variable T_C.

Output $\overline{GH}$ from the main logic unit, which, if you remember, addresses the third column of the Truth table, is inverted in gate 2 to form GH, and is fed to gates 7, 10, 13 and 16. Also fed to these gates are the four combinations of Q and W which have been inverted in the gates 6, 9, 12 and 15. The switches $S_4(b)$, $S_9(b)$, $S_{14}(b)$, $S_{19}(b)$ select C = 0 in the Truth table by feeding the outputs of gates 7, 10, 13, and 16 to gate 22. The output of gate 22 is inverted in gate 23 because the main logic unit requires the inverse of the $T_C = 0$ signal. For $T_C = 1$ $S_5(b)$, $S_{10}(b)$, $S_{15}(b)$, $S_{20}(b)$ and gates 24 and 25 are employed.

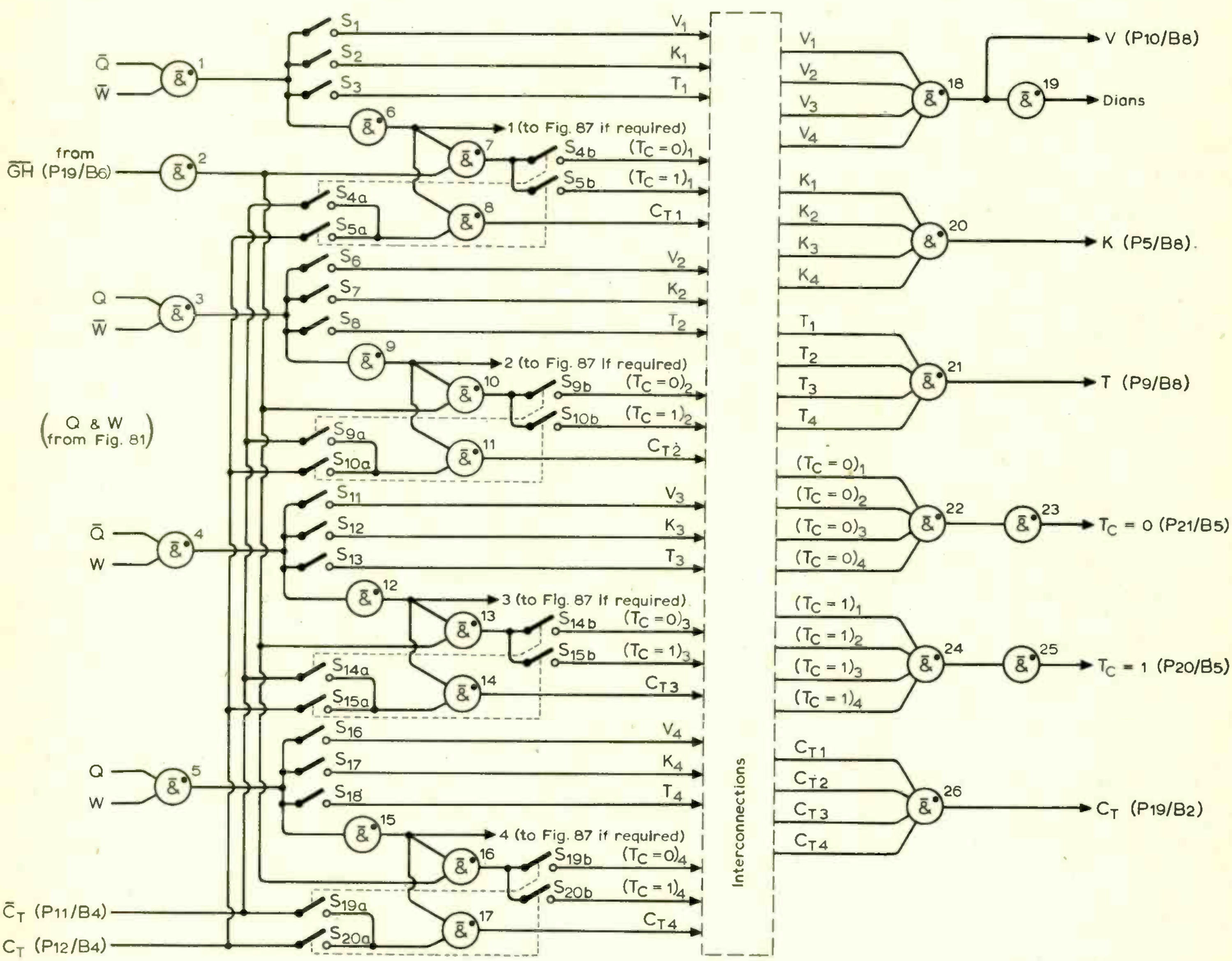


Fig. 86. The circuit of modification 7.

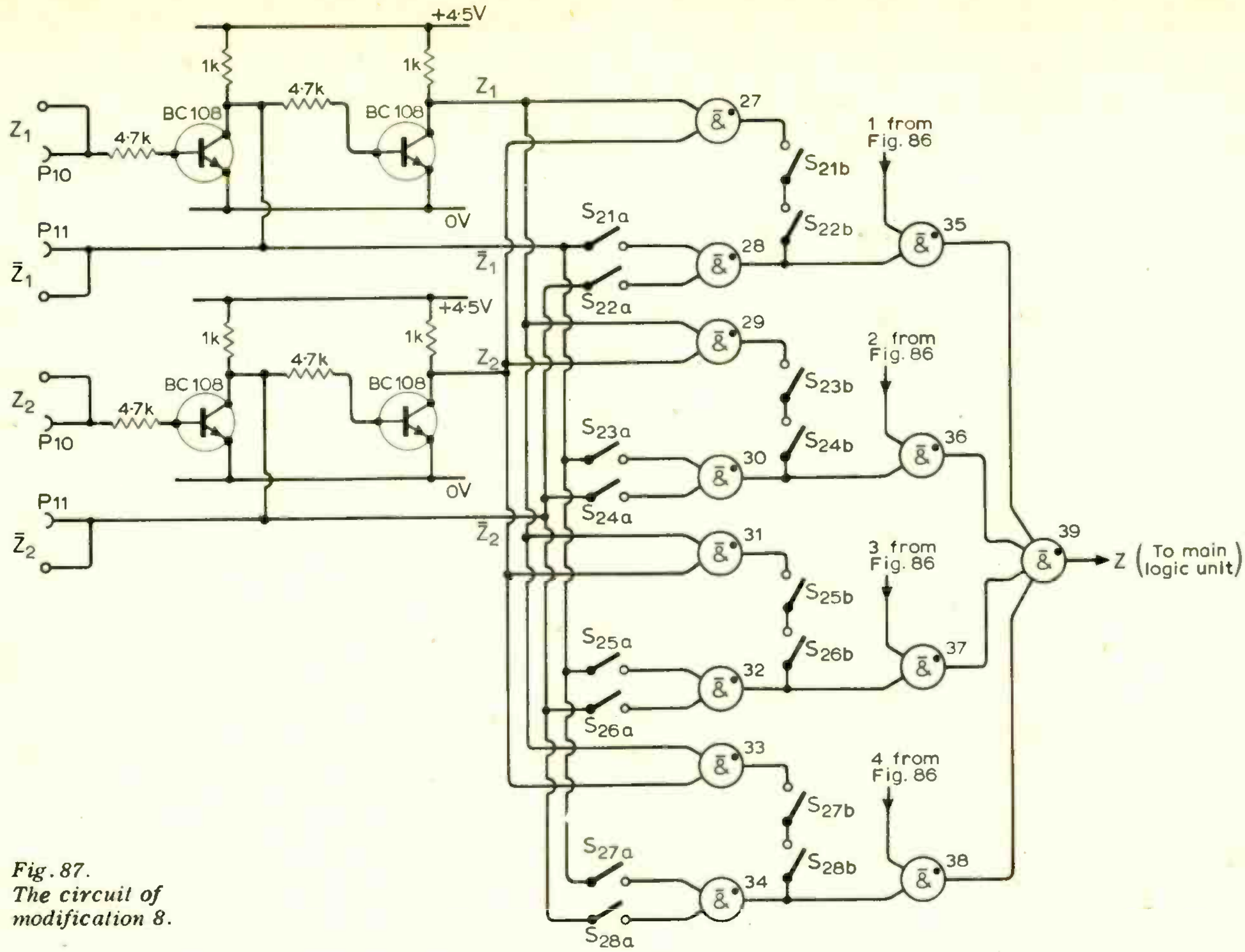


Fig. 87. The circuit of modification 8.

These switches can therefore be used to cause all 1s to be displayed in the third column of a Truth table (T_C). Another pole (a) on the same switches causes the C_T or $\overline{C}_T$ output variable of the main logic unit to be gated with Q and W area addressing signals which are combined in gate 26 to provide C_T for the main logic unit. This ensures that when C = 0 in column three of a Truth table $\overline{C}_T$ is presented to the external logic circuit, when C = 1 then C_T is output.

As mentioned earlier the switches S_0 (Fig. 85) do not have any electrical connections and serve only to cancel out the C = 0 and C = 1 switches so that the C column of the Truth table is blank.

8: Adding individual comparison facilities for each display area

This modification is carried only when modifications 4 and 7 have been incorporated. It enables up to two external logic circuits to be connected to the Display Aid and enables any display area to be switched to show the output of circuit one or the output of circuit two or the difference between circuit one and circuit two. The circuit diagram is shown in Fig. 87.

Z and $\overline{Z}$ inputs to the instrument are provided by the two transistor double inverter stages. The gating system is identical to that shown in Fig. 79 and described under modification 3, only now there are four of them, one for each display area. An additional gate for each display area (35, 36, 37 and 38) combines the output of the comparators with the area address signals available at gates 6, 9, 12, and 15 of Fig. 86.

The output of gates 35, 36, 37, and 38 are combined in gate 39 to provide the Z input for the main logic unit. The layout of the switches is shown at the right hand side of Fig. 85. Taking area one as an example: closing S_{21} will show the output of external circuit one in area one; pressing S_{22} will show the output of external circuit number two in area one; pressing both S_{21} and S_{22} will show the difference between external circuits one and two in area one.

Switch combinations

It will be interesting at this point to see how the various photographs shown in part one of this series (p. 198, May issue) were produced.

In photograph A a binary full adder was connected to the display aid, the SUM output was connected to the Z input. The switches which were pressed were as follows:

area one: Truth table (S_3); C = 0 (S_4), and circuit one (S_{21}).

area two: Truth table (S_8); C = 1 (S_{10}) and circuit one (S_{23}),

area three: Karnaugh map (S_{12}); and circuit one (S_{25}),

area four: Venn diagram (S_{16}); and circuit one (S_{27}).

For photograph B the external logic circuit was an AND gate with its output connected to the Z_1 input of the display aid. The input of the AND gate was connected to the output variables $\overline{A}$, $\overline{B}$ and $\overline{C}$. Switch positions were as follows:

area one: Truth table (S_3); C = 0 (S_4), and circuit one (S_{21})

area two: Truth table (S_8); C = 1 (S_{10}), and circuit one (S_{23})

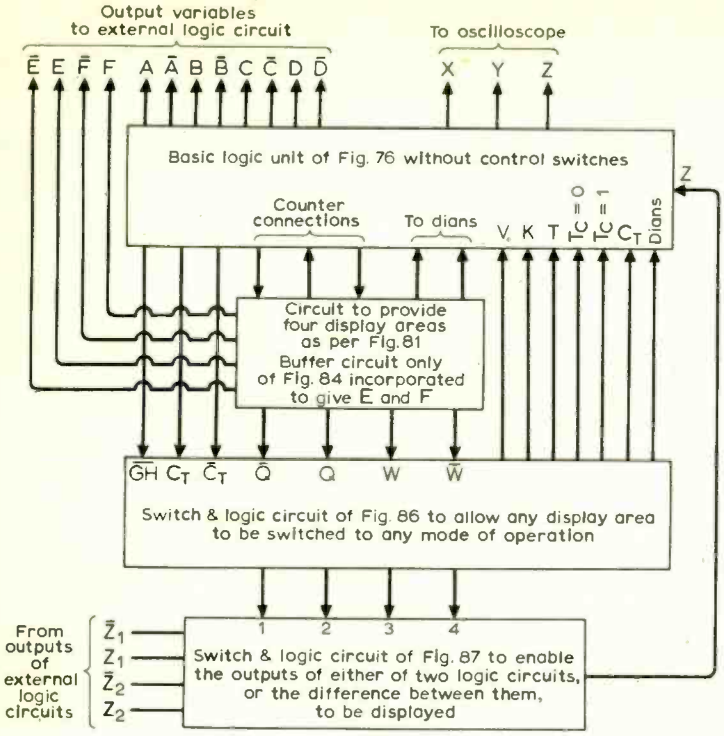


Fig. 88. A block diagram showing the interconnection of units in the type U instrument.

area three: Venn diagram (S_{11}); and circuit one (S_{25})

area four: Karnaugh map (S_{17}); and circuit one (S_{27})

In photograph C the output variable A was connected directly to the Z_1 input and the output variable $\bar{A}$ was connected to the Z_2 input of the display aid. Switch positions were as follows:

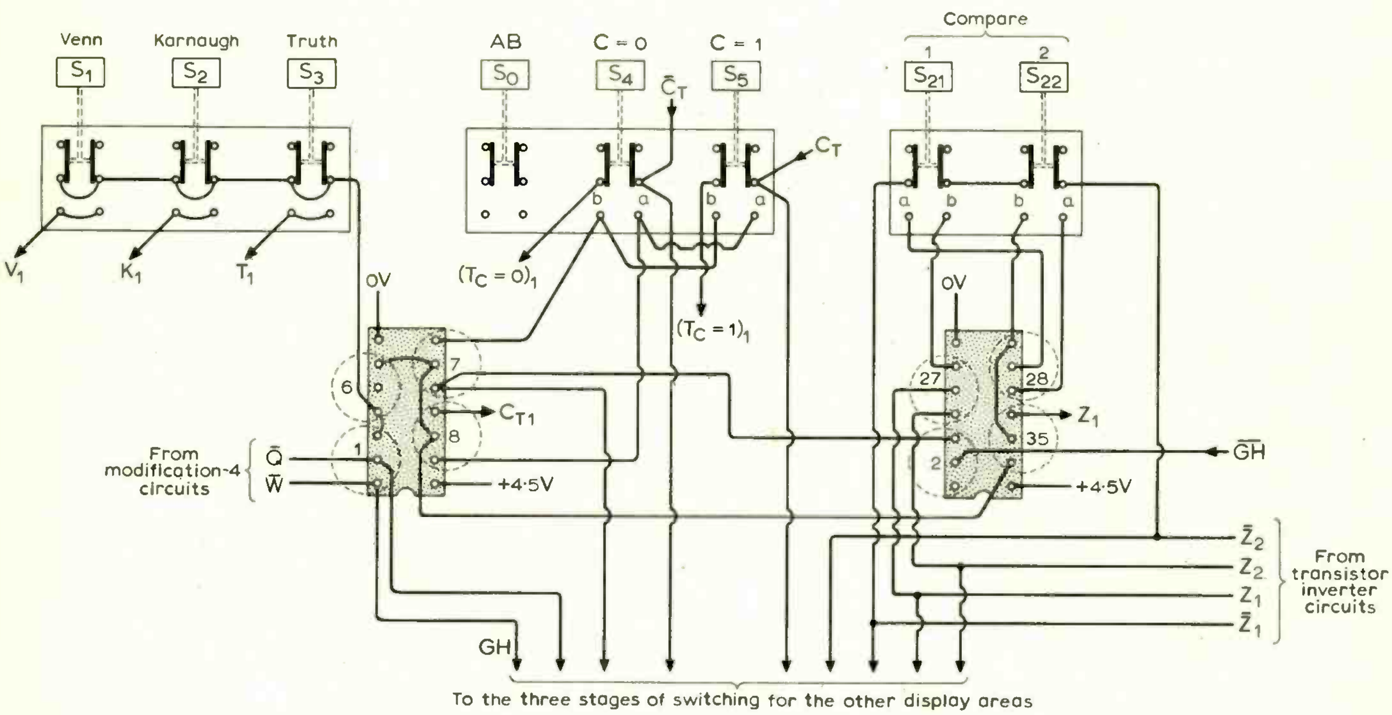
area one: Venn diagram (S_1); and circuit one (S_{21})

area two: Karnaugh map (S_7); and circuit one (S_{23})

area three: Venn diagram (S_{11}); and circuit two (S_{26})

area four: Karnaugh map (S_{17}); and circuit two (S_{28})

Two binary adders were used to produce photograph D. One of the adders was deliberately made unserviceable and its SUM output was connected to Z_1. The sum output



(Above) Fig. 89. Part practical layout for type U instrument. The two i.cs are ZN346Es.

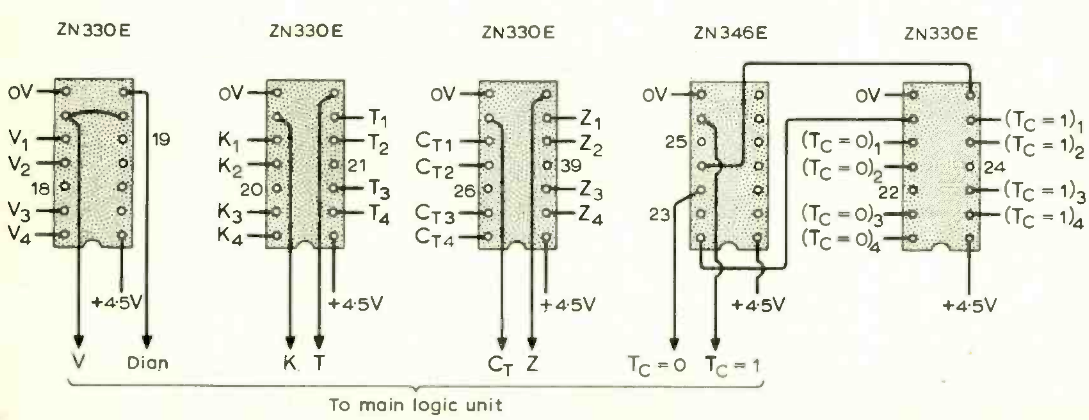


Fig. 90. More wiring details of the type U instrument.

of the serviceable adder was connected to Z_2. Switch positions were as follows:

area one: Venn diagram (S_1); and circuit one (S_{21})

area two: Venn diagram (S_6); and circuit two (S_{24})

area three: Venn diagram (S_{11}); and difference (S_{25} and S_{26})

area four: Karnaugh map (S_{17}); and difference (S_{27} and S_{28})

The above examples were given in order that the reader may see how to operate the instrument so that the various logic and switching circuits can be more readily understood.

Building the type U logic display aid

The prototype instrument was type U as mentioned in the list of compatible modifications given last month and as such incorporates modifications 4, 7 and 8. It is proposed to give some practical details of this instrument, but of course it would be impossible to give the same detail for all 21 types.

The system block diagram is shown in Fig. 88. This does not require any comment, however, it should be of value when the time comes to interconnect all the various units.

Fig. 89 gives a wiring diagram for the switching circuits for display area number one. The three switching circuits for the other three display areas are wired-up in almost the same way. The only difference is that the $\overline{GH}$ output of the main logic circuit only requires to be inverted once (gate 2, Fig. 86) which is done in Fig. 89. This means that when all four stages are wired-up there will be three spare two-input gates. These can be used to partly fill the need for some of the buffer-amplifiers needed for the E and F variables for six-variable Karnaugh map operation.

Fig. 90 shows how the output side of the switching circuit is wired-up. The numbers near the integrated circuits of Figs. 89 and 90 correspond to the gate numbering in Figs. 86 and 87.

If one examines Fig. 73 (p.421, September issue) the necessary components for modifications 7 and 8 can be seen mounted on a board on the extreme right behind the mains transformer. The board in the foreground, bolted to the main logic unit, contains the parts necessary for modification 4.

Faults on this part of the circuit (modifications 7 and 8) can be very, very trying. The reader is advised to take extreme care with the construction. It is a good plan to adopt some form of colour-coding system, particularly with the switch wiring, and stick to it.

The switches themselves do not have any mounting holes, so the procedure adopted in the prototype was to solder them to mild steel angle which was bolted to the front panel; however, this is a matter of personal preference.

The description of the *Wireless World* Logic Display Aid is now complete and we wish you well with the construction.

Next month, in the last article in this series, a simple modification will be described showing how the aid may be used with a 19-inch oscilloscope and some external logic circuits will also be suggested.

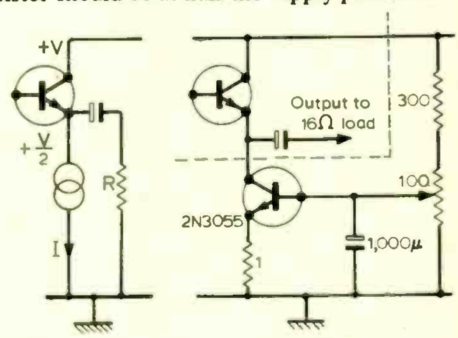
(To be concluded)

More Letters to the Editor

(Other letters on pages 518-19)

Amplifier efficiency

Mr. Vanderkooy's letter (August issue, p.381), set me thinking. Why waste audio power in an emitter load, why not replace it by a constant current source adjusted to give the correct standing current, and, of course, having a relatively high dynamic impedance? (Fig. *a*.). The only a.c. load is now provided by *R*, and so the emitter of the output transistor should be at half the supply potential.



(a) (b)

With the transistor full on, current through the load will be, instantaneously, $(V/2)/R$ and with it cut off, the current will be I. These two currents should be equal, i.e. $I = V/(2R)$, e.g. with a supply of 30 volts and load of 15 ohms, the standing current should be 1 amp. Efficiency should be 25% if the constant current source is ideal and the output transistor has zero saturation voltage.

To test the theory, I used Mr. Vanderkooy's circuit, replacing the 22-ohm emitter resistor by the hurriedly devised and far from ideal arrangement of Fig. *b*. Using a supply of 32 volts and a standing current of 1 amp, output power at the onset of symmetrical clipping was just over 5 watts. Increasing the supply to 40 volts and the current to 1.2 amps, the maximum output rose to nearly 10 watts, an efficiency of about 20%. This is not a new idea—a similar circuit was used by P. F. Ridler for the output stage of his "Low Distortion RC Oscillator" (*W. W.*, August 1967, p.383), and it needs a fairly large heat-sink area, but ten watts or so may be obtained without resorting to water cooling! Of course, all one has to do now is to drive the lower transistor and one arrives at Mr. Linsley Hood's class A circuit!

IAN G. JOHNSON,
Farnborough, Hants.

Radio in airship R100

The Electrical Engineering Squadron at this Station has undertaken to renovate, on behalf of the Royal Air Force Museum, the experimental receiver, Type RX18A, from the R100 airship.

We would be grateful if you could publish this appeal for information on the receiver, especially with regard to valve types and coil winding details.

R. M. HARRISON (F/O),
R.A.F., Syerston,
Newark, Notts.

Test Your Knowledge

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

18.: Waveguide components and techniques

In all the questions it is assumed that the basic waveguide is standard rectangular and that it is propagating the dominant mode.

1. The behaviour of a waveguide component or circuit can often be inferred by analysis of the equivalent twin-transmission-line circuit. In constructing the analogue the transmission-line wires are taken to lie:
(a) along the centre lines of the broad walls of the guide
(b) along the centre lines of the narrow walls of the guide
(c) along a pair of opposite corners of the guide
(d) along a pair of adjacent corners of the guide separated by a broad guide wall.

2. If a waveguide component, in which changes of guide dimensions occur, is to be designed with the aid of the equivalent transmission-line circuit, appropriate values of line impedances to use for the various guide sections are in each case:
(a) the wave impedance of the section of guide
(b) the wave impedance multiplied by the narrow guide dimension
(c) the wave impedance multiplied by the wide guide dimension
(d) the wave impedance multiplied by the narrow guide dimension and divided by the wide guide dimension.

3. A waveguide component may be found to contain an "iris" (a thin metal plate or plates perpendicular to the guide axis extending part of the way across). The purpose of the iris is generally to:
(a) protect the component by providing a point at which sparking will occur first if the component is overloaded
(b) "match out" a mismatch in the component
(c) suppress higher order modes
(d) prevent dust from reaching certain parts of the component.

4. A waveguide component is required to have a slot in the guide wall parallel to the axis of the guide, and the slot must not radiate a significant amount of microwave energy. The slot:
(a) may be anywhere in the guide walls
(b) may be anywhere in a wide wall, but must not be in a narrow wall
(c) must be either along the centre line of a wide wall or a narrow wall
(d) must be along the centre line of a wide wall.

* West Ham College of Technology, London, E.15.

5. In order to determine, with the aid of a Smith Chart, a point at which a susceptance can be placed to match a mismatched waveguide termination, three of the following need to be known (and nothing more). Select the redundant information:
(a) the v.s.w.r.
(b) the position of the voltage minimum nearest to the source of mismatch
(c) the frequency
(d) the guide-wavelength.

6. The principle of reciprocity is obeyed:
(a) by all waveguide components
(b) by no waveguide components
(c) by all waveguide components except certain ferrite devices
(d) only by certain waveguide components containing ferrites.

7. If the construction of a waveguide component requires two similar small discontinuities to be introduced into the guide, the distance between them:
(a) should be as small as possible
(b) should be as large as possible
(c) should be a whole number of half guide-wavelengths.
(d) should be an odd whole number of quarter guide-wavelengths.

8. In a microwave resonant cavity the electric and magnetic fields:
(a) have maximum amplitudes which coincide in space, and are in phase
(b) have maximum amplitudes which coincide in space, and are in phase quadrature
(c) are in phase, and the maximum amplitude of one coincides in space with the minimum amplitude of the other
(d) are in phase quadrature, and the maximum amplitude of one coincides in space with the minimum amplitude of the other.

9. It is desired to build a resonant cavity, to resonate at a given frequency, having as high a Q as possible (the general form of the cavity being specified). The cavity should be designed to have:
(a) as large a volume as possible
(b) as large a surface area as possible
(c) a maximum ratio of volume to surface area
(d) a minimum ratio of volume to surface area.

10. A resonant cavity terminates a waveguide. The v.s.w.r. in the guide at the resonant frequency of the cavity is found to be 2:1 and the position of the standing-wave pattern at resonance is the same as its position when the frequency is well away from resonance. The coupling parameter of the cavity is:
(a) zero, (b) $\frac{1}{2}$, (c) unity, (d) 2.

11. Most microwave generators require to feed a waveguide in which the V.S.W.R. at the input does not exceed a specified value (often 1.5:1). If a generator feeds a waveguide with a large mismatch the main effect is:
(a) electrical breakdown in the waveguide
(b) a reduction of power output from the generator in all cases
(c) a change in generator frequency only
(d) both power output and frequency instability.

12. In a waveguide choke coupling an effective good contact is achieved at the waveguide wall by moving the actual point of physical contact one quarter wavelength back along a half-wave short-circuited guide section (the choke). The choke ring cut into the flange always has a much wider slot than the gap between the flanges (which forms the first half of the choke). The reason for this is:
(a) convenience of manufacture
(b) to give the joint broad-band properties.
(c) to prevent arcing at the corner
(d) so that dirt will not be trapped in the choke ring.

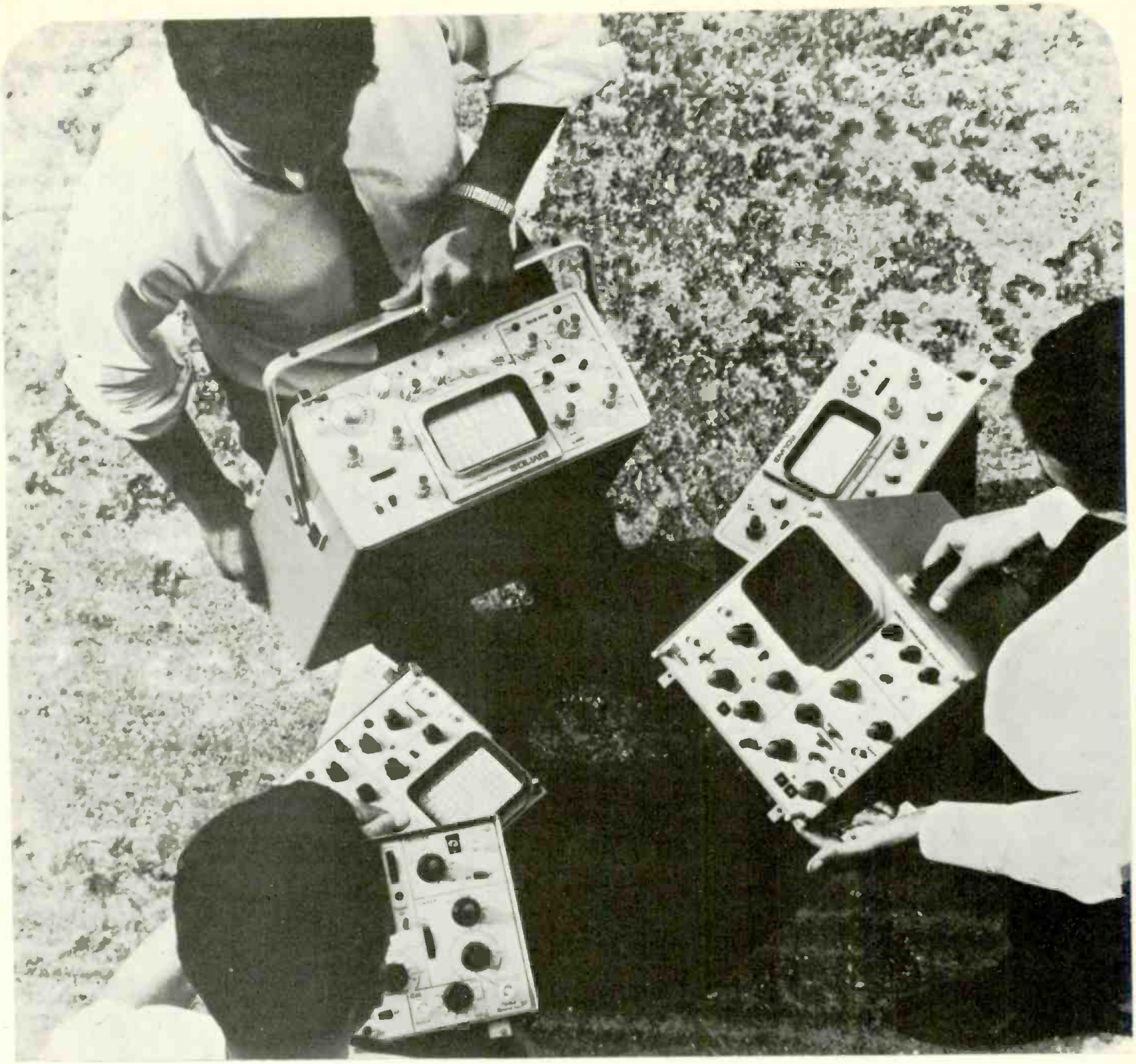
13. In a simple coaxial line to waveguide transformer (probe launching section) the distance between the probe and the short-circuit in the guide should be approximately:
(a) one half free-space wavelength
(b) one half guide wavelength
(c) one quarter free-space wavelength
(d) one quarter guide wavelength.

14. In a directional coupler the coupling holes:
(a) must be in broad faces of both guides
(b) must be in narrow faces of both guides
(c) must be in the broad face of one guide and the narrow face of the other
(d) may be either in the broad faces of both guides or the narrow faces of both guides.

15. In a compensated magic *T* (hybrid junction):
(a) each arm is isolated from the other three
(b) each arm is isolated from two of the other three
(c) each arm is isolated from the arm opposite
(d) only one pair of arms are isolated from each other.

16. Of the forms of attenuator listed below one reflects energy rather than absorbing it. It is:
(a) the resistive film attenuator
(b) the piston attenuator
(c) the flap attenuator
(d) the rotary vane attenuator.

Answers and comments, page 549



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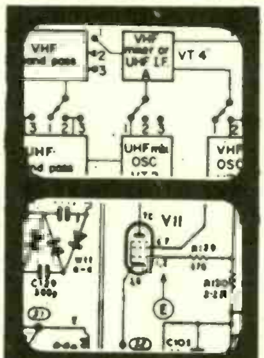

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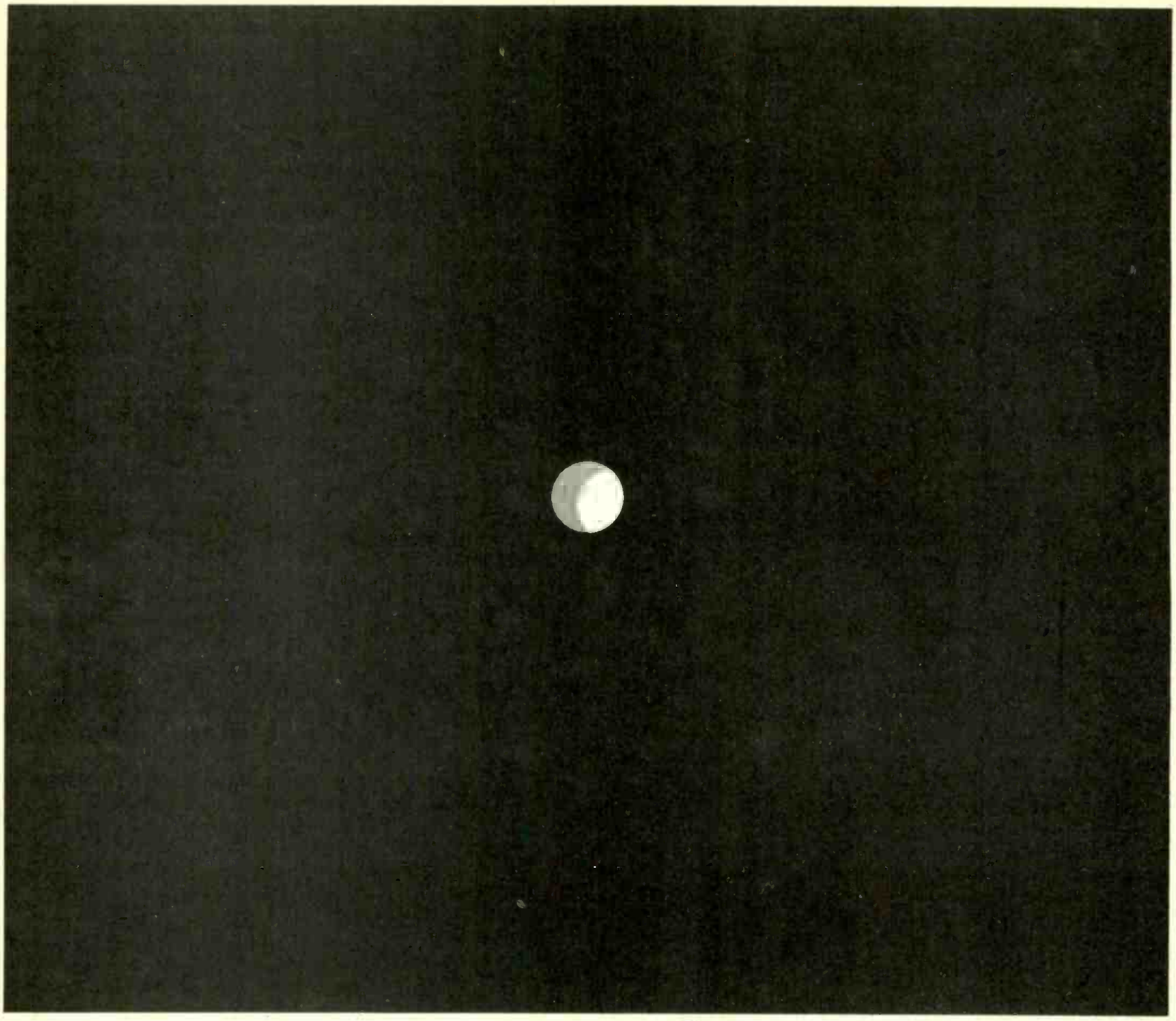

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World of Amateur Radio

Local authorities and amateurs

British amateurs are concerned at the difficulties which are sometimes encountered from local and government authorities in the installation of transmitting and receiving aerials on residential property (often it seems as an outcome of complaints of television interference). The main problems arise from the Town and Country Planning Act, 1962, which is increasingly being interpreted as requiring that planning permission should be obtained for even relatively modest masts and towers and aerial arrays.

A further threat is that, with the availability of all-u.h.f. television, some local authorities are believed to be preparing to extend their regulations to v.h.f. aerials (for example for the 70 or 144 MHz bands) which would previously have been regarded as of roughly similar construction to domestic television aerials and therefore not requiring planning permission. Attempts by the R.S.G.B. to exclude from planning permission aerial masts and towers of under 35ft in height and carrying typical amateur aerials have been rejected by the Minister of Housing and Local Government. The Ministry claims that the local planning authorities should continue to have the opportunity to consider individual proposals.

Some amateurs have also been faced with demands from local authorities for an increase of rateable values of homes where there is a large amateur aerial installation. While to date it seems that most of these demands have been successfully contested, the Treasury has rejected an R.S.G.B. request that no such proposals for rating increases should be made.

There can be little doubt that current legislation provides the authorities, where they so wish, with the means to harass, rather than encourage, amateur activity.

Birth of broadcasting

Regular broadcasting in the U.K. was initiated, not only at the request of, but through the insistence of the experimental amateur—so commented *Wireless World* in 1923. This era has been recalled recently by special amateur v.h.f. and h.f. contests held as part of the Dutch commemoration of what (at last) is now generally regarded as the start, 50 years ago, of the first regular radio broadcasting service in the world—the concerts and talks broadcast over PCGG at The Hague from November 6th, 1919 onwards. These concerts were initiated and advertised by a young Dutch engineer Hanso Idzerda who, even before the first World War, had founded a Technical Wireless Bureau and who, in 1917, had persuaded Philips at Eindhoven to manufacture what became known as the Philips IDZ valve.

The Hague concerts pre-dated those from KDKA, Pittsburg, which has often been given credit for the start of regular broadcasting. Incidentally, the first musical transmission was made by Fessenden on an h.f. alternator station in 1906.

Idzerda's later life was marked by disappointments, with his pioneering achievements often belittled as large firms came into the field. His death was equally tragic. He was executed by the Germans in November 1944 on suspicion of espionage when caught searching for fragments of an exploded V2 rocket in a prohibited area.

There can be little doubt that the Dutch concerts helped create the demand by wireless enthusiasts in the U.K. for the start of regular broadcasting. In 1921, following an appeal in *Wireless World*, about £750 was subscribed by British enthusiasts to allow the concerts to continue.

Arthur Robinson, G3MDW, secretary of the Northern Heights Amateur Radio Society, Yorkshire, photographed during a visit to W1BB, the well-known station near Boston, Massachusetts of Stewart Perry, the veteran "Top-Band" (1.8MHz) enthusiast. The current "Top Band" DX season has opened with a number of notable long-distance contacts including several between Australia and the Eastern United States.

Television interference

The recently released Post Office statistics for cases of interference to television and radio reception in 1968 show a marked increase in the number ascribed to amateur and other transmitters. Of 70,254 interference cases closed by the P.O. investigators, 1151 or just over 1.5% were ascribed to amateur transmitters. The number has risen appreciably in the past five years or so. It is widely believed by amateurs that modern TV receiver installations, particularly those fitted with transistor wideband mast-head (or back-of-set) pre-amplifiers, are much more susceptible to strong local signals on frequencies far removed from the TV channels than older receivers. Another increasing problem is the number of viewers using set-top aerials which can be much more susceptible to interference.

Amateurs are however hoping that the spread of u.h.f. television will result in a marked easing of the position, since instances of amateurs causing interference on Bands IV and V are far rarer than on v.h.f.

The Post Office statistics also show the rising incidence of interference generated by thermostat controls in domestic gas and oil-fired central heating systems, particularly after some months of operation. Electrical interference from such contact devices now exceeds that from electric motors, previously the most frequent cause of interference.

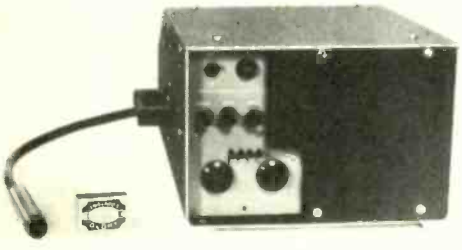
In Brief: Membership of the R.S.G.B., in the year to June 30th, rose by 1347 to a total of 15,392—this compares with an increase of 644 in the previous year. The membership now includes rather over one-half (some 8000) of all British licensed amateurs. Its overseas membership is 1378 . . . . The Australian Post Office has approved the installation by amateurs of unattended v.h.f. repeater stations operating on the 144-MHz band . . . . The French P.T.T. is to support, at the next congress of the Universal Postal Union, a proposal that would admit QSL cards in the "small packet" post . . . . The Scottish v.h.f. convention is being held at The Carlton Hotel, North Bridge, Edinburgh, on October 26th; the convention includes a dinner, lectures and an exhibition (GM3OWU, "Westerlea", 9 Juniper Avenue, Juniper Green, Midlothian, EH14 5EG) . . . . For the first time amateurs have spanned the English Channel using the 10-GHz band. Dain Evans, G3RPE, operating portable near Dover contacted the French amateur station F2FO/P near Cap Gris Nez. The British station had an output of only 15mW with a 10-inch dish aerial.

PAT HAWKER, G3VA

New Products

Sub-miniature Television Camera

A sub-miniature television camera (type BC1103), believed to be the smallest commercially available in the world, has been designed by E.M.I. for inspection of the inside of pipes and for operation in inaccessible locations under arduous conditions. The BC1103 consists of two units, the cylindrical camera head and a camera control unit. The camera head measures only 24mm in diameter and 122mm in length, is complete with integral lens and lighting unit, and is sealed to prevent the ingress of moisture and dirt. A 13mm (½-inch) vidicon camera tube is used and the high performance head amplifier employs f.e.ts and integrated circuits. The lens lighting unit incorporates a lens with an angle of view of approximately 40°. The f/6 camera lens gives adequate depth of field for pipes of bore from 25mm to 65mm. The camera head can be connected to its associated control unit by up to 65m of steel reinforced camera cable. The camera control unit



(shown in the photograph with the camera) weighs only 19kg. The control unit provides all the power, scanning and processing circuits for the camera channel. Broadcast type 625/525 line synchronizing pulses ensure compatibility with all makes of video monitors and video tape recorders. Three camera controls (target, beam and electrical focusing), in addition to the lighting intensity controls and the power on/off switch are mounted on a recessed front panel. An air pump is fitted to the camera control unit to provide cooling and to enable the camera head to be operated continuously in ambient temperatures up to 45°C. E.M.I. Electronics Ltd, Hayes, Middx.
WW307 for further details

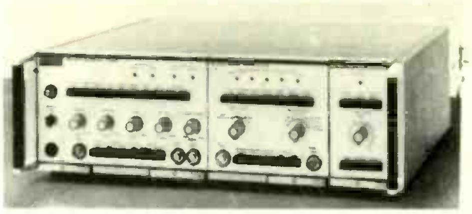
Digital A.C./D.C. Multimeter

Apart from the benefits gained from a digital display, the TE 360 multimeter from Guest International exhibits best-case accuracy figures of ±0.1% of reading, ±0.1% of f.s.d., and is capable of a wide variety of measurements. These include 20 ranges covering a.c. and d.c. voltage and d.c. current, and five ranges of resistance. Voltage may be measured up to 1kV, current up to 2A, and resistance up to 2M Ω

Input impedance varies from 10M Ω to 1kM Ω on d.c. volts and is 10M Ω on all a.c. voltage ranges. The display includes 3 digits and over-range indication, polarity and decimal points. Readings are given at 0.2s intervals and there are optional facilities for b.c.d. and print command outputs. Power requirements are 115 or 230V, 50 to 60Hz. A battery version is available. Price £198. Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey, CR4 7JA.
WW327 for further details

Video Test-signal Generator

A complete set of signals for checking and measuring the video characteristics of television studio equipment, transmission links and transmitters is provided by a new test-signal generator available from Pye Unicam. All signals generated conform to C.C.I.R., I.E.C., and C.M.T.T. requirements. The generator, Philips PM 5572/74, features integrated-circuit design virtually throughout and consists of three modules which are housed in a case 132mm high. The three units—blanking mixer and power supply unit, sine-wave generator and pulse generator—are interconnected by either cable or plug-in connectors, and the complete generator can be expanded through the addition of further modules. The sine-wave unit can be used as a fixed-frequency, multiburst or video-sweep generator. In the first mode of operation it provides 1-10MHz signals variable in 1MHz steps. In the second, it produces 1-5MHz multiburst signals with or without black-white reference lines, and in the third it gives sweep signals from 100kHz—10MHz with or without 1MHz markers. Various types of test signal for checking the performance of video-transmission circuits, video-amplifiers, etc., are provided by the pulse generator unit. These include square-wave, sawtooth, staircase and sine² signals. Square-wave signals are available with repetition rates of 0.5 and 50Hz, and 15 and 250kHz, and all have risetimes of less than 60ns. However, filters can be switched in to ensure standard risetimes. Sawtooth signals



provided consist of line-frequency sawtooths with or without intermediate lines at the black-white level. The staircase signal has either five or ten steps. Both types of signal can have superimposed 1-10MHz or colour sub-carrier signals added in the blanking mixer. Where a superimposed colour sub-carrier is used with the above signal, it is also possible to switch in a colour-burst signal. The amplitude of all components in the composite signal can be adjusted via controls on the blanking mixer, and other controls permit, for example, black-white signals to be clipped or limited as required. It is also possible to invert the set-up level and include or exclude frame information from the composite signal. Pye Unicam Ltd, York Street, Cambridge.
WW310 for further details

Four-quadrant Multiplier

Philbrick/Nexus Research, is now offering a small four-quadrant multiplier. The model 4450 is compatible for use as a computing element in the laboratory and, in applications where an accurate multiplication process is required with no limitations as to the polarity of the input signals. Several applications such as modulation, frequency doubling, and power measurements, can be accomplished using the model 4450. The multiplier operates at rated accuracy to 10kHz with full output voltage capabilities to 100kHz. Its output is representative of the instantaneous product of two input signals. Only one external

trim is required for setting up. An optional scale factor trim may be used to improve accuracy to ±0.6% typical (±1% maximum) referred to 10V full-scale output. When scale-factor trim is not used, accuracy is ±1% typical and ±2% maximum. The price of the model 4450 in quantities of 1–9 is £41 10s each. Philbrick/Nexus Research, 81a North Street, Chichester, Sussex.
WW309 for further details

Frequency-synthesized Drive Unit

An h.f. drive unit, designated type GK 203, is announced by the Communications Division of Redifon. All solid-state and self-contained, with integral power unit, the GK 203 uses frequency synthesis to develop 285,000 channels in 100Hz steps from 1.5 to 30MHz and to generate modulated signals in seventeen selectable modes of transmission. The new unit can be used with most h.f. transmitters and linear amplifiers. While the GK 203 will accept an input from an external frequency standard, it incorporates an internal reference source which can be used as a standard for other equipment. Where several of these drive units are used, an economy may be effected by omitting the reference source from all except one master unit. Transmission modes cover c.w., m.c.w., d.s.b., compatible a.m., s.s.b. with fully suppressed carrier or with pilot carrier at −16dB or −26dB levels, and, as an optional extra facility, i.s.b. at either of two pilot carrier levels. On all services employing a single sideband the u.s.b. or l.s.b. mode is selectable by a front-panel switch. Automatic volume compression can be switched in to maintain a high modulation index even at

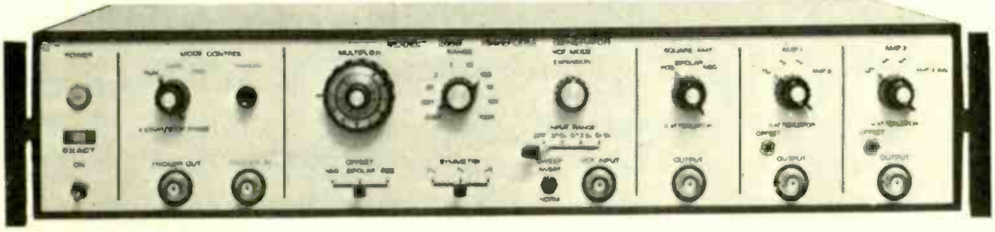
low speech levels, and automatic voice or tone activation of transmit/stand-by switching can also be selected. Sidetone and two forms of muting are available for associated receiver, to provide aerial muting or a.g.c. desensitizing. Redifon Ltd, Broomhill Road, Wandsworth, London S.W.18.
WW329 for further details

6,000-watt Amplifier

A 6,000-watt amplifier has been developed by Derritron. Whilst primarily designed for operating with a 1950lb thrust vibrator, this amplifier can be used as a variable frequency power source. The amplifier incorporates an oscillator and a closed-circuit water cooling system, and uses silicon transistors throughout. Check-out facilities are included and the amplifier is protected against overload. Derritron Electronics Ltd, Sedlescombe Road North, Hastings, Sussex.
WW314 for further details

Multi-waveform Generators

The series 500 waveform generators from Environmental Equipments is designed to provide the functions of many different instruments, such as square-wave generator, sine-wave oscillator, sweep generator, f.m. modulator, variable repetition-rate pulse-generator, ramp and raster generator, stimulation and simulation signal in medical research, control signals for aerospace and environmental testing. These generators feature bipolar-sine, square, triangle, ramp, reverse ramp and pulse outputs. In addition models 504B and 505B add haversine and havertriangle waveforms. The wide frequency range extends from 0.0001Hz (greater than 2 hours) to 1MHz (1μs) covering requirements from biological to radio frequencies. Models 503B and 505B offer precise control of frequency by an external voltage. By applying a 0 to +5V, 0 to −5V, or 0 to ±2½V the frequency can be swept over a 50:1 range—usable range is 100:1. All models have triple output amplifiers giving push-pull output if required, high output voltage, and adjustable d.c. offset. Gating, triggering (single shot) and variable start/stop phase are also available. Typical waveform specifications are: sine distortion, less than 1%, triangle linearity better than 99%, square wave rise/fall times 50ns. Environmental Equipments Ltd, Denton Road, Wokingham, Berks.
WW338 for further details



Solid-state High-voltage Equipment

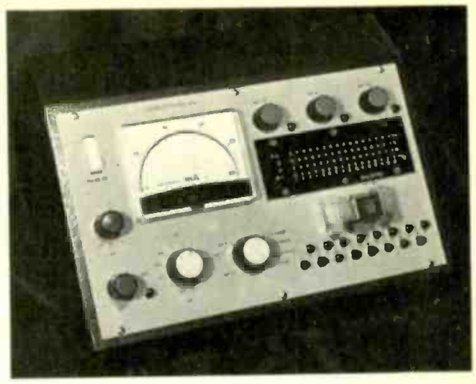
Miles Hivolt have produced an instrument enabling a 25kV 1 mA supply to be contained within a panel height of only 133mm. The output of this instrument, the Hivolt TH25, can be short-circuited indefinitely, or load flash-over can occur without damage either to the driver transistors or the associated circuits. Plug-in printed circuit boards are used in a modular design. The e.h.t. generator comprises an oscillator module and a moulded voltage multiplier stack. The TH25 is fully metered for current measurement. The voltage is set by means of a ten-turn potentiometer. Although the Hivolt TH25 is produced in such a small size, heat dissipation has been kept extremely low and there is no undue temperature rise. The equipment is designed for bench or rack mounting. Alternatively, the company are supplying the model TH20 which may be accommodated in manufacturers' equipment and as such does not require metering. In this case the voltage adjustment is by means of a ten-turn preset potentiometer normally set by the user within the range 10-20kV. Miles Hivolt Ltd, Shoreham, Sussex.
WW306 for further details

Transistor-switched Indicator Lamps

Available from Oxley Developments is a new range of transistor-switched indicator lamps, for use with negative logic. They use a p-n-p transistor, and are switched ON by a negative signal. The new units have complementary characteristics to the current range of transistor-switched indicator lamps. The "Barb" feature permits simple fixing on the front of the panel and allows close grouping of the units. The removable lens cap, available in seven colours, facilitates bulb replacement from the front of the panel. Also, lens caps can be supplied which are virtually unbreakable. Oxley Developments Company Ltd, Priory Park, Ulverston, North Lancs.
WW319 for further details

Digital Integrated Circuit Tester

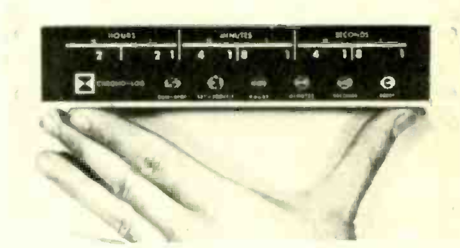
A compact, low cost, integrated circuit tester, manufactured by John Reeve Instruments, (designated the 51B) provides push-button selection of any test pin on most standard types of d.t.l. and t.t.l. circuits. Measurements are displayed on a 5in scale-length meter. Fully protected against overload and fitted with self-contained variable



power supplies and a pulse generator, the instrument is completely portable. Flexibility in operation is assured by utilizing manual control and dispensing with the need for programming cards. Up to 16 circuit pins are provided for on the basic instrument and packages of any configuration may be tested by using test sockets with adaptors which plug into the front panel of the instrument. The tester can be used in conjunction with various items of ancillary equipment for checking other types of logic or displaying circuit characteristics on a transistor curve tracer. Fully automatic functional tests and semi-automatic test sequencing can be carried out using special plug-in units. Price £235. John Reeve Instruments, 8 Ownstead Gardens, South Croydon, Surrey. CR2 OHH.
WW303 for further details

Digital Clock and Time Code Generator

A series of integrated circuit digital clocks and time code generators is available from Sintrom Electronics. The digital clock, the 30,000, designed for use with computers, data logging, data processing and digital readout systems requiring real or elapsed time inputs, is available in over 7,000 standard versions. Outputs, in b.d.c. or Nixie decimal front panel displays, can be in units of less than a second or as long as a month. The b.c.d. output is available in serial and/or parallel format. A wide variety



of timebases is available. An interlock circuit allows the external system to 'hold' the clock during readout without introducing any timing error. The time code generator, which provides I.R.I.G. and N.A.S.A. time code formats in both modulated carrier and level shift forms in addition to b.c.d. outputs, provides timing information to analogue recorders as well as to digital systems. Many versions are available with choices of timebase, power supply, output format and displays. Sintrom Electronics Ltd, 2 Castle Hill Terrace, Maidenhead, Berks.
WW331 for further details

L.F. Signal Generator

A v.l.f. and l.f. signal generator (type 422) is announced by the Airmec division of Racal. It is a solid-state crystal-monitored digital-display instrument, and has a continuously variable output from 0.005Hz to 50kHz. The 10V square

and sinewave outputs are available via a built-in matched 600 Ω 80dB attenuator and an unattenuated triangular output is provided at 5V p-p about earth. The 422 is suitable for many applications, including the audio, servo and medical fields. A coarse tuning control gives continuity of tuning by making the direction of rotation for frequency increase reversible for successive half-ranges of the frequency decade switch. This "zig-zag" arrangement obviates the necessity of reversing the coarse control back over its full travel when switching between decades. Accuracy is up to ±2 parts in 10^5 with stability of 1 in 10^4 over 30min. The precision with which selected frequencies are displayed is demonstrated by the least significant digit in the readout indicating micro-hertz for the lowest frequency range. The use of high-frequency basic oscillatory circuit ensures that the output frequency can be altered with no appreciable time delay. This, together with the fast presentation readout time of 110 milliseconds for any frequency, enables changes of output frequency of the instrument to be effected and displayed instantaneously. Racal Instruments Ltd, Bennet Road, Reading, Berks.
WW302 for further details

Miniaturized Reed Switch

The FR/Hamlin reed switch MTRR-2 has been reduced in size. The glass length is now 0.54in (13.7mm) instead of 0.625in, but the diameter remains at 0.090in. Contact rating is 10W maximum at 250mA. The off-centre gap makes the MTRR-2 ideal for permanent magnet applications. FR Electronics, Wimborne, Dorset.
WW334 for further details

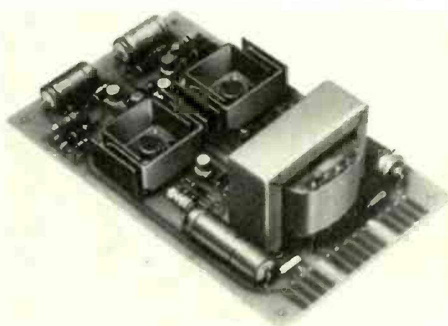
Megohmmeters

General Radio have announced two new megohmmeters; types 1863 and 1864. These meters are useful for measuring insulating materials as well as capacitor or semiconductor leakage. Although similar in appearance and accuracy, their operating ranges differ in order to meet differing needs. The 1863 can measure resistances from 50k Ω to 20 TΩ (2 x 10^{13} Ω) at five test voltages from 50 to 500V. The 1864 (illustrated) can measure resistances from 50k Ω to 200 TΩ at 200 test voltages from 10 to 1000V. Each

has an output voltage that is proportional to meter reading for limit testing. General Radio Company (U.K.) Ltd, Bourne End, Bucks.
WW301 for further details

Op. Amp. Power Supply

Weir's compact new model 915/912 power supply is suitable for use with most makes of operational amplifier requiring a balanced 12 or 15V regulated d.c. supply at currents up to 100mA. The units have long-term overload and short-circuit protection effected by constant current limiting at approximately 120% of rating. The two outputs can also be used in series to provide single outputs of 30V or 24V at 100mA. Both outputs have dual remote sensing for use where the power unit has to be located at some distance



from its load. Connections can be made via a printed circuit edge connector which is supplied with the unit. Regulation drift is less than 0.05%. Ripple and noise are less than 1mV p-p. Weir Electronics Ltd, Durban Road, Bognor Regis, Sussex.
WW318 for further details

Wire-wound Resistors

Impectron now distribute a resistor, called the Cerwistor, in which instead of the usual method of winding the resistance wire on the outside of a tube or bar of porcelain it lies *inside* the porcelain. This construction ensures that even the thinnest resistance wire is given mechanical protection. The Cerwistor is small in relation to the rated dissipation, and its flat body takes up very little space. It is available in 3-, 5-, 8- and 10-watt ratings at standard preferred values as recommended by I.E.C. series E24 which means 24 values between 1 and 10, between 10 and 100, etc. The insulation resistance is greater than 1000M Ω (with silicon protection even greater than 100,000M Ω). Standard tolerance is ±5% of the nominal resistance value, better tolerances can be supplied as specials. Impectron Ltd, King Street, London W.3.
WW315 for further details

Miniature Stabilized Power Unit

The PU40 miniature power unit from Fenlow provides stabilized d.c. voltages between ±10V and ±15V set by two external resistors. The input is the mains supply of 210 to 225V 40 to 60Hz. It is an encapsulated unit measuring approx. 82 × 63 × 25mm and has the following performance. Output current 40mA on each line with short-circuit protection. Line regulation is 0.01% for input voltage variation between 210 and 255V. The no-load to full-load regulation is 0.01%, and the total noise and ripple less than 2mV on each line. The unit is intended to drive a number of operational amplifiers, but its price of £20 should mean that it will find much wider applications as a building block for use in small

mains-powered instruments and also for experimental work in the laboratory. Fenlow Electronics Ltd, Whittet's Eyot, Jessamy Road, Weybridge, Surrey.
WW308 for further details

Contact Cleaner

A glass fibre eraser available from Garford-Lilley and Brother is suitable for contact and commutator cleaning, as well as for the preparation of joints prior to soldering. This brush will remove not only oxidization, but many forms of contamination from copper, aluminium, steel, etc., without damage to the components. The eraser consists of a stiff glass fibre brush mounted in a pencil shaped metal body. The exposed brush length can be adjusted for wear by a screw device fitted at the top of the body. Refills are available in boxes of 25 brushes. Garford-Lilley and Brother Ltd, 3 Hampton Court Parade, East Molesey, Surrey.
WW336 for further details

Trimmer Potentiometer

Reliance Controls have introduced four new trimmers. The CW52 miniature wire-wound trimmer is unsealed and available in a resistance range of 20 Ω to 20k Ω with a resistance tolerance of ±10%. Mechanical adjustment is 20 turns. Pin configuration is 0.2in, 0.3in and 0.4in with 0.5in between the outer pins. The CW52 can also be used for panel mounting and allows for adjustment through a panel up to $\frac{1}{4}$in thick. The CW52 is thus an unsealed version of the already established fully sealed CW51. The CW53 and CW54 are two new sealed trimmers with the same electrical specification as the CW52. The CW53 is

based on a dual in-line configuration with a 0.5in spacing along, a 0.3in spacing across, the body. The wiper connections on this trimmer are duplicated for mechanical stability. The CW54 has a 0.3in, 0.4in and 0.1in pin configuration with 0.7in between outer pins. The CW55 is an unsealed version of the CW54 with identical electrical specifications. All these trimmers are manufactured with terminals of gold-plated brass and wipers of gold-plated beryllium copper. Reliance Controls Ltd, Drakes Way, Swindon, Wilts.
WW311 for further details

D.C. Amplifier

Advance Industrial Electronics announce the introduction of the new Zeltex Model 240 f.e.t.-

input differential amplifier designed for use in low-level d.c. transducer, gain-switching and unloading-circuit applications. The unit features a built-in feedback network, adjustable closed-loop gain. Gain is set to any value between 1 and 1000 with an external resistor. High input impedance (10^{11} ohms) and an 80dB common mode rejection ratio (at any gain setting) make the Model 240 suitable for industrial, medical and biological applications. The gain-bandwidth product is 1MHz min. The unit can be soldered to a p.c. board or plugged into an optional mating connector. Price (1—9) £37. Advance Industrial Electronics, Raynham Road, Bishops Stortford, Herts.
WW321 for further details

Universal Digital Comparator

A digital comparator, the 6003B, designed to provide computer decision-making facilities when used in conjunction with any digital output device, is now available from Sintrom. It will accept single or multiple input data-groups from the parent digital equipment, compare the input to present limits, and within 20ms indicate one of five possible output decisions. The decision signals are in the form of contact closures and front panel lights. The model 6003B will accept

information from any digital equipment with outputs in 1-2-4-8 or 1-2-4-2 parallel b.c.d. form, whether the signal indicates frequency, voltage, capacitance, data card or computer information. One comparator can provide up to five output decisions, totalling 17 digits maximum and limit settings can be quickly made by means of front panel thumbwheel switches or remote programming from other equipment. Comparator units can be stacked to increase output decisions. Sintrom Electronics Ltd, 2 Castle Hill Terrace, Maidenhead, Berks.
WW316 for further details

Transient Amplitude Detector

A battery-operated transient amplitude detector capable of reproducing a 30ns width pulse to 90% amplitude accuracy has been developed by, and is now available from, Electro-Metrics Corporation, a subsidiary of Fairchild Camera and Instrument Corporation. The unit, designated model TAD-66, makes use of a high impedance differential probe for handling input signals from 0.001V to 25V. Four peak detectors, operating in parallel, sample and hold the input signal after amplification—two operating on the normal input and two on the input inverted—to assure fully redundant peak detection. The outputs of each pair of peak detectors are fed to amplitude comparators. Each comparator sees only the highest signal level that was fed to the detectors. A timing and sampling system alternately samples the outputs of the comparators to provide a pulse train, each pulse representing the highest transient seen during the sample time of the peak detectors. Sampling rates are variable from 10Hz to 1200Hz from built-in triggering, or up to 10kHz from external triggering. Slow sampling rates provide data that can be displayed on oscilloscopes and X-Y plotters. At the highest rates, the outputs are handled by a computer or other fast reacting device. The 30ns pulse-width handling capability means that the TAD-66 will handle signals accurately at frequencies from 10Hz to up to nearly

50MHz. If amplitude accuracy is not important and only indication of a transient is required, the unit will sample, hold and provide an output indication of a transient with a width of only a very few nanoseconds. The unit is battery-operated and has both a 600 Ω balanced output and a 50 Ω single-ended output for connecting to external display devices. Fairchild Electro-Metrics Corporation, 88 Church Street, Amsterdam, New York 12011, U.S.A.
WW313 for further details

Digital Multimeter

Fluke International announces a digital multimeter which uses an analogue-to-digital converter with only one-fifth of the parts normally required. The unit, Model 8300A, has five digits plus 20% over-ranging. The basic unit measures 0 to 1100V d.c. in three ranges. Sampling speed is 25ms. Low-cost options include a.c. voltage, millivolt-ohms, external reference (ratio) and fully isolated remote programming and data output. Because the new a.-d. technique substantially cuts down on the number of components used, a number of operating characteristics are improved. The new technique used in the Fluke 8300A is

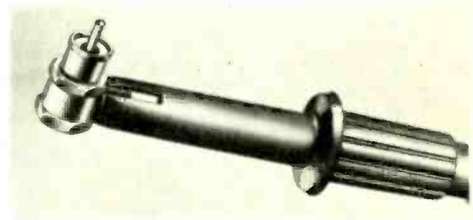
based on storage capacitors, a single b.c.d. counter and a resistive ladder network to serially determine and display all digits. It is called the recirculating remainder A to D system. Fluke International Corporation, Garnett Close, Watford WD2 4TT.
WW322 for further details

Transistor Arrays

Two general-purpose transistor arrays have been added to the range of linear i.cs available from R.C.A. The CA3026 and CA3054, which contain dual independent differential amplifiers with associated constant current transistors on a common monolithic substrate, have wide applications in low-power systems at frequencies from d.c. to 120MHz. Bias and load resistors have been purposely omitted to allow maximum application flexibility. The monolithic construction of the arrays gives close electrical and thermal matching between each pair of amplifiers, making these devices particularly useful in dual channel applications. The six n-p-n transistors which form each pair of amplifiers are general purpose types exhibiting low l.f. noise and a gain bandwidth product in excess of 300MHz. The CA3026 is contained in a hermetic 12-lead TO-5 package and is rated for operation from −55° to +125°C. The CA3054, which is electrically identical to the CA3026, is contained in a 14-lead dual in-line plastic package for applications requiring a limited operating temperature range, between 0°C and +85°C. The many applications of these devices include dual sense amplifiers, dual Schmitt triggers, multifunction combinations, i.f. amplifiers, product detectors, doubly balanced modulators and demodulators, balanced quadrature detectors, cascade limiters, synchronous detectors, pairs of balanced mixers, synthesizer mixers and balanced cascode amplifiers. The CA3026 and CA3054 are available at 15s 6d each for quantities of 100 plus from R.C.A's three distributors: Semicomps Northern Ltd, Robert Electronics Ltd, and Electronic Component Supplies (Windsor) Ltd. Large orders of 1,000 plus should be made direct to R.C.A. Ltd., Sunbury-on-Thames, Middlesex.
WW324 for further details

Oscilloscope Probe Adaptor

Sealectro have developed a new right-angled sub-miniature adaptor for use with oscilloscope probes. Designated Conhex 55-005-0119, the device will convert standard shielded probes to right angled devices and is particularly useful for



multiple test point monitoring in complex circuitry. The unit can be screwed into the end of the oscilloscope probe assembly in place of the standard tip. All metal parts are gold plated and the insulator is of Teflon. Sealectro Ltd, Farlington, Portsmouth, Hants.
WW317 for further details

Remote Programming Digital Multimeter

Dana Electronics announce a new range of programmable digital meters—the 4433/235 (non-isolated output) and the 4434/235 (isolated output). Both have isolated programming facilities for a.c., d.c., ohms and active filter as standard. The 4434 has the added feature of a built-in delayed command generator. These delays are appropriate to the function or filter speed called up and release the systems engineer from settling-time problems. The delayed command can be

over-ridden at any time by direct command. Prices: 4433/235—£1,050; 4434/235—£1,150. Dana Electronics Ltd., Dallow Road, Bilton Way, Luton, Beds.
WW326 for further details

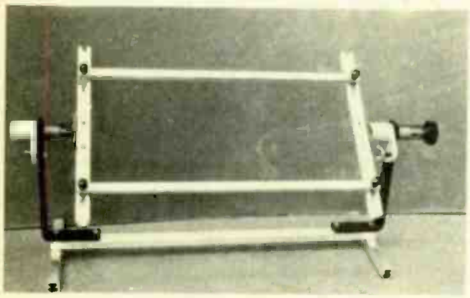
Monolithic Linear Multiplier

A monolithic linear four-quadrant multiplier, the MC1595, is available from Motorola. The output voltage is a linear product of two input voltages and a constant scale factor. The circuit is so designed that the scale factor and the input/output voltage ranges can be adjusted by the user to accommodate a wide variety of applications. Good linearity is obtained—typically 0.5% error for the X-input and 1% for the Y-input. Other features of the MC1595 are good temperature stability and an input voltage range of ±10V. Applications of the MC1595 include arithmetic opera-

tions (multiplication, division, squaring, finding square roots, and determining mean square), detection (a.m., f.m., phase and synchronous), modulation/demodulation (a.m. and balanced), frequency doubling, direct reading electric power measurements, trigonometric operations, and electronic gain control. Also available is a relaxed specification version with a temperature range of 0°C to +75°C, known as MC1495L. The multiplier is housed in a TO-116, 14-pin, dual in-line ceramic package. Motorola Semiconductors Ltd, York Hose, Empire Way, Wembley, Middx.
WW330 for further details

P.C. Board Holder

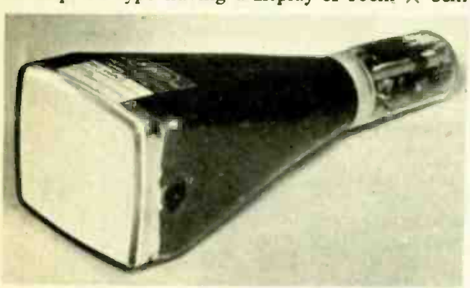
The Keyston Mark II printed circuit work-holder is suitable for bench mounting or free standing. The work frame accepts boards up to 15 × 10in (380 × 250mm) and up to ⅛in (3mm) thick and the working angle may be adjusted to suit the individual operator. The trunion mountings have



positive notch locations allowing the board to be reversed in a single operation. Extra guide rails can be fitted for simultaneous multi-assembly of smaller boards. A foam component-clamping pad is available. Keyston Engineers Ltd, 8 Tettenhall Road, Wolverhampton, Staffs.
WW312 for further details

Instrument C.R.T.

The M-O Valve Co. announces an extension to its range of high performance instrument c.r.ts, with the introduction of the 1400B—a single gun, mesh-p.d.a. type having a display of 10cm × 8cm



and an overall length of only 35cm. The X-sensitivity is 11V/cm and the Y-sensitivity 5V/cm. Deflection linearity is better than 5%. A typical final anode voltage for the 1400B is 12kV and under these conditions it can be used in oscilloscopes having bandwidths of 100MHz. The M-O Valve Co. Ltd, Brook Green Works, London W.6.
WW323 for further details

"Communications" Transistors

Twenty new "communications" transistors manufactured by T.R.W. Semiconductors Inc, California, are now available from M.C.P. Electronics. All are designed to be capable of withstanding severe mismatch under adverse load or phase conditions. These 12.5V devices are divided into four families. The five designated 2N5687-91 are for use in the 20-88MHz band and they range in power from 1.5 to 40W. Series 2N5702-6 is for use in the 144-175MHz band with a similar output power range. Five transistors designated 2N5697-5701 cover the 450-470MHz band and have power outputs from 0.25 to 20W. The fourth series, 2N5710-14, is specifically designed for high level a.m. modulation applications. Power output in this group ranges from 0.3 to 20W. M.C.P. Electronics Ltd, Alperton, Wembley, Middlesex.
WW305 for further details

Electronic Switches

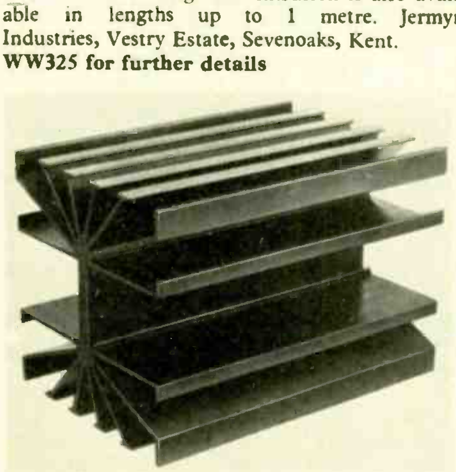
Now available from Interplanetric is a range of electronic switches, which employ Schottky diodes, for applications where high reliability, small size and fast switching is required. With low distortion and good transient response, the performance is claimed to be superior to that of balanced mixers used as switches. Low-loss, wide band, ferrite networks further contribute to the efficiency of the switches. Switching port voltages have been selected such that a positive voltage turns the switch on, and a negative voltage turns the switch off, thus avoiding the threshold uncertainty which results when zero switching voltage is used. Models are available with a built-in driver operating from a standard unipolar switching input compatible with common integrated circuitry. Interplanetric, 39-49 Cowleaze Road, Kingston upon Thames, Surrey.
WW332 for further details

Pulsed J-band Gunn Diode

A pulsed J-band (12-18GHz) hybrid mode Gunn effect oscillator has been announced by Plessey. Designed principally for use in high resolution, short range radar, these devices are made from epitaxial gallium arsenide layers grown by a process originating from the Allen Clark Research Centre at Caswell. The devices can be operated in both coaxial and waveguide cavities. Power outputs are up to 5W under 1μs pulsed conditions, and p.r.fs up to 50kHz. Conversion efficiencies are between 7 and 12%. Rise times are typically less than 2ns, and typical input requirements are 30V, 2A. Plessey Components Group, Microelectronics Division, Cheney Manor, Swindon, Wiltshire.
WW333 for further details

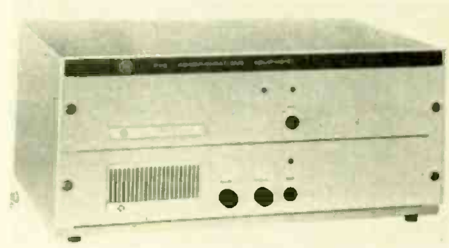
Heatsink Extrusion

The latest heatsink material to be added to the Jermyn range is the A25/2007. This extrusion offers a very large surface area with a substantial mounting web for the semiconductor. A feature of the extrusion is its light weight: for example a thermal resistance of 0.5°C per watt is typical for the heatsink type A25/2022 which is black anodized and has an overall size of approx. 115 × 120 × 140mm long. The extrusion is also available in lengths up to 1 metre. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW325 for further details



Radiotelephone Fixed Station

A new radiotelephone fixed station has been announced by Pye Telecommunications Ltd. Known as the F30FM, the fixed station, which is fully solid-state, is suitable for simplex or duplex operation in one of four frequency bands in the range 32.5—174MHz. There is



a choice of 12.5kHz, 20/25/30kHz or 40/50/60 kHz channel spacing and the transmitter has a power output of 30W. Modular construction in conjunction with printed circuit sub units provides easy access to all components and simplifies servicing. Pye Telecommunications Ltd, St Andrew's Road, Cambridge.
WW337 for further details

Low Reverse-leakage Rectifiers

Solitron of America announce a series (F927) of high-voltage axial lead, low reverse-leakage rectifiers. The series has a p.i.v. range of 5,000 to 25,000V and a reverse leakage of 1μA at 25°C, and will handle 0.5A at 55°C in free air. The

devices can be applied in all standard, single and polyphase rectifier circuits. The units are corona free and said to meet stringent electrical, mechanical and environmental specifications. Solitron Devices, Inc, 256 Oak Tree Road, Tappan, N.Y.10983, U.S.A.
WW320 for further details

Phase Sensitive Detector

AIM Electronics announces a new phase sensitive detector type PSD 122A which has an output drift less than 0.005% per °C and with a full scale deflection of ±5V. This means that zero drift is less than 250μV/°C. Linearity is better than 0.05% and there is an overload indicator which shows when the incoming signal is outside the permitted limits. The dynamic range is over 70dB. The instrument has its own meter built in. The unit accepts a reference signal of over 100mV r.m.s., which is used either as a quadrature or in-phase reference to the measured signal. The measured signal is 1 volt r.m.s. for full scale deflection of the meter (corresponding to ±5 volts at the monitor socket). The sensitivity may be increased to 1μV r.m.s. input for full scale deflection by the use of AIM's standard range of filters and amplifiers. The PSD 122A has an input bandwidth of 150kHz and a noise equivalent bandwidth of 0.025Hz. Price £147. AIM Electronics Ltd, The River Mill, St. Ives, Huntingdon.
WW304 for further details

November Meetings

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

LONDON
5th I.E.E.—"Some feasibility studies of synchronized oscillator systems for p.c.m. telephone networks" by M. R. Miller and "Wisdom: a method of synchronizing distributed systems to a p.c.m. system" by P. A. Wing at 17.30 at Savoy Pl., W.C.2.
5th I.E.R.E.—"C.A.D. of communication systems and circuits" by P. S. Brandon at 18.00 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
6th R.T.S.—"The application of silicon diode array targets in television camera tubes" by A. J. Woolgar and C. J. Bennett at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.
7th I.E.E.—Colloquium on "Bio-electrical engineering and power sources" at 14.30 at Savoy Pl., W.C.2.
7th Brit. Acoustical Soc.—"Microwave acoustics" at 17.00 at Imperial College, S.W.7.
11th I.E.R.E.—Discussion on "Studies of the lower atmosphere by modelling techniques" at 18.00 at 9 Bedford Sq., W.C.1.
12th I.E.E.—"Mintech and the electronics industry" by I. Maddock at 17.30 at Savoy Pl., W.C.2.
12th I.E.E.—"Noise problems in measurement" by Dr. E. A. Faulkner at 17.30 at Savoy Pl., W.C.2.
12th I.E.R.E.—"Locomotive-borne computer for continuous train control" by M. S. Birkin at 18.00 at 9 Bedford Sq., W.C.1.
12th Soc. Environmental Eng.—"The British calibration service" at 18.00 at Imperial College, Mech. Eng. Dept., Exhibition Rd., S.W.7.
12th S.E.R.T.—"Industrial electronics" by A. F. Giles at 19.00 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
13th I.E.R.E./I.E.E.—Second lecture on "Physiology for engineers" at 18.00 at St. Bartholomew's Hospital Medical College, E.C.1.
13th R.T.S.—"Colour recording—a look at the 'video printing' and 'Vidtronics' systems" by R. J. Venis and J. Mulliner at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.
14th I.E.R.E./I.E.E.—Discussion on "Computer standardization: bane or blessing? (an examination of the issues especially with respect to I/O interfaces)" at 14.15 at Savoy Pl., W.C.2.
17th I.E.E.—Discussion on "Alternatives to degree examinations as a means of assessment" at 17.00 at Savoy Pl., W.C.2.
18th I.Mech.E.—Discussion on "Computer aided design" at 09.30 at 1 Birdcage Walk, S.W.1.
18th I.E.R.E.—"Solid state television receivers—a pattern of second generation designs for monochrome and colour" by P. L. Mothersole at 18.00 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
19th I.E.E.—Discussion on "Instruments for the recovery of signals from noise" at 17.30 at Savoy Pl., W.C.2.
20th Inst. Electronics.—"A technique for the evaluation of data communication networks" by M. B. Ashdown at 18.30 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
21st I.E.E.—Colloquium on "R.F. and microwave industrial heating" at 10.00 at Savoy Pl., W.C.2.
21st I.E.E.—"Recollections of the early days of the thermionic valve industry" by S. R. Mullard and L. S. Harley at 17.30 at Savoy Pl., W.C.2.
26th I.E.R.E.—"Management by objectives" by D. Simpson at 18.00 at 9 Bedford Sq., W.C.1.
27th R.T.S.—Symposium on "Professionalism and training in educational television" at 17.00 at the I.T.A., 70 Brompton Rd., S.W.3.

BELFAST
25th I.E.R.E.—"Audio frequency hi-fi amplifiers" by I. Hardcastle at 18.30 at the Ashby Inst., Queens University, Stranmillis Rd.

BIRMINGHAM
12th R.T.S.—"Electronic video recording" by Sir Francis McLean at 19.00 at Broadcasting House, Carpenter Rd.

BRIGHTON
11th I.E.R.E.—"The place of the library in electronic engineering" by Miss E. Garratt at 18.30 at the College of Technology.

BRISTOL
19th I.E.E./I.E.R.E.—"E.M.I. 2001 colour television camera" by I. J. P. James at 19.00 at the University.
27th I.E.E.—Faraday Lecture "People, communications and engineering" by J. H. H. Merriman at 18.30 at Colston Hall.
28th I.E.E.—Faraday Lecture at 10.00 (students) at Colston Hall.

CAMBRIDGE
13th I.E.R.E./I.E.E.—"Digital control of radar displays" by H. Giles at 20.00 at the University's Engineering Labs, Trumpington St.

CARDIFF
12th I.E.R.E.—"Moire fringe measurement and numerical control of machine tools" by A. T. Shepherd at 18.30 at the University of Wales, Inst. of Science & Technology.
13th—"The electron microscope" by B. Rees at 19.00 at the University of Wales Institute of Science & Technology, Cathays Park.
14th S.E.R.T.—"Traffic control" by A. Gregory at 19.30 at Llandaff Technical College, Western Avenue.

CHATHAM
20th I.E.R.E.—"The Concorde flight control and landing systems" by D. M. Fryer at 19.00 at the Medway College of Technology.

COVENTRY
13th I.E.R.E.—"The use of light frequencies in communications" by R. B. Dyott at 19.15 at the Lanchester College of Technology.

DORKING
5th I.E.E.—"Medical electronics" by Dr. D. W. Hill at 19.30 at Martineau Hall, Dorking Halls.
25th I.E.E.—"Computer aided design" by J. A. Weaver at 19.30 at the Star & Garter Hotel.

DURHAM
26th I.E.E.T.E.—"Modern techniques of air-traffic control" by J. Henderson at 19.30 at the University's Science Labs, South Road.

GLOUCESTER
18th I.E.E.T.E.—"Electrics and electronics in aircraft" by H. Hill at 19.30 at the Technical College, Brunswick Rd.

HIGH WYCOMBE
18th I.E.E.—"Elementary principles of digital computers" by L. F. Cowan at 19.15 at the College of Technology.

HUDDERSFIELD
27th I.E.R.E.—"Lasers" by Prof. O. S. Heavens at 19.00 at the College of Technology, Dept. of Electrical & Electronic Engineering.

LEICESTER
13th I.E.R.E.—"Ground station aerials for satellite communications" by D. H. Shinn at 18.30 at the University Physics Lecture Theatre.

LIVERPOOL
12th I.E.R.E.—"Aircraft and instrumentation" by C. A. Williams at 19.00 at the University's Dept. of Electrical Engineering.

LOUGHBOROUGH
18th I.E.R.E./I.E.E.—"Impact of microelectronics for circuit engineers" by C. S. Den Brinker at 18.30 at the University of Technology, Edward Herbert Bldg.

MALVERN
13th I.E.R.E.—"Airborne collision avoidance systems" by S. S. D. Jones at 19.30 at the Abbey Hotel.

MANCHESTER
18th I.E.R.E.—"Automobile electronics" by W. F. Hill at 19.15 at the Renold Bldg., U.M.I.S.T., Altrincham St.
27th S.E.R.T.—"Stereo broadcasting" at 19.30 at Renold Bldg, U.M.I.S.T.

NEWCASTLE-UPON-TYNE
5th S.E.R.T.—"The Post Office Tower of London" by A. W. Mead at 19.30 at the Charles Trevelyan Technical College, Maple Terrace.
12th I.E.R.E.—"Application of positive temperature coefficient thermistors" by C. G. Smith at 18.00 at the Polytechnic (Rutherford College), Dept. of Physics & Physical Electronics.

NEWPORT, I.o.W.
14th I.E.R.E.—"Radar in a marine environment" by H. Giles at 19.00 at the Technical College.

PLYMOUTH
13th I.E.E./I.E.R.E.—"Satellite communication" by J. Lawson at 19.00 at the University.

READING
24th I.E.E.—"Hi-fi" by J. Moir at 19.30 at the J. J. Thomson Laboratory, the University, Whiteknights Park.
25th I.E.R.E.—"Automatic test equipment" by O. H. Davie at 19.30 at the J. J. Thomson Laboratory, the University, Whiteknights Park.

RUGBY
18th I.E.E.—Faraday Lecture "People, communications and engineering" by J. H. H. Merriman at 14.30 (students) and 19.30 (public) at the Granada Cinema.

RUGELEY
6th I.E.R.E.—"Electronic musical instruments" by Leslie E. A. Bourne and B. Arnold at 19.00 at Shrewsbury Arms Hotel, Market St.

SOUTHAMPTON
25th I.E.E.—Faraday Lecture "People, communications and engineering" by J. H. H. Merriman at 10.30 and 14.30 (students) and 18.30 (public) at the Guildhall.

Literature Received

For further information on any item include the appropriate WW number on the reader reply card

ACTIVE DEVICES

We have received the following literature from Nobel Electronics, Nobel House, 5-7 High St, Welling, Kent.

- Semiconductor summary 1969, listing STC digital and linear i.cs, transistors and diodes **WW401**
- Semiconductor price list for above catalogue **WW402**

RCA Great Britain Ltd, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx, have produced the following publications:

- RCA solid-state products guide **WW403**
- SK series replacement guide **WW404**
- Mounting hardware supplied with semiconductor devices **WW405**

Mullard minibook No.3 "Semiconductor devices" has been prepared by the Mullard educational department as an introduction to semiconductor devices for those with only a very basic knowledge of electronics. It is available from Mullard Educational Service, Torrington Place, London W.C.1, price 5s.

Amendments for the AEI Semiconductors and Technical Data Book have been prepared by AEI Semiconductors, Carholme Road, Lincoln.

- 12A, amendments for Vol.1 .... **WW406**
- 12B, amendments for Vol.2 .... **WW407**

PASSIVE COMPONENTS

West Hyde Developments, 30 High St, Northwood, Middx, have published a catalogue which describes the Contil Mod-2 range of p.v.c. coated instrument cases **WW408**

Ferranti Ltd, Dunsinane Ave, Dundee DD2 3PN, Scotland, has the following microwave literature available:

- Ferrite circulators 5.9 to 6.4 GHz **WW409**
- Ferrite circulators 3.7 to 4.2 GHz **WW410**

The full range of products manufactured by Oxley Developments Co. Ltd, Priory Park, Ulverston, Lancs., such as Barb insulators, plugs and sockets and trimmer capacitors, is described in a catalogue **WW411**

Received from Erie Electronics Ltd, South Denes, Great Yarmouth, Norfolk, the following literature:

- Moulded track potentiometers **WW412**
- Additional data sheets and price list for Erie catalogue **WW413**

"Battery replacement guide" gives the RCA equivalent for batteries in the domestic products of over 300 manufacturers. RCA Great Britain Ltd, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx. **WW414**

HARDWARE

The "Zip Twist" fastener, which can be pushed on to studs of fragile material and given a quarter-of-a-turn to lock and which has a self-threading action for removal, is the subject of a leaflet from the Carr Fastener Co. Ltd, Stapleford, Nottingham NG9 8AJ **WW415**

The "Pana Vise", which is a bench mounted vice allowing work to be held at any compound angle within a half sphere, is described, with accessories, in literature from Special Product Distributors, 81 Piccadilly, London W1V OHL **WW416**

P.T.F.E. shapes, including rod, tube, sheet, strip and sleeving, are described in publication from Polypenco Ltd, Gate House, Welwyn Garden City, Herts. **WW417**

EQUIPMENTS

A 1ns rise-time sampling unit, the type S-5, which has a 1MΩ-15pF input impedance, is described in a leaflet from Tektronix UK Ltd, Beaverton House, Harpenden, Herts **WW418**

The following two booklets are available from Aveley Electric, South Ockendon, Essex:

- Systron Donner analogue computers (10/20-40/80) **WW419**
- Aveley news (monthly) giving information on equipment imported from Germany **WW420**

A digital integrated circuit tester (type 51B) is the subject of a leaflet from John Reeve Instruments, 8 Ownstead Gardens, Sanderstead, South Croydon, Surrey CR2 OHH **WW421**

A series of low-noise broadcast quality microphone amplifiers are described in a leaflet from Elcom (Northampton) Ltd, Weedon Road, Industrial Estate, Northampton **WW422**

A wide range of instrumentation is described in a booklet "New electronics for measurement, analysis and computation" from Hewlett-Packard, 224 Bath Rd, Slough, Bucks **WW423**

GENERAL INFORMATION

Available from the City and Guilds of London Institute, 76 Portland Place, London W1N 4AA, a publication called "SI Symbols, abbreviations & conventions", price 2s.

We have received two more books in the "Measurements concepts" series from Tektronix U.K. Ltd, Beaverton House, Harpenden, Herts. They cost 10s each including postage.

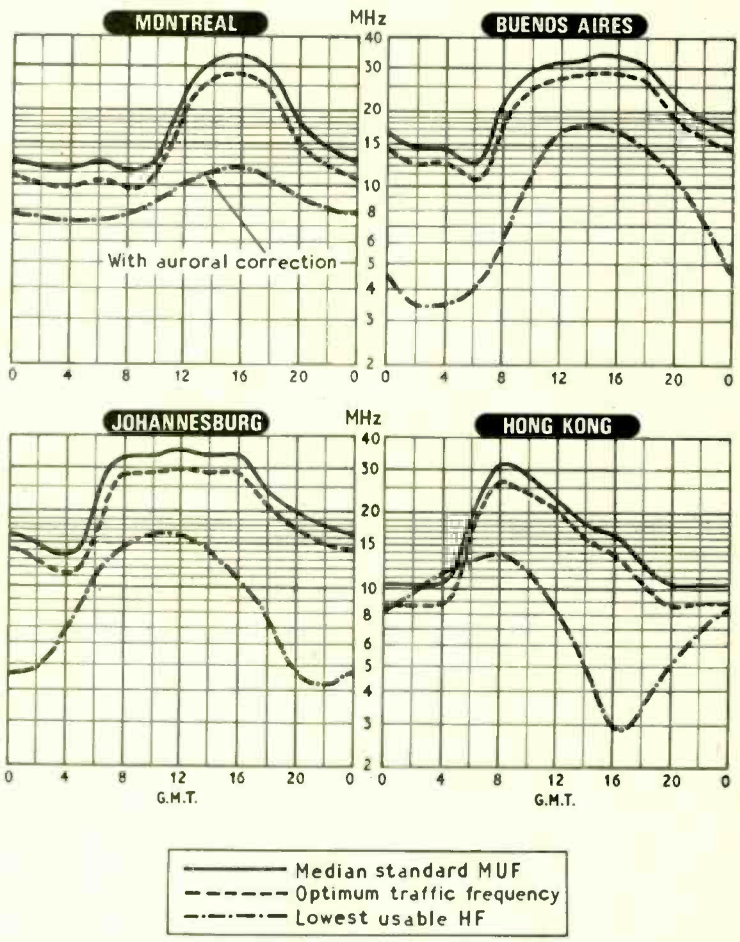
"Spectrum analyzer measurements" and "Automated test systems".

The latest edition of the British Amateur Electronics Club Newsletter contains a report of the Club's exhibition of electronic games and articles of constructional interest. Mr. C. Bogod, 26 Forrest Road, Penarth, Glam.

The following literature has been produced by the British Standard Institution, 2 Park Street, London W1Y 4AA:

- PD6435: "Instructions to technical committees for the preparation of generic specifications for electronic parts of assessed quality", price 21s.
- BS9500: "Sockets of assessed quality for electronic tubes and valves and plug-in devices: generic data and method of test," price 16s.

HF Predictions—November



It will be seen that the MUF for Johannesburg is just below 35MHz for an eight-hour period with very small variations. This should provide excellent conditions in the 26-MHz broadcasting band and the 25-MHz amateur band. The South America curve tends to a similar shape and favourable daylight conditions can also be expected. The Far East route will require full use of frequency complements to combat the continually changing MUF.

LUFs depend partly on geographic variation of atmospheric noise level and therefore, unlike MUFs, do not apply to both directions of a route. Those shown were calculated by Cable & Wireless Ltd for reception of specific point-to-point services in the U.K. but serve as a guide for all modes and services.

Answers to "Test Your Knowledge"—18

Questions on page 536

1. *(a)* The analogy is often justified by regarding the guide as consisting of two centre-line strips joined by a continuous row of quarter-wave stubs (making up the rest of the guide walls) on each side. This analysis is not, however, strictly correct since currents in the broad faces of the guide walls are not entirely transverse.

2. *(d)* This result is arrived at by considering the average value of the mean-square voltage across the wide faces of the guide, and the power flowing in the guide.

3. *(b)* Depending on its form the iris is equivalent to an inductance, capacitance, or combination of the two, shunting the guide. Its normalized admittance can be calculated from its dimensions.

4. *(d)* The slot must not interest lines of current flow in the guide walls.

5. *(c)* The position for the susceptance (post or iris) is found in terms of guide-wavelengths distance from the reference voltage minimum.

6. *(c)* Waveguide isolators, circulators and gyrators are non-reciprocal. These all use ferrite materials.

7. *(d)* In this way the reflections from the two cancel. The smaller the number of quarter-wavelengths (at the design frequency) the greater the range of frequencies over which the reflections will almost cancel.

8. *(d)*.

9. *(c)* The energy stored depends on the volume of the cavity, the power dissipated on the cavity surface area.

10. *(b)* Since the standing wave pattern is in the same position at resonance as it is well away from resonance the cavity is undercoupled. Hence the coupling parameter is 1/v.s.w.r.

11. *(d)* Since the source of reflection is generally many wavelengths from the input any slight change in frequency will cause a large change in the impedance which the guide presents to the generator. This, in turn, affects both the frequency and power output of the generator.

12. *(b)* This is an application of the high-low impedance principle in which alternate quarter-wave sections of high and low impedance guide are used.

13. *(d)* The wave travelling towards the short circuit suffers a reversal of phase on reflection, and this, added to the phase lag of π radians introduced by the journey to the short circuit and back, causes the wave reflected from the short circuit to be in phase with the wave propagated directly in the required direction in the wave guide.

14. *(d)* To couple out energy from a guide a hole has to interrupt only lines of current flow, but the fields stimulated in the other guide must be correctly oriented to propagate in that guide.

15. (c) Matching elements are incorporated in the junction to achieve this condition.

16. *(b)* In the piston attenuator the attenuation is provided by a section of cut-off waveguide.

Real & Imaginary

by Vector

"Plus ça change, plus c'est la même chose"

This month I'm going to do something that I'm rather good at, namely sitting back and letting someone else do the work. The excuse for doing so is contained in a paper read at a meeting of the Institution of Electrical Engineers under the title "Co-ordination of Research in Works and Laboratories".

In his introduction H. R. Constantine, the author, reminds us that to be a great and prosperous nation today implies being at the forefront in scientific genius and in engineering capacity. He then takes his first sideswipe at us by saying that there was a time when this country was able to hold its own against any other nation, but that we are now in the process of falling asleep while others surpass us.

He goes on to say that the reasons why we have lost our commercial supremacy are not to be found in any lack of ability or want of inventive genius. Our backsliding has been mainly due to the lack of responsiveness by government authorities, manufacturers and financial leaders to the needs of scientific genius. Many examples (he says) could be given of new ideas or inventions devised by British brains which have been ignored here and have subsequently been taken up abroad. The situation is aggravated by the national characteristics of selfishness and stubbornness which prevents a Britisher from communicating his methods to his fellow workers. (Strong meat for any Learned Society to digest!)

Arguing for more co-ordination in research the author notes that powerful banking organizations exist to offer a stronger financial front against foreign competition while various employers' associations are in being to further business. There are also selling organizations to promote exports, so why not a research combine also?

He then sets out one approach to the problem. This envisages the establishment of a vast national research laboratory (or complex of laboratories) under the control of a government-appointed body consisting of engineer-representatives of universities and industry. The administrative side would be undertaken by another body, chosen for its business ability.

This maxi-laboratory would take over the whole of the pure research now done by universities, colleges, technical institutions and private or works laboratories. Any manufacturer who wanted a given matter researched would apply to the central authority who would be in a position to tell him what had already been done in that particular line and to advise him regarding the best way to continue. Any research project brought to a successful conclusion would be passed to the central 'bank' where it would be freely available to any British manufacturer who wanted it. (Note that these suggestions apply only to pure research; each manufacturer would be free to conduct his own applied research.)

Having painstakingly built a nationalized edifice brick by brick (only a few of the main features have been decribed above) the author puts a substantial charge of high explosive in its basement and proceeds to light the blue touchpaper. The proposal (he maintains) is impracticable on grounds of cost. He then expounds an alternative scheme. This, much abbreviated, is a method of co-ordinating existing laboratories. It proposes a central board of control composed of private individuals representing the various interested parties—universities, manufacturers and so on. This board would keep full records of what individual laboratories were doing and would maintain records of published research work on the largest possible scale. The board would be given full powers to order any laboratory to undertake a specific piece of research or to leave another alone.

One essential feature of the scheme is to provide a posse of travelling engineers whose duties would be to visit the various laboratories at frequent intervals and to report back to H.Q. giving general and detailed accounts of what was afoot, or of research that was needed. New ideas would also be culled. As with his first suggestion the author recognizes that one of the prime requirements would be the establishment of an efficient central records office.

At this juncture the author pauses to consider the evils of continuing with a multiplicity of independent laboratories, each working in comparative ignorance of what others were doing. He makes the following points:—

(1) In general, manufacturers' laboratories tend to attempt too many researches at once and are not properly equipped to do any one of them.

(2) They are usually under the ultimate control of a top executive whose orientation is towards sales, not research.

(3) It is physically impossible for each individual firm to acquire and maintain a technical library on a scale that ensures it contains information on everything.

(4) Each laboratory is intensely jealous of all rivals and will on no account let others know what it is doing. As a result, twenty firms could be carrying out exactly the same research work.

Item (4) is clearly a major stumbling block and the author is at pains to deal with it. In his scheme a manufacturer's research information would be sent to the central board under a strict seal of security; it would be used primarily for records purposes, to ensure that overlapping of projects did not take place.

University laboratories would still continue with their routine laboratory training programmes; the central board would be interested only in the absolutely new experimental work in hand. The board would work in close liaison with the university authorities, merely ordering that specified research should be carried out over a certain period and giving general instructions as to how it should be approached.

Patents are one of the headaches in any such scheme and the author deals faithfully with this problem also. He suggests that an equitable solution would be to invest the central board with the responsibility of deciding whether it was worth while to take out a patent application in any given circumstance; if it were, the board would do so, paying all the attendant expenses. It would then proceed to dispose of the rights to those manufacturers declaring themselves interested, in consideration of agreed payments. After these payments had been pooled, the inventor and his assistants would be appropriately rewarded.

The author concludes by saying that in spite of the detailed proposals set out, the chief purpose of the paper is to draw attention to the need for fresh thinking on how research could best be handled, both in the national interest and for the benefit of manufacturers and universities. His final words are an appeal to the Institution to take the initiative and convene a conference of all potentially interested parties, "in order to settle in the first place the absolute necessity for some such concerted action and to come to some decision as to the general outlines that such a scheme would have".

In the discussion that followed the reading of the papers, the proposals were damned with faint praise. Some words of the final speaker are, I think, worth recording:

"I am perfectly certain it is a waste of energy to try to centralize the whole business of research . . . overlapping [of research projects] is a very good thing. There is a certain sporting element in overlapping and I think if an Englishman is to make any progress in research or anything else he must be able to feel that there is a certain amount of sport at the back of it all—money is not sufficient. There must be that sporting element of rivalry . . . ."

And that's about all I've room for; the paper itself is very much longer. But one final word if I may: The paper was read before the Institution just over fifty years ago and was published in the *Journal of the I.E.E.* in October, 1920. Meanwhile, relax. You're not being nationalized yet.

THE SINCLAIR SYSTEM 2000 range is an original concept in which very advanced circuit and production techniques result in equipment comparable to far costlier types in quality and performance. The units form a complete stereophonic system or may be bought and used separately as required. Solid aluminium is used throughout in matching designs of outstanding elegance and the amplifier and tuner can be stacked or positioned side by side.

THE AMPLIFIER has a total output of 35 watts RMS music power (17.5 watts per channel). Total harmonic distortion is 0.5% at 1 kHz. Six push buttons serve for the selection of seven inputs—ceramic and low output magnetic pick-ups, radio, microphone, auxiliary, tape head outputs of 7½ and 3¾ ips and mono/stereo. Frequency response extends from 15 Hz to 30 kHz ±1dB. Rotary controls are used for volume, bass, treble and balance. Outputs may be fed to loudspeakers of any impedance from 3 to 15 ohms. Case size—12 x 6 x 2 inches high (30 x 15 x 5 cm).

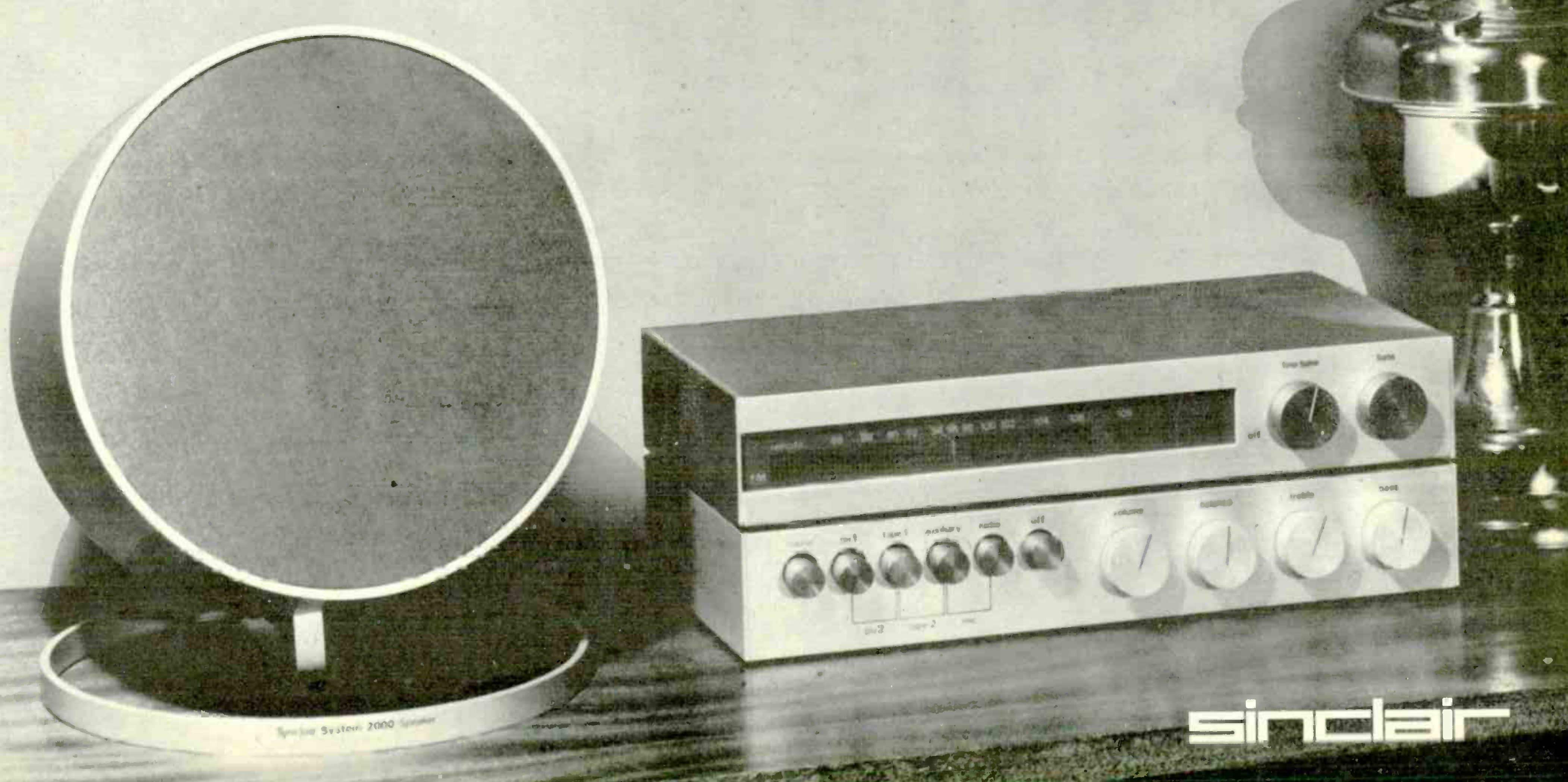
THE VHF/FM TUNER uses a pulse counting discriminator for the best possible audio quality. Important features include inter-station noise suppression, built-in AFC and electronic fine tuning, making the tuner a delight to handle. Tuning is from 86 to 108 MHz. A plug-in stereo decoder is available for adding to the mono version, or the tuner may be purchased complete in stereo form.

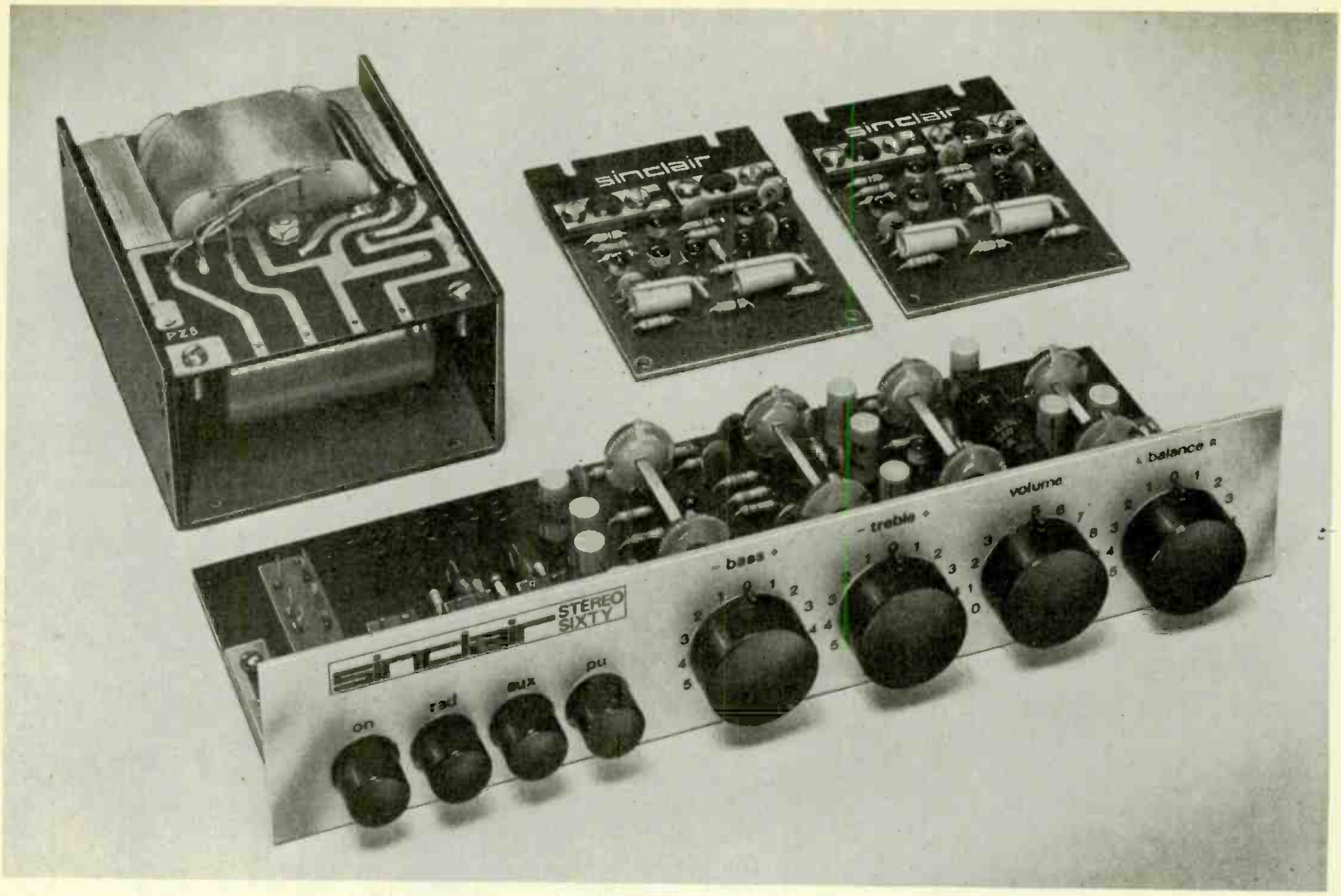
THE LOUDSPEAKER is an outstanding example of attractive contemporary design in which very high standards of reproduction are incorporated. This remarkably compact unit handles up to 10 watts continuous loading and has an impedance of 4 ohms at 1 kHz. Size 9 inches diameter by 4 inches deep.

Ask your dealer to demonstrate the System 2000 and judge this imaginatively designed equipment for yourself, or write or phone for leaflet.

System 2000 35 watt Integrated Stereo Amplifier	29 gns
System 2000 F.M. Tuner	25 gns
+5/0 P.T. surcharge	
Plug-in stereo decoder	4 gns
System 2000 4 ohm loudspeaker	12 gns
+4/7 P.T. surcharge	

Sinclair Radionics Limited, 22 Newmarket Road, Cambridge. Tel. Cambridge 52731





Project 60 an exciting alternative

The buyer of an amplifier today has a remarkably wide variety to choose from. It is unlikely that a purchaser would have real difficulty in finding a unit that met all his requirements, although the price might not be as low as could be wished. The only snags are that one's needs can change and that the technically correct amplifier may be physically inconvenient. If you are confident that there is an amplifier available, of the right size and price, which will meet all your needs for the forseeable future, then that is your best buy. If not, however, we can offer you another possibility which we believe to be an exciting alternative approach. That alternative is **Project** 60.

Project 60 is a range of modules which connect together simply to form a complete stereo amplifier with really excellent performance. So good, in fact, that only 2 or 3 amplifiers in the world can compare with it in overall performance.

The modules are: **1**. The Z-30 high gain power amplifier, which is an immensely flexible unit in its own right. **2**. The Stereo 60 preamplifier and control unit. **3**. The PZ.5 and PZ.6 power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6. The power supplies differ in that the PZ-6 is stabilised whilst the PZ-5 is not. This means that the former should be used where the highest possible continuous sine wave rating is required. In a normal domestic application there will not be a significant difference between using either power unit unless loudspeakers of very low efficiency are being used.

All you need to assemble your system is a screwdriver and a soldering iron. No technical skill or knowledge whatsoever is required and, in the unlikely event of you hitting a problem, our customer service and advice department will put the matter right promptly and willingly.

Perhaps the greatest beauty of the system is that it is not only flexible now but will remain so in the future. We shall shortly be introducing additional modules which will include a comprehensive filter unit, a stereo F.M. tuner and an even more powerful amplifier for very large systems. These and all other modules we introduce will be compatible with those shown here and may be added to your system at any time.

Project 60 modules have been carefully designed to fit into virtually every known type of plinth or cabinet and templates provided enable you to position them. Only holes have to be drilled into the wood of the plinth and any slight slips here will be covered completely by the aluminium front panel of the Stereo 60. The Project 60 manual gives all the instructions you can possibly want clearly and concisely.

AUDIO & PHOTO CINÉ FAIRS, STAND 95, OLYMPIA

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Telephone: 0223 52731

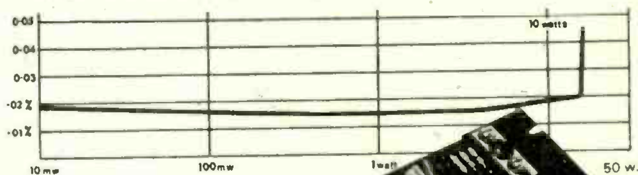
WW—111 FOR FURTHER DETAILS

Z-30 TWENTY-FOUR WATT CONTINUOUS SINE WAVE POWER AMPLIFIER

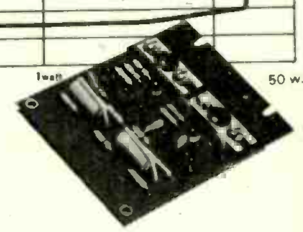
The Z-30 is a complete power amplifier of very advanced design employing 9 silicon epitaxial planar transistors. Total harmonic distortion is incredibly low being only 0.02% at full output and all lower outputs. As far as we know, no other high fidelity amplifier made can match this specification, no matter what the price. Thus you can be utterly certain that your Project 60 system will do full justice to your other equipment however good it may be. The Z-30 is unique in that it will operate perfectly, without adjustment, from any power supply from 8 to 35 volts. It also has sufficient gain to operate directly from a crystal pickup. So in addition to its use in a high fidelity system you can use a Z-30 to advantage in your car or a battery operated gramophone for your children, for example. These, and many other applications of the Z-30, are covered in the Project 60 manual.

APPLICATIONS

High fidelity amplifier: car radio amplifier: record player fed direct from pick-up: intercom: electronic music and instruments: P.A., laboratory work, etc. Full details of these and many other applications are given in the manual supplied with your Z.30.



Power versus distortion curve of Sinclair Z.30.



SPECIFICATIONS

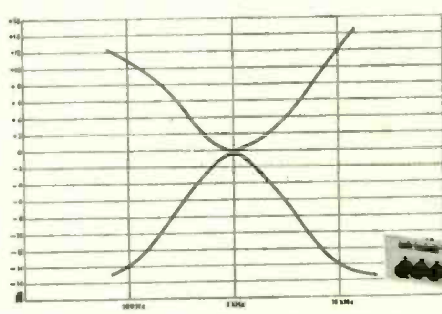
Power output—15 watts continuous sine wave into 8 ohms using a 35 volt supply: 24 watts continuous sine wave into 3 ohms using a 30 volt supply.

Frequency response:	30 to 300,000 Hz ± 1dB.
Signal to noise ratio:	better than 70dB unweighted.
Distortion:	0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.
Size:	$3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{2}$ inches.
Input sensitivity:	250mV into 100 Kohms.
Damping Factor:	>500.
Output—Class AB:	
Loudspeaker impedances 3 to 15 ohms.	
Power requirements:	8 to 35 V.d.c.

Ready built, tested and guaranteed, with Z.30 manual. **89/6**

STEREO SIXTY PREAMPLIFIER AND CONTROL UNIT

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to achieving a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.



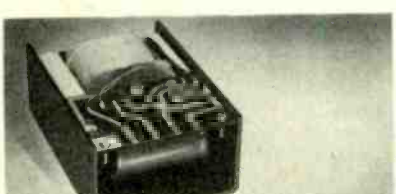
SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV: Magnetic Pickup—3mV Correct within ± 1dB on R.I.A.A. curve. Ceramic Pickup —up to 3mV: Auxiliary—up to 3mV.
- Output—1 volt.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE + 15 to − 15dB. at 10 KHz: BASS +15 to −15dB at 100 Hz.
- Power consumption 5mA.
- Power requirement—PZ.5 or PZ.6.
- Finish—brushed aluminium front panel with black knobs.
- Mounting—on cabinet front by spindle bushes and adjustable brackets.

Ready built, tested and guaranteed **£9. 19s. 9d.**

AT THE AUDIO FAIR STAND 95

SINCLAIR POWER SUPPLY UNITS



PZ-5 30 volts unstabilised—sufficient to drive two Z-30's and a Stereo 60 for the majority of domestic applications.

Price: **£4. 19s. 6d.**

PZ-6 35 volts stabilised—ideal for driving two Z-30's and a Stereo 60 when very low efficiency speakers are employed.

Price: **£7. 10s. 6d.**

GUARANTEE

If at any time within 3 months of purchasing Project 60 modules from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter.

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD, CAMBRIDGE
Telephone 0223 52731

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To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE

Please send ....

for which I enclose cash/cheque money order

NAME ....

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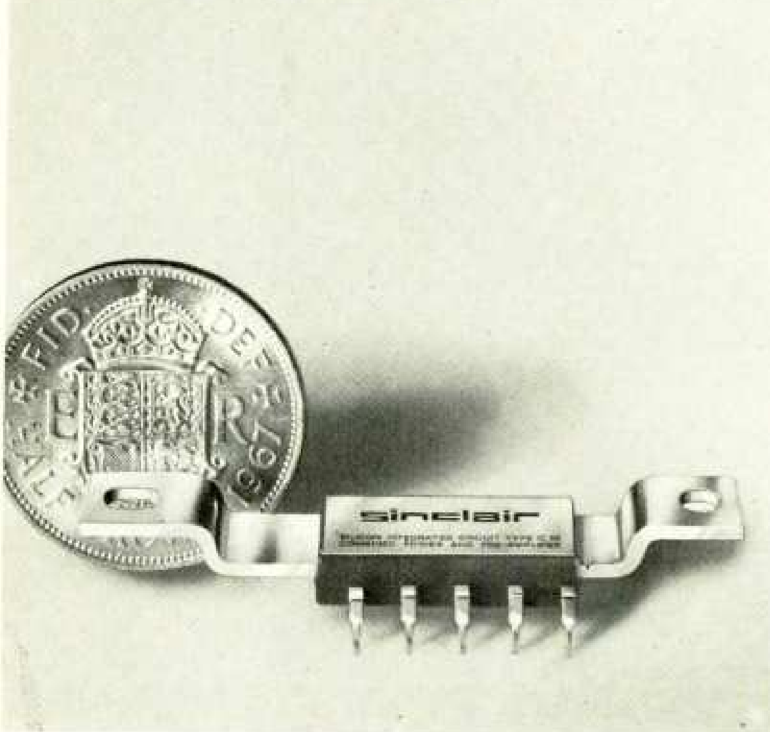
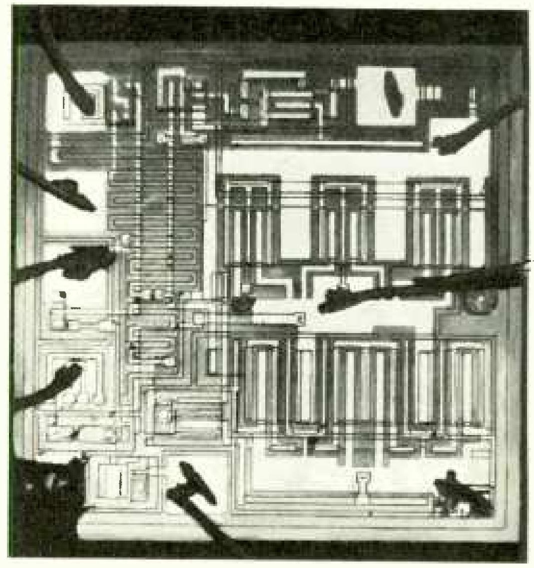
WW11.69

SINCLAIR IC-10



10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



A 13 transistor circuit measuring only one twentieth of an inch square by one hundredth of an inch thick!

the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick, has an output power of 10 watts. It contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout), etc. Once proven, the circuits can be produced with complete uniformity which enables us to give a 5-year guarantee on each IC-10, knowing that every unit will work as perfectly as the original and do so for a lifetime.

■ SPECIFICATIONS

Output:	10 Watts peak. 5 Watts R.M.S. continuous
Frequency response:	5 Hz to 100 KHz ± 1dB
Total harmonic distortion:	Less than 1% at full output.
Load impedance:	3 to 15 ohms.
Power gain:	110dB (100,000,000,000 times) total.
Supply voltage:	8 to 18 volts.
Size:	1 x 0.4 x 0.2 inches.
Sensitivity:	5mV.
Input impedance:	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages, making battery operation eminently satisfactory.

■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

USE THIS ORDER FORM FOR YOUR IC-10

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE

Please send

.... *NAME* ....

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for which I enclose cash/cheque money order WW.11.69

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IC-10 *with IC-10 manual and 5-year guarantee Post free.* **59/6**

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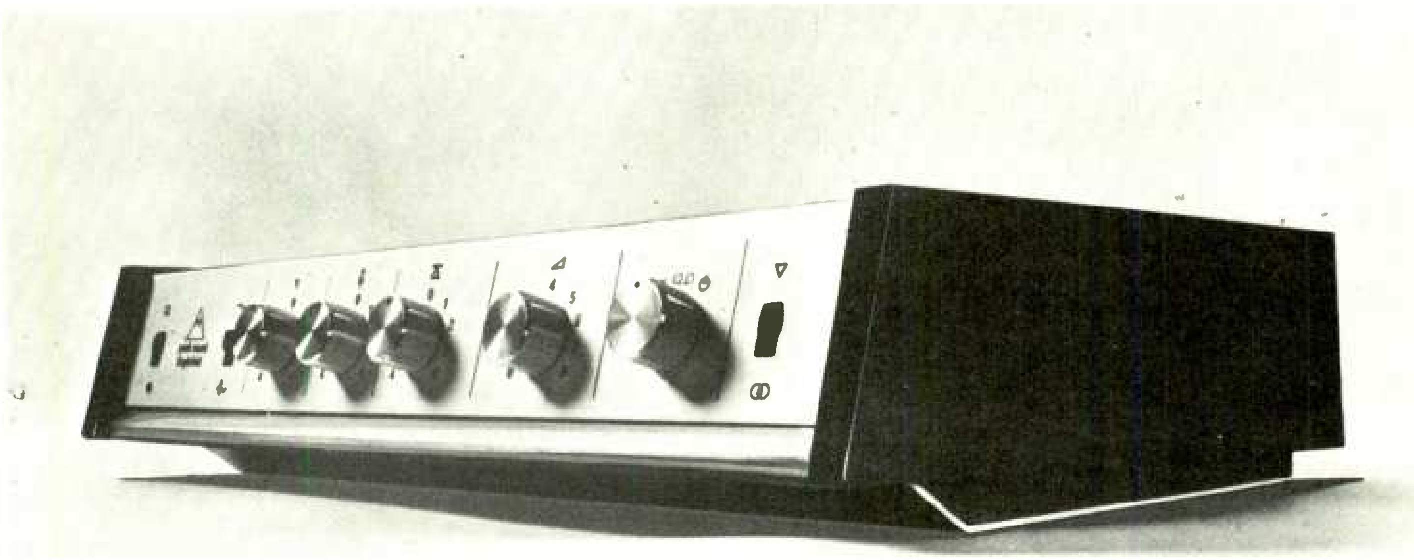
peak sound



A NEW DESIGN FROM PEAK SOUND

think of hi-fi this way

Think of a stereo amplifier delivering 12 watts R.M.S into 15 ohms per channel and having a total harmonic distortion of 0.1% at full output at 1 kHz. Think what an overload factor of 29dB means on all inputs. Think what it means, too, to have a top-flight amplifier housed in a cabinet of elegantly original design that is both beautiful and completely practical back and front. Think what such an amplifier with its many desirable features might cost – then remember that by assembling the Peak Sound "Englefield" yourself from the pre-built lab. tested modules we design and make, you can own one of the best designed amplifiers you have ever heard for about £38. The ease with which you can do this will delight you. So will the performance and appearance of the complete equipment. The Englefield system enables you to use the exclusive design cabinet for either a 12 + 12 watt assembly or 25 + 25 watt assembly, the pre-amp and tone control unit module being common to either. Each has its own built-in necessary power supply unit.

SPECIFICATION

Using two Peak Sound PA 12-15's. SCU 400 and PS 45K

Power output per channel	13 watts into 15 Ω: 18w into 8 Ω: 24w into 3 Ω. all R M S
Frequency bandwidth	10Hz to 45kHz for 1dB at 1 watt
Total Harmonic Distortion at 1kHz at 11 5w into 15 Ω	0 1%
Input sensitivities—	Mag P.U 3 5mV Imp. R I A.A. equalized Tape—100mV linear: Radio 100mV linear
Overload factor—	29dB on all input channels
Signal/noise ratio—	−65dB on all inputs
Controls—	Volume: Treble (+12 to −12dB at 10kHz): Bass (−12dB to +12dB 100Hz) Filter 9kHz at 12dB/per octave: Mono/Stereo: On-off: Balance

Using two PA 25 15 amplifiers and PS/68S power supply output is then 26 watts into 15 Ω per channel at 1kHz or 35w into 8 watts

THE MODULES

An Englefield Stereo Amplifier offers the constructor choice of either the well-known and proven PA.12-15 or PA.25-15 power amplifier modules.

	£	s	d
Englefield Amplifier Cabinet with front panel. knobs. sockets. cut and stripped wire to length. fuses. edge connectors. etc.	£6	0	0
Two PA.12-15 power amp. built modules (£5.19.6 each)	£11	19	0
SCU/400 Pre-amp./Control module. built	£15	15	0
PS/45 Power Supply kit	£4	10	0
	£38	**4**	**0**

Using two PA.25-15 power amplifier modules at £11.15.0 each and PS/68S Stabilized Power Supply Unit at £13.10.0. total price for complete system comes to **£58 15 0**

OTHER PEAK SOUND PRODUCTS

ES.10-15 Bassandall Loudspeakers as described in Wireless World.

•

SA.10-10 Economy Stereo Amplifier in kit form

•

"Cir-Kit" circuit building strip.

•

Matching Stereo Tuner Modules available shortly.

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Go to your Stockist. Peak Sound products are already available from dealers in all parts If your own local stockist is not yet ready with the Peak Sound items you require. please send direct together with your supplier's name and address and your requirements will be dealt with without delay

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Green, Egham, Surrey
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To Peak Sound, 32 St. Jude's Rd., Englefield Green, Egham, Surrey.

Details of Englefield systems, please and ....

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Address ....

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FE—153—BD **£38-10-0**

low drift • low noise
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*Mains

	£	s.	d.
350-0-350V. 60mA., 6.3V. 2A.	2	2	0
500V. 300mA. 6.3V. 4A., 6.3V. 1A.	3	19	9
500-0-500V. 0.25A., 6.3V. 4 Act., 6.3V. 3 Act., 5V. 3A.	4	19	9
525-0-525V. 0.5A., 6.3V., 6 Act., 6.3V. 6 Act., 5V. 6A.	5	13	6

*Low Voltage

	£	s.	d.
30-0-30V. 4A.	3	12	6
28V. 1A., 28V. 1A., 28V. 1A., 28V. 1A., 30V. 250mA.	4	15	0

*Primaries 10-0-200-220-240V.

20W Transistor Amplifier (W.W. Nov. 1966)

	£	s.	d.
Driver	1	4	6
Mains	1	19	6
L.P. Filter, Chassis Mounting		12	6
L.P. Filter, Printed Circuit Mounting		15	6

70V & 100V Line Matching

Fitted with terminal panel, taps at 0.5, 2, 4 and 8W. into 15 ohms .. 9/- each in 100 Lots
Flying leads, taps at ¼, ½, 1, 2 and 4W. into 3 ohms .. 7/3 each in 100 Lots

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15 watt QQVO3-10 TX less case (heaters) PSU mod. and crystal, 6 or 12v. Heaters. Post 4/6, **£8.15.**
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Hartley 13A DB	£22
Cossor 1049 DB	£35
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Output 20–500 v. in two ranges. Positive line at 300 mA. Variable output 170 v. fixed; 0–170 v. variable. Two A.C. outputs at 6·3 v. A.C. are provided.

These units are offered in first-class condition. For A.C. mains. 200–250 v. A.C. Overall case dimensions 20 × 16 × 10 ins. approx.

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Low Voltage P.S.U. Type 4D

3–30 v. D.C. at 3 amps. Fully variable.
Current limiting control.
Sensing facilities for remote operation.
Protected and fused for 110/250 v. A.C. mains.
Small size only: 5½ × 5 × 11 ins. deep.
Stability: 1000–1.
Ripple: 1 mV. max. Weight: 16 lbs.

These units are built to high present-day standards and are offered BRAND NEW BOXED at £20 inclusive of post and packing.

ALSO AS ABOVE
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Size 4 × 3½ × 7 ins. Weight: 6 lbs.
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UHF RECEIVER R.D.O.
With 3 R.F. tuning units to cover 38–1000 MHz. These receivers are built to U.S. Navy specifications and are ideally suitable for laboratory and communications use. For 240 v. A.C. operation.
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Non-spillable lead acid type. Rating: 12 v. 4 amp. hours, will withstand heavy overloads without damage.
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Supplied fully sealed/charging instructions.
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We have for disposal complete sets comprising 2 batteries to a total of 12 v. at 180 amp/hours. Supplied filled as NEW CONDITION.
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One of the major uses of a directional coupler is to obtain a sample of the R.F. Power in a transmission line and apply it to an indicator. We can supply couplers with a power handling capacity of up to 300 Watts, the response is flat over the 66–88 Mc/s, 156–184 Mc/s and 200–450 Mc/s bands. Two pick-up probes are mounted on the coupler, one giving incidence the other reflective power, the voltage developed is rectified and may be fed to a calibrated meter, C/W 50 ohm plugs.
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Standard wafer size: 1¾ ins. Single-pole 12-way, 3-bank flange mounting. 48 v. D.C. coils. Minimum voltage 30 v. D.C. Supplied BRAND NEW 45/-. **Similar to above** but one wafer with long spindle to enable user to make up to own requirements. Coil voltage: 30–48 v. D.C. BRAND NEW 35/-.

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These are high quality heat sink type. Rated at 15 ohms, 250 watt. Size only 4½ × 2 × 2½ ins. A Dale product at a surplus price. Only 19/6 each, post and packing 2/6.

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Quantities available

HIGH VALUE RESISTANCE BOX TYPE R.7003
Specification. Range: 0·01–11·10 Megohm in 0·01 Megohm divisions. Accuracy: 0·05 per cent. Maximum power rating: 0·1 watt per step. Case: Hammer finished stove enamel.
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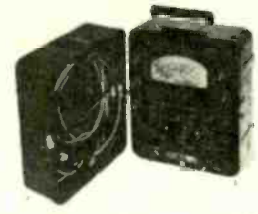
PORTABLE WHEATSTONE BRIDGE
Specification. Type: Moving Coil Galvanometer. Ranges: (1) 0·05 to 5 ohms; (2) 0·5 to 50 ohms; (3) 5 to 500 ohms; (4) 50 to 5,000 ohms; (5) 500 to 50,000 ohms. Scales: Switched. Slidewire: 0·5 to 50. Galvanometer Scale: 10–0–10. Case: Moulded plastic. Internal Source: 4 v. Dry battery. Operating Temperature: +10 to +35 deg. C. Operating Humidity: Up to 80 per cent R.H. Dimensions: 200 × 110 × 65 mm. Weight: 0·9 kg. List price £25. Our price £9.19.6.

PORTABLE MULTIRANGE METER



Specification. Ranges: 0–60 and 0–300 µA, D.C. 0–3, 0–30 and 0–120 mA, D.C. 1·2 and 12 amps D.C. 0·6–3 and 6–30 mA, A.C. 24–120 mA, A.C. 0·24–12 A, A.C. 3–12–30–300–600–1,200 and 6,000 v. D.C. 0·6–3, 2·4–12, 6–30, 60–300, 120–600, 240–1,200 and 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 × 170 mm. Weight: 8 kg. Supplied with 2 voltage dividers, H.V. leads, spare rectifiers, 1·5 and 22·5 v. battery.
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Polyskop II. 0·5–1,200 MHz.

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UHF Signal Generator Type SCR. 1,000–1,900 MHz.

UHF Millivoltmeter Type URV.

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Attenuation 0·1 micro v.–100 mV.
Supplied in very good condition.
Frequency coverage: 2–400 MHz.

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Range: 30–900 MHz.
Approved by G.P.O. as standard for mobile communications equipment, etc.

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Range, with plug-in, up to 220 MHz.
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Range: 0–500 v. and 001–10 v. as null detector.

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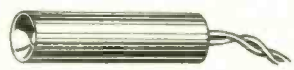

MAX RATINGS
Total dissipation (in free air, T_{amb} = 25°C.) .... 100mW. Derating Factor .... 2mW/°C. Output Current Intensity .... 100mA. Voltage .... 25V. Operating Temperature .... from —30° to +125°C.
Supplied complete with suitable lenses, full Technical Data and Application Sheets, including Line of Sight Speech Link.

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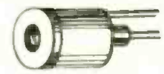
Filamentless, infra-red emitter in a robust, sealed cylinder coaxial with beam to facilitate optical alignment and heat sinking.



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MAX RATINGS
Forward current I_F max. D.C .... 400mA. Forward peak current I_F max.* (pk) 6A
Power dissipation* .... 600mW. Derating factor for T_{amb} greater than 25°C .... 7.5mW/°C.
Reverse voltage V_R max 1-0V.
When mounted on an aluminium heat sink 1in. x ¼in. x ¼in.
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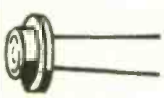
CADMIUM SULPHIDE CELLS (Cds)

Inexpensive light sensitive resistors which require only simple circuitry to work as light triggering units in a wide range of devices, such as: flashing or breakdown lights, exposure meters, brightness controls, automatic porch lights, etc. Not polarity conscious — use with A.C. or D.C. Spectral response covers whole visible light range.



MKY101-C
Epoxy sealed. ⅜ in. diam. x ⅛ in. thick. Resistance at 100 Lux – 500 to 2,000 ohms. Maximum voltage 150 A.C. or D.C. Maximum current 150 mW.
10/6 *post free*

MKY71
Glass sealed with M.E.S. base. Glass envelope 5/16 in. diam., overall length 1 in. Resistance at 100 Lux – 50 Kohms to 150 Kohms. Maximum voltage 150 A.C. or D.C. Maximum current 75 mW. **8/6** *post free*

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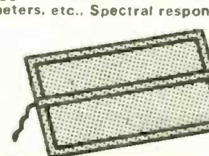
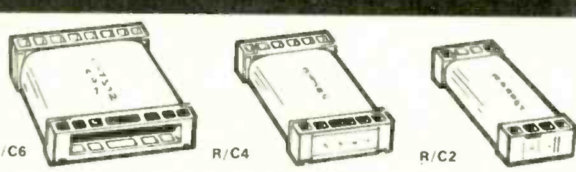
Selenium cells in which light energy is converted into electricity directly measurable on microammeter or used with amplifier as light trigger for alarm and counting devices, luminous fluxmeters, exposure meters, colorimeters, etc., Spectral response covers visible light range.

Type 1—1½ x 1 3/16 in. Output 1 mA at 0.6 volts at 1,000 Lux **5/-** *post free*

Type 3—100 x 50 mm. Output 4 mA at 0.6 volt at 1,000 Lux **22/6** *post free*



REED SWITCH COILS & CAPSULES



Compact assemblies of reed switches and operating coils that permit the design of an infinite variety of multiple switch circuits in an extremely small space. They eliminate the bulk and open contact disadvantage of electro-mechanical relays; hermetically sealed contact isolation ensures longlife reliability. Small enough to combine with solid-state components on printed circuit boards. Ideal for switching matrices, binary kits, control systems, etc. These were removed intact from highly expensive computer mechanisms and are guaranteed to be in perfect working order. Each capsule consists of a rare-metal screened, 24 volt DC operating coil on a nylon former with one detachable end for the removal and replacement of reed switches.

Types available:
R/C2 Two reed switches, contacts normally open. Size overall: 1¼ x ⅜ x ⅜ in. **5/-** *post free*
R/C4 Four reed switches, contacts normally open. Size overall: 1¼ x ⅝ x ⅜ in. **10/-** *post free*
R/C6 Six reed switches, 4 contacts normally open, 2 normally closed. Size overall: 1¼ x 1¼ x ⅜ in. **15/-** *post free*

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Highly flexible light guides that transmit light to inaccessible places as easily as electricity is conducted by copper wires. Fibre optics make it possible to control, miniaturize, split, reflect or transfer light from one source to many places at once and to operate photo devices, logic circuits, or illuminate in ways never before possible. Proops offer both glass fibre optics or inexpensive Crofon plastic fibres for hundreds of experiments or serious applications in a fascinating new science.

RANK TAYLOR-HOBSON ENGINEERS KITS

Basic fibre optic components that demonstrate new ways of employing light in serious applications. Two kits are available: each contains high-grade glass-fibre light guides consisting of thousands of fibres tightly bundled in flexible sheaths with ferruled, optically polished ends, together with connecting and light source components. Each is supplied complete with card wallets containing technical and application data.

KIT 1
Contains: 1.5 mm. x 24 in., 3 mm. x 18 in., and 6 mm. x 12 in. light guides, plus 24 in. long x 2 exit component for punched card or coding applications. Also battery operated light source, 2-way 'Y' adaptor with non-random separation, and 3 mm./3 mm. and 3 mm./1.5 mm. connectors.

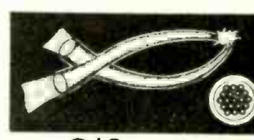
£16

KIT 2
Contains: 3 mm. x 18 in., 6 mm. x 12 in. light guides; 1.5 mm. 'Y' guide with two 12 in. long tails; 24 in. long 12 exit component for coding or punched card applications. 24 in. lengths of Crofon 64 filament and monofilament plastic light guide. Also, coherent solids consisting of 25 mm. diam. field flattening lens, 6 mm. x 12 in. image conduit with polished ends, 4 mm. x 25 mm. image invertor. Complete with 2-way adaptor, fibre optic torch and batteries, 3 mm./3 mm. and 3 mm./1.5 mm. connectors.

Post free **£28**

LOW-COST CROFON FLEXIBLE LIGHT GUIDE

Newly developed plastic light transmitting media made by Du Pont and consisting of 64 special plastic fibres, each .010 in. diam. and bundled together in a tough, flexible sheath. Can be used for many serious projects and inexpensive prototype work. Ends can be ground flat, dyed or capped with Epoxy resin. Temp. range —40° to 176°F. No loss of light through bending. **12-page data and applications booklet supplied.**



Minimum order—2 ft. **8/6** *per foot post free*

RCA TRIAC — CA40432

Suitable for light dimming and motor control circuits
Gate-controlled, full-wave, A.C. silicon switch with integral trigger that blocks or conducts instantly by applying reverse polarity voltage. Suitable for A.C. operation up to 250 volts; controls currents up to 1440 watts. Size only ⅜ in. diam. x 5/16 in. high. **Complete with heat sink, data and applications information.**

45/- *post free*

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Telephone: 01-580 0141

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CLOSED CIRCUIT TELEVISION

NEW AND PERFECT BRITISH MADE EQUIPMENT
AT LESS THAN HALF ORIGINAL COST!

An extremely flexible closed-circuit system made by Britain's largest manufacturer of electronic equipment. The basic system comprises two units—camera and control monitor. The units are fully transistorised with a wide use of printed circuitry making for compact size, simple installation and high reliability (both in and out of doors). High sensitivity and 625 line resolution ensure excellent picture quality under normal lighting conditions. Closed circuit television provides the penetrating, all-seeing eye that scans, inspects, controls and directs—that is today accepted as invaluable in almost every aspect of industry, commerce, transport and education. A wide range of accessories are available which further increase the system's almost limitless applications.

A LIMITED QUANTITY OF COMPLETE SYSTEMS AVAILABLE

SYSTEM SPECIFICATION **Scanning standards:** 625 line, 50 fields, 2:1 interlace. **Horizontal resolution:** 600 lines. **Bandwidth:** 8 Mc/s over complete system. **Linearity:** ±2% positional error. **Geometry:** ±2% of rectangle averaged over picture. **Auto Sensitivity:** over the range 60:1 in light value—normal picture obtained with illumination of only 2ft. candles (50% subject reflectance) at lens aperture of f/2. **Spectral Response:** Panchromatic. **Ambient Temperature:** Max. temperature for all units −30°C. to +55°C. Power requirements 90/130 v. and 200/240 v. A.C., 50-60 c/s. **Consumption:** 45 watts including camera. **Camera Lenses:** Standard 16 mm. cine lenses with "C" mounts are normally used. **Accessories:** *See under Camera and Control Monitor.*

CAMERA

Totally enclosed dustproof unit only 3½ x 4 x 10½ in., weighing 4 lb. Finished in two-tone blue/grey. Vidicon tube. Automatic sensitivity control enables the camera to maintain full picture quality over a brightness range of 60:1. 625 line scanning standard 2:1 interlaced, frame synchronised to mains supply. 600 lines horizontal picture definition with a bandwidth of 8 Mc/s. All supplies are obtained from the control monitor (consumption 5 watts).

CAMERA ACCESSORIES

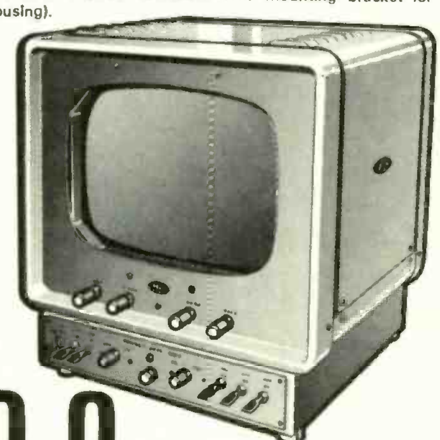
Lenses: Superb quality 25 mm. (1 in.) f/1.8. "C" mount lenses made especially for this system are available, also a limited quantity of motorised zoom lenses.
Remotely Controlled Weatherproof Pan and Tilt Heads: Pan 340° at 6° per sec., Tilt +50° at 4° per sec. 230/250 v., 50 c/s operated.
Remotely Controlled Pan and Tilt for Indoor Use Only: Details as above.
Weatherproof Camera Housing: Windscreen Wiper, 75 w. heater, internal circulation fan, mounting bracket for camera housing (the latter items are extras for the Weatherproof Housing).

CONTROL MONITOR

14 in. screen, overall size 16 x 14 x 18 in. (excluding Remote Control Unit on which Monitor is shown), weight 30 lb. Panel controls provided: Mains on/off, Contrast, Brightness, Remote Focus. Preset controls (under side panels) include: Frequency lock, Monitor height, Frame linearity, Camera height, Camera width, Auto sensitivity, Camera linearity, Cable correction, Video Gain, Beam Current, Y shift, Electrostatic focusing for camera and monitor. Additional input: Video −100 mV peak white positive into 50 ohms; Synch. 2 v. peak/peak negative. Output: 100 mV peak white positive; 2 v. peak/peak negative. Ambient temperature range −30° C. to +55° C.

ACCESSORIES

Remote Control Switching Unit (shown under Control Monitor): Controls auxiliary functions at the camera, i.e. pan/tilt, zoom, windscreen wiper, etc. Size 18 x 14 x 3 in., weight 8 lb.
Distribution Unit: Used for selecting the required picture from those available on the control monitors and distributing it to the appropriate viewing monitor. Size 19½ x 13½ x 8¾ in., weight 30 lb.
Viewing Monitors: These are conventional domestic type receivers—19 in. and 23 in. models available.



Owing to the complexity and limited quantity of units available this equipment is available to CALLERS ONLY.

LASKY'S BASIC SYSTEM PRICE **ONLY £135.0.0**

1—camera (complete with Vidicon) less lens, 1—Control Monitor, 25 yds. of cable. PRICES FOR LENSES AND ACCESSORIES ON APPLICATION.

ALSO

A selection of multi-channel **VIEWING MONITORS** are available from stock suitable for use with many existing CCTV installations.

A selection of **VIDEO TAPE RECORDERS** are also available from stock. We will be pleased to quote on receipt of your requirements.

PLEASE NOTE—THESE SYSTEMS ARE AVAILABLE ONLY FROM OUR HEAD OFFICE
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A demonstration system is available for your inspection by appointment

Lasky's

TMK METER KITS

ANOTHER LASKY'S EXCLUSIVE

These two new meter kits by TMK offer the professional, electronics hobbyist and student the unique opportunity of building a really first class precision multimeter at a worthwhile saving in cost. The impact resistant bakelite cabinets are supplied with the meter scale and movement mounted in position; the model 200 also has the rotary range selector in position. The highest quality in components and 1% tolerance resistors are used throughout. Both offer professional standards of accuracy. Supplied complete in every detail with full constructional, circuit and operating instructions.

MODEL 200

20,000 O.P.V. Multimeter. Features 24 measurement ranges with mirror scale. Large 3 x 2in. meter, full scale accuracy: DCV and current: ± 2%. ACV: ± 3%, resistance ± 3%. Special 0.6V DC range for transistor circuit measurements.

SPECIFICATION:

- DCV: 0-0.6-6-30-120-600-1,200V at 20K/OPV.
- ACV: 0-6-30-120-600-1,200V at 10K/OPV.
- DC Current: 0-0.06-6-60-600mA.
- Resistance: 0-10K-100K-1M-10M/ohms (58-580-5.8K-58K at mid-scale).
- Capacitance: 0.002-0.2 μF (AC 6V range).
- Decibels -20 to +63dB
- Output: 0.05 μF blocking capacitor. Uses two 1.5V (U.7 type) batteries. Black bakelite cabinet, size 5¼ x 3⅜ x 1⅞in. Complete with test leads.

LASKY'S KIT PRICE 85/- Post 3/6

MODEL 5025

50,000 O.P.V. FEATURING 57 MEASUREMENT RANGES

A highly reliable instrument using an entirely new range selection mechanism which permits the use of a really large meter in a more compact cabinet. The range selected is clearly indicated on the actual meter face facilitating instant identification without taking your eyes from the meter. High speed rotary range selection knob; also features polarity reversal switch, shielded meter movement with overload protection circuit. Special A and mA measurement ranges.

SPECIFICATION:

- DCV: 0-0.25-2.5-10-50-250-1,000V at 25K/OPV 0-0.125-1.25-5.0-25-125-500V at 50K/OPV.
- 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.
- DCmA: 0-2.5-25-250mA at 125mV; 0-5-50-500mA at 250mV.
- DC Amps: 0-5A at 125mV; 0-10A at 250 mV.
- Resistance: 0-10M/ohms (13, 65, 650,6.5K and 65K/ohms at centre scale).
- Output Capacitor (0.1 μF, 400Vw) in series with ACV ranges.
- Decibels: −20 to + 81.5dB in 10 ranges.

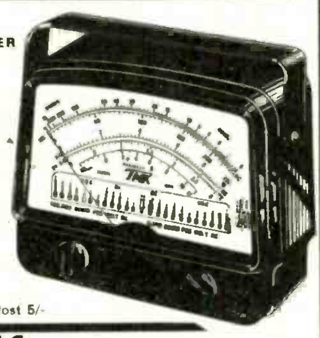
Operates on two 1.5V (U.7 type batteries). Black bakelite cabinet, size 5¼ x 6⅞ x 2⅞in. Strong resilient plastic handle. Complete with test leads.

LASKY'S KIT PRICE £10.10.0 Post 5/-

ALSO AVAILABLE READY-BUILT AND TESTED £12.10.0 Post 5/-.

TMK 100K "LAB" MULTIMETER

BUILT AND TESTED

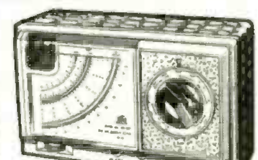


A highly accurate Multimeter using a 10 μA Meter hand calibrated to a DC accuracy of ± 3% of full scale. Special features ultra large meter scale, 6½ x 3½in., incorporating an entirely new type of range selection panel which gives instant identification without taking your eyes from the meter. An audible buzzer is provided for easy short testing. SPEC. DCV ranges: 0.5, 2.5, 10, 50, 250, 500, 1,000V at 100K/OPV. ACV ranges: 3, 10, 50, 250, 500, 1,000V at 5K/OPV. DC current: 0-10, 100 A. 0-10, 100mA, 0-2.5, 10Amps. Resistance: 0-1K, 10K, 100K, 10M, 100M/ohms. Decibels: − 10 to + 49.4dB. Continuity test Audible buzzer. Operates on 1x1.5V U2 and 1x15V 8.154 type batts. Cabinet size 7⅞x6⅞x3⅛in. Weight 4lb.

LASKY'S PRICE £19.10.0 Post 5/-

TTC Model C-1051

POCKET MULTIMETER, READY-BUILT



A completely new design 20,000 O.P.V. pocket multimeter with mirror scale and built-in thermal protection. Exceptionally large easy to read meter with D'Arsonval movement. Colour coded scales. Single positive click-in, recessed selection switch for all ranges. Ohms zero adjustment. Range spec. a.c. volts: 0-6-30-300-1,200V at 10K/ohms/V. DC volts: 0-3-15-150-300-1.2KV at 20K/ohms/V. Resistance: 0-60K-6megs. DC current: 0-60 μA—300mA. Decibels: −20dB to +17dB. Hand calibration gives extremely high standard of accuracy on all ranges. Uses one 1½V penlight battery. Strong impact resistant plastic cabinet—size only 4⅞x3⅛x1⅛in. Two colour buff/green finish. Complete with test leads and battery.

LASKY'S PRICE 75/- Post 2/6

ALSO AVAILABLE C–1052 3 KOPV METER £5.19.6

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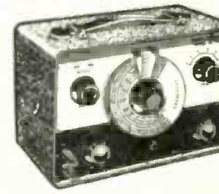
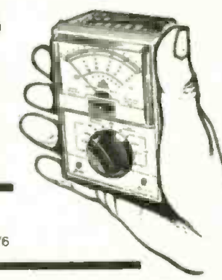
TE-20 RF SIGNAL GENERATOR



A high-quality factory-tested and calibrated RF Signal Generator offering a full frequency range cover of 120KHz in 6 bands plus one harmonic band. Dual high/low RF output terminals provided and separate variable Audio output. Etched circular scale accuracy ± 2%—read against hair line on perspex cursor. Power "on" pilot light fitted. Brief specifications: Frequency range (6 fundamental bands). A. 120-320KHz. B. 320-1,000KHz. C. 1-3, 4MHz. D. 3.2-11MHz. E. 11-38MHz. F. 36-130MHz. Harmonic band 72-260MHz. Frequency accuracy ± 2%. Output-RF (high) 100mV max. RF (low) 100μV max. Audio output 400Hz. 8V approx. (adjustable). Power requirements 105/240V, 50/60Hz AC. Valve line-up: 12BH7A, 6AR5 and selenium rectifier. Strong metal case size 7x10x5½in.; finished in grey crackle. Complete with test leads and instruction book.

LASKY'S PRICE £15.0.0 Post 5/-

TTC MODEL C-1000

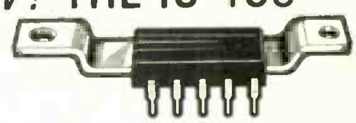


A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ± 3% accuracy on full scale of DC ranges, 4% on AC ranges. 2⅛in. square meter. SPECIFICATIONS: AC/V ranges: 0-10, 50, 250,1,000V at 1K/O.P.V. AC/V ranges: 0-10, 50, 250 100V 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.

LASKY'S PRICE 39/6 Post 2/6

AVAILABLE NOW! THE IC-403

INTEGRATED CIRCUIT AMPLIFIER MODULE



Originally developed for computer and space projects—these tiny modules—size only 25x10x5 millimetres—represent the most amazing breakthrough in circuit design since the introduction of the transistor. The IC-403 is an integrated power and pre-amplifier requiring only the addition of tone and volume controls, power source and speaker to form a complete audio amplifier of 3W output.

SPECIFICATION (ratings at 25°C): Output power typically 3W from 250mV input. Frequency response 20Hz to 80KHz + 3dB. Max. operating voltage 21V. Min. operating load 7.5 ohms. Pre-amp. input imp. 2M/Ohms. Pre-amp. D.C. input current 50nA.

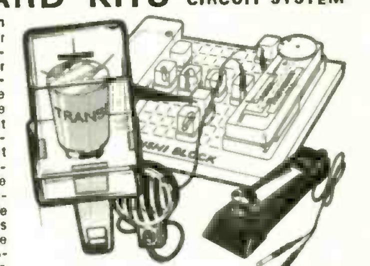
THE IC-403 IS AVAILABLE FROM STOCK EXCLUSIVELY FROM LASKY'S—COMPLETE WITH INSTRUCTION DATA AND SUGGESTED CIRCUIT APPLICATIONS. FREE INSTRUCTION DATA LEAFLET ON REQUEST. JUST SEND S.A.E.

LASKY'S PRICE 49/6 Post 1/6. **2 for 95/-** post free.

Also available from stock Sinclair IC-10. 59/6 post free.

DENSHI BOARD KITS

EDUCATIONAL CIRCUIT SYSTEM



The **DENSHI BOARD** system enables the young experimenter and electronics hobbyist to produce a wide range of transistor circuits of increasing sophistication—without soldering or the use of any tools at all! Basically the system comprises a slotted circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are incapsulated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. **Each DENSHI BOARD KIT comes complete with 80-page manual of circuits and data.**

THESE ARE JUST A FEW OF THE CIRCUITS YOU CAN BUILD IN MINUTES: VARIOUS RADIO RECEIVERS, AMPLIFIERS, MORSE CODE PRACTICE DEVICE, SIGNAL INJECTOR, SIGNAL TRACER, WIRELESS MICROPHONE, ETC.

DENSHI BOARD KIT SR-1A *comprises:* Base board; tuner block; 4 resistors; choke coil transformer; 2SA transistor for RF; 2 diodes; 3 capacitors; battery block; morse key; antenna lead; crystal earphone; various bridge and connecting pieces and 80 page manual. **This kit permits the building of 16 basic circuits.**

LASKY'S PRICE £4.19.6 POST 3/6

DENSHI BOARD KIT SR-2A *as SR-1A plus:* 2SB transistor for AF; 2 resistors; 1 capacitor; crystal microphone; test probes; electrode; additional connecting pieces; 9V battery. **This kit permits the building of 30 circuits.**

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Output 3·0 watts into 7·5 ohms. only 57/-

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This remarkable monolithic integrated circuit amplifier and pre-amp is now available for dispatch from stock. It is the equivalent of ·13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is D.C. coupled and applicable for an unusually wide range of uses, all of which are detailed in the manual provided with it. Sinclair IC.10 as advertised, post free .. .. **59/6 NETT**

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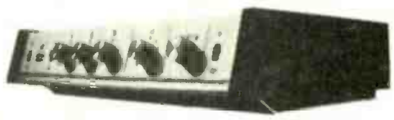

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Better than 60dB all inputs.

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2N1303	4/–	2N3053	5/6	AC126	6/6	BC147	4/3	BF167	8/6	NKT274	4/3
2N1304	4/–	2N3054	15/6	AC128	6/–	BC148	3/3	BF178	10/6	NKY403	14/10
2N1305	4/–	2N3055	16/6	AC176	6/3	BC149	4/3	BF180	12/–	NKT404	14/6
2N1306	6/9	2N3391A	5/6	ACY22	3/3	BC157	3/6	BF194	7/–	NKT405	15/–
2N1307	6/9	2N3708	2/9	ACY40	3/6	BC158	3/3	BFX29	12/3	NKT713	5/5
2N1308	8/9	2N3904	9/–	AD140	19/–	BC159	3/6	BFX85	8/3	NKT773	5/3
2N1309	8/9	2N3906	9/–	AD149	17/6	BC177	6/–	BFX88	7/9	NKT781	6/–
2N1613	6/6	2N3794	2/11	AD161 }	14/– pr.	BC178	5/3	BFY50	4/9	P346A	5/9
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	each		each
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MINIATURE (µF/V): 5/10; 10/10; 25/10; 50/10;, **9d.** each. 25/25; 50/25; 100/10; 200/10, 1/– each. 50/50; 100/25; 1/6 each. 100/50; 250/25, 2/– each.

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BSY27	3/-	OC26	5/-
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BSY29	3/-	OC35	5/-
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OC72	2/6	AAY42	2/-
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OC140	3/6		

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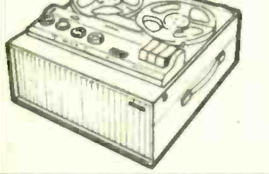

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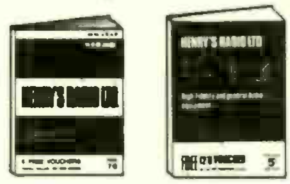

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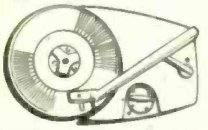

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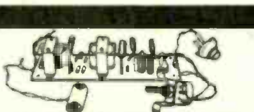

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9 Volt 5 transistors with volume control, output 3 ohms.
Ideal for use with STAAR RECORD DECK.
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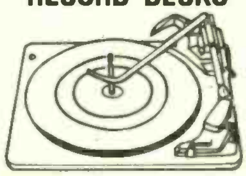

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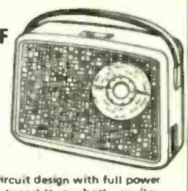

New printed circuit design with full power output. Fully tuneable on both mw/lw. bands. 7 Mullard transistors, Fitted 5" speaker, Room Filling Power. Easy to build with terrific results. All local and continental stations. Complete detailed instructions.
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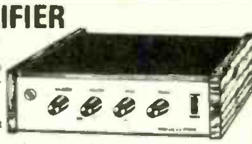
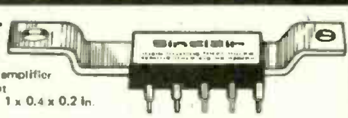


SINCLAIR EQUIPMENT



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IC-10 Integrated Circuit Amplifier	59/6
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*Data sheets 3/6 set for these, for others see catalogue.

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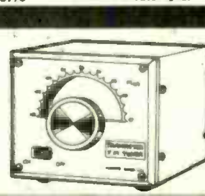

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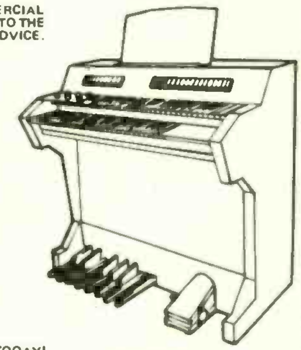

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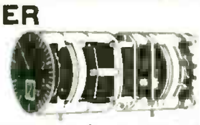
Dual range voltmeter. 0-5 and 0-100 v. D.C. FSD 1 mA. In carrying case with tests prods and leads. 32/6. P. & P. 3/6.

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.

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Sintered Cadmium Type 1.2 v. 7AH. Size: height 3½ in., width 2⅛in. × 1 1/16in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6. P. & P. 2/6.

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2 × lamp Dry Reeds (makes contacts) mounted in 870 ohm 9-18v coil. Size 3in. × 3½in. × ⅜in. New. Price 8/6 per pair. Post Paid.
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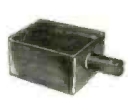
Telephone Dials (New) 14/6d. Post Paid.

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.

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New at a fraction of maker's price.
2,500 mfd. 100 v... 12/6 4,000 mfd. 25 v... 10/-
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(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 3⅛in. Shaft length ⅜in. dia. ½in., 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.
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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.

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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.

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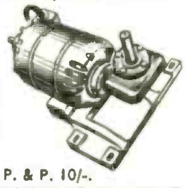
PARVALUX TYPE SD19 230/250 VOLT AC REVERSIBLE GEARED MOTORS



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/-.

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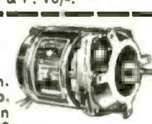


(Type 1) 71 r.p.m. torque 10 lb. in. Reversible 1/70th h.p. 50 cycle .38 amp.
(Type 2) 28 r.p.m. torque 20 lb. in. reversible 1/80th h.p. 50 cycle .28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v A.C. Supplied complete with transformer 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.

LARGE DIGIT 12 v. D.C. MAGNETIC COUNTER

4in. drum, calibrated 1-9. Figures 1½in. high ⅞in. 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

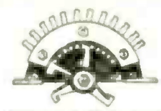
230 v. A.C. 50 cycle 5 figure counter (non resetable). 18/6, P. & P. 1/6.

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.

MINIATURE UNISELECTOR

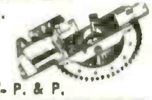


3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. 22/6, plus 2/6 P. & P.

UNISELECTOR SWITCHES *NEW*

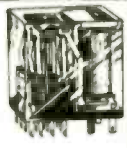
4 BANK 25 WAY FULL WIPER
25 ohm coil, 24 v. D.C. operation. £5.17.6, plus 2/6 P. & P.

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 AT A HIGHLY COMPETITIVE PRICE

COIL Ω	WORKING D.C. VOLT	CONTACTS	PRICE
170	9—12	4 c/o H.D.	14/6
170	9—12	3 c/o + 1 H.D.	12/6
280	6—12	2 c/o incl. base	14/6
280	9—18	4 c/o incl. base	15/6
700	12—24	2 c/o incl. base	12/6
700	16—24	4 c/o incl. base	15/6
700	16—24	4M 2B incl. base	12/6
1250	20—40	2 c/o H.D. incl. base	12/6
2500	30—50	2 c/o H.D. incl. base	12/6
9000	40—70	2 c/o incl. base	10/-

H.D. = Heavy Duty *POST PAID*

MINIATURE RELAYS
9—12 volt D.C. operation. 2 c/o 500 M.A. contacts. Size 1in. × ⅞ × ½in. Price 11/6 Post paid.
30-36 v. D.C. operation. 2 c/o 500 M.A. contacts. 3.200 ohm coil. Size only 1 × 11/16 × 13/16in. 8/6 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.

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/-

SANWA MULTI RANGE TESTERS

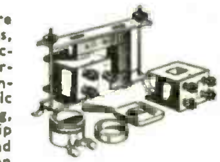
NEW MODEL UD-50 MULTI TESTER, 20,000 O.P.V. MIRROR SCALED WITH OVERLOAD PROTECTION. Ranges: D.C. volts: 100mV., 0.5 v., 5 v., 250 v., 1,000 v. A.C. volts. 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 5µA. 0.5 mA., 5 mA., 50 mA., 250 mA. Size: 5⅛ × 3⅜ × 1⅝ in. **Complete with batteries and test prods. £7.5.0** Post paid

RING TRANSFORMER

Functional Versatile Educational

This multi-purpose Auto Transformer, with large centre aperture, can be used as a Double wound current Transformer, Auto Transformer, H.T. or L.T. Transformer, by simply hand winding the required number of turns through the centre opening. E.g. Using the RT.100 V.A. Model the output could be wound to give 8V. @ 12½a., 4V. @ 25a., 2V. @ 50a., etc.
Price: RT.100VA 3.18 turns per volt, £2 5 0 + 3/6 p. and p.
RT.300VA 2.27 turns per volt, £4 4 0 + 5/6 p. and p.
RT. 1KVA 1.82 turns per volt, £6 10 0 + 6/6 p. and p.

DEMONSTRATION TRANSFORMER (STENZYL TYPE)



Two removable coils are tapped at 0, 110, 220 volts, and 6, 12, 36 volts respectively. A composite apparatus designed for class demonstration. Electro magnetic induction, jumping ring, induction lamp, relationship between field intensity and ampere turns, induction melting, are just a few of the possible experiments. New modified model. £14/10/-. P. & P. 10/-.

L.T. TRANSFORMERS

All primaries 220-240 volts.

Type No.	Sec. Taps	Price			Carr.
1	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.	£7	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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57 BRIDGMAN ROAD, LONDON, W.4. Phone: 995 1560
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SHOWROOMS NOW OPEN
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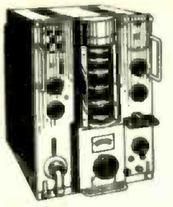
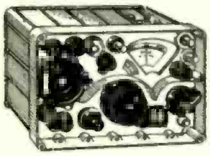
PERSONAL CALLERS ONLY
9 LITTLE NEWPORT STREET, LONDON, W.C.2.
Tel.: GER 0576

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/-.



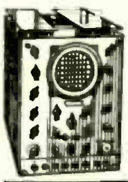
HAMMARLUND SP600 JX COMMUNICATION RECEIVER
Frequency range 540 Kc/s to 54 Mc/s in 6 Bands. Few available in excellent condition, tested and checked. **£100** each.

R209 Mk. II COMMUNICATION RECEIVER



11 valve high grade communication receiver suitable for tropical use. 1-20 Mc/s. on 4 bands. AM/CW/FM operation. Incorporates precision vernier drive, B.F.O. Aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked. **£15.0.0** Carr. 20/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES BARGAIN

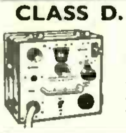


An excellent general purpose D/B oscilloscope. T.B. 2 cps-750 Kc/s. Bandwidth 5.5 Mc/s Sensitivity 33 Mv/cm. Operating voltage 0/110/200/250 v. A.C. Supplied in excellent working condition. **£22/10/-**. Or complete with all accessories, probe, leads, lid, etc. **£25**. Carriage 30/-.

MARCONI CT44 TF956 AF ABSORPTION WATTMETER
1 μ/watt to 6 watts. **£20**. Carr. 20/-.

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.

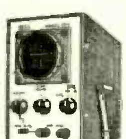
CLASS D WAVEMETERS No. 2
Crystal controlled. 1.2-19 Mc/s. Mains or 12v. D.C. operation. Complete with calibration charts. Excellent condition **£12/10/0**. Carr. 30/-.

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/-.

RACAL MA.168 TRANSISTORISED DIVERSITY SWITCH
Brand new condition **£15**. Carriage 10/-.

TO-2 PORTABLE OSCILLOSCOPE



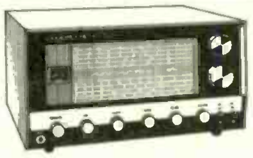
A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS—1 MHZ. Input imp. 2 meg Ω. 25 PF. Illuminated scale. 2" tube. 115 × 180 × 230 mm. Weight 8lbs. 220/240v. A.C. Supplied brand new with handbook. **£22/10/-**. Carr. 10/-.

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. 88B-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**. 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. 88B-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.

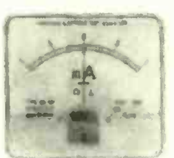
RCA COMMUNICATIONS RECEIVERS AR88D
Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s—32 Mc/s continuous. Output impedance 2.5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0**. 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/-.

SOLARTRON CD711S.2. DOUBLE BEAM OSCILLOSCOPE
An extremely high quality oscilloscope originally costing £400. Switched beam. Identical Y1, Y2 Amplifiers D.C. to 9 Mc/s. Sensitivity 3mV/CM to 100 V/CM. Time base 10μ/sec. to 10 M/secs. Calibrator. X amplifier D.C. to 2·5 Mc/s. Z Modulation. 110/250 v. A.C. Supplied in good working order. **£65**. Carriage 50/-.

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

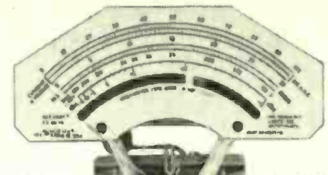
Completely transistorised 5 watts per channel I.H.F. music power. Inputs for gram and tuner. Separate volume controls and variable tone control for Bass and Treble. A compact size, big performance stereo amplifier ideal for limited space systems. Beautifully finished in grey and aluminium. Size 7½in. × 2 15/16 in. × 5½in. AC. 220/240v.

Price **£11.19.6** Carr. 7/6.

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.

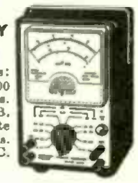
AVOMETER MOVEMENTS



50μA 20KΩ/V.

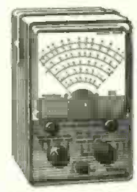
Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New and Boxed **69/6** P. & P. 3/6

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.

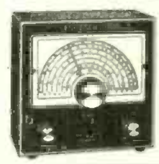
COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES
D.C. coupled. Band width 1 Kc/s. Perfect order. **£25**. Carr. 30/-.

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 x 8½ x 9in. Supplied in brand new condition complete with all connectors, fully tested, **£45**. Carr. 20/-.

GEARED MAINS MOTORS
Parvalux 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 7½" × 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. **£6/10/0**. P. & P. 7/6
1,500 W. **£7/19/6**. P. & P. 8/6
7,500 W. **£15/10/0**. P. & P. 20/-.

G. W. SMITH & Co. (Radio) Ltd.
ALSO SEE OPPOSITE PAGE

SUPER-BARGAIN STOCKTAKING SALE!!

Use form below for your order. CONDENSERS MUST BE ORDERED BY STOCK NUMBER ONLY. If any sale item is 'sold-out' when order received we shall substitute items of equal value.

ELECTROLYTIC CAPACITORS

Stock No.	Capacity	Voltage	Price s.	Price d.	No. Required	£ s. d.
1	1 uf	6		4		
2	4 uf	25		4		
3	4 uf	4		4		
4	6 uf	6		4		
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.	Price 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 of any one value. 2/- per dozen of any one value.
Tick the values required.

13 ohms	560 ohms	3.3 k ohm	10 k ohm	39 k ohm	91 k ohm	1.2 meg ohm	8.2 meg ohm
22 ohms	750 ohms	3.6 k ohm	16 k ohm	43 k ohm	130 k ohm	1.5 meg ohm	9.1 meg ohm
36 ohms	1 k ohm	4.3 k ohm	18 k ohm	47 k ohm	360 k ohm	1.8 meg ohm	10 meg ohm
47 ohms	1.5 k ohm	4.7 k ohm	22 k ohm	51 k ohm	430 k ohm	3.6 meg ohm	
91 ohms	1.8 k ohm	5.6 k ohm	24 k ohm	62 k ohm	470 k ohm	5.1 meg ohm	
220 ohms	2.2 k ohm	6.8 k ohm	27 k ohm	75 k ohm	560 k ohm	6.2 meg ohm	
470 ohms	2.4 k ohm	7.5 k ohm	30 k ohm	82 k ohm	620 k ohm	7.5 meg ohm	

or our selection (mixed) **6/6d.** per 100.

Total:

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS 10/- per 100 of any one value. 3/- per dozen of any one value.
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.**

MAINS DROPPER TYPE RESISTORS. Hundreds of types from .7 ohm upwards. 1 watt to 50 watts. A large percentage of these are Multi-tapped droppers for radio/television. Owing to the huge variety these can only be offered "assorted". **10/-** per dozen.

GIANT SELENIUM SOLAR CELLS. Last few to clear at half price! Circular, 67 mm. diameter **5/-** each. 50 mm. × 37 mm. 3 for **10/-**.

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/-.

G. F. MILWARD, DRAYTON BASSETT, near TAMWORTH, STAFFS. Phone: TAMWORTH 2321

BRAND NEW SEMICONDUCTORS & COMPONENTS GUARANTEED

TRANSISTORS

Brand new and fully guaranteed. PLEASE NOTE:—A large number of our transistors have now been reduced in price. Many more semi-conductors in stock. Please enquire for types not listed.

2G301	4/-	2N3055	15/-	2S501	5/6	BC126	11/-	BSX21	7/6	NKT275	4/-
2G302	4/-	2N3133	6/-	2S502	5/6	BC140	11/-	BSX26	10/6	NKT281	5/6
2G303	4/-	2N3134	6/-	2S503	5/6	BC147	3/6	BSX27	10/6	NKT401	17/6
2G306	8/6	2N3135	5/-	3N83	37/6	BC148	3/6	BSX28	6/-	NKT402	18/-
2G308	6/-	2N3136	5/-	3N128	18/6	BC149	3/6	BSX60	19/6	NKT403	15/-
2G309	6/-	2N3390	7/6	3N140	19/6	BC157	4/-	BSX61	12/6	NKT404	12/6
2G371	3/-	2N3391	5/-	3N141	21/6	BC158	3/6	BSX76	4/6	NKT405	15/-
2G374	5/6	2N3391A	6/-	3N142	16/6	BC159	4/-	BSX77	6/6	NKT406	12/6
2G381	4/6	2N3392	5/-	3N143	19/6	BC160	12/6	BSX78	6/6	NKT451	12/6
2N404	4/6	2N3393	5/-	3N152	24/-	BC167	3/6	BSY10	5/6	NKT452	12/6
2N696	4/6	2N3394	5/-			BC168B	3/6	BSY11	5/6	NKT453	9/6
2N697	5/-	2N3402	5/6			BC168C	3/9	BSY24	4/-	NKT603F	6/6
2N698	6/-	2N3403	5/6	R.C.A.:		BC169B	3/6	BSY25	4/-	NKT613F	6/6
2N706	2/6	2N3404	7/6	40250	12/6	BC169C	3/9	BSY26	4/-	NKT674F	5/-
2N706A	2/6	2N3405	9/-	40309	9/6	BC170	3/6	BSY27	4/-	NKT677F	5/-
2N708	4/-	2N3414	5/6	40310	13/-	BC171	3/6	BSY28	4/-	NKT713	5/-
2N709	12/6	2N3415	6/6	40311	10/6	BC172	3/6	BSY29	4/-	NKT717	8/6
2N718	6/-	2N3416	9/6	40312	13/6	BC182L	4/6	BSY32	5/-	NKT734	5/6
2N726	5/-	2N3417	9/6	40314	10/6	BC183L	4/6	BSY36	5/-	NKT736	7/-
2N727	5/-	2N3605	5/6	40315	10/6	BC184L	4/6	BSY37	5/-	NKT773	5/-
2N743	4/6	2N3606	5/6	40316	13/-	BC212L	5/-	BSY38	4/6	NKT781	6/-
2N744	4/6	2N3607	4/6	40317	11/-	BCY10	5/6	BSY39	4/6	NKT10339	6/6
2N753	5/6	2N3662	7/6	40319	15/-	BCY12	5/6	BSY40	6/6	NKT10419	6/-
2N914	3/6	2N3663	8/-	40320	10/6	BCY30	5/6	BSY51	8/6	NKT10439	7/6
2N916	3/6	2N3702	3/6	40323	10/6	BCY31	5/6	BSY52	9/-	NKT10519	6/6
2N918	6/-	2N3703	4/6	40324	12/6	BCY32	7/6	BSY53	8/6	NKT20329	9/6
2N929	5/6	2N3704	4/6	40326	10/6	BCY33	4/-	BSY54	10/6	NKT20339	7/6
2N930	7/-	2N3705	4/-	40329	7/6	BCY34	4/6	BSY56	6/-	NKT80111	15/6
2N987	10/6	2N3706	4/6	40344	8/-	BCY38	4/6	BSY78	9/6	NKT80112	19/6
2N1090	6/6	2N3707	4/-	40347	9/6	BCY39	7/6	BSY79	9/6	NKT80113	22/6
2N1091	6/6	2N3708	3/6	40348	14/6	BCY40	6/6	BSY82	10/6	NKT80211	18/6
2N1131	6/6	2N3709	3/6	40360	11/6	BCY42	3/-	BSY83	10/6	NKT80212	18/6
2N1132	6/6	2N3710	4/-	40361	12/6	BCY43	3/-	BSY84	11/6	NKT80213	18/6
2N1302	3/6	2N3711	4/-	40362	14/6	BCY54	7/6	BSY85	13/6	NKT80214	18/6
2N1303	3/6	2N3819	9/-	40370	8/6	BCY58	4/6	BSY87	10/6	NKT80215	18/6
2N1304	4/6	2N3820	21/6	40406	16/-	BCY59	4/6	BSY90	11/6	NKT80216	18/6
2N1305	4/6	2N3823	17/6	40408	16/-	BCY60	19/6	BSY95A	2/6	OC20	21/6
2N1306	5/-	2N3854	5/6	40467	16/6	BCY70	4/6	BSW41	8/6	OC22	8/-
2N1307	5/-	2N3854A	5/6	40468A	16/6	BCY71	8/6	BSW70	5/6	OC23	8/-
2N1308	6/-	2N3855	5/6	AC107	6/-	BCY72	4/-	D16P1	7/6	OC24	8/-
2N1309	6/-	2N3855A	6/-	AC126	4/-	BCZ10	4/6	D16P2	8/-	OC25	8/-
2N1420	5/6	2N3856	6/-	AC127	5/-	BCZ11	4/6	D16P3	7/6	OC26	6/6
2N1507	5/6	2N3856A	6/-	AC128	4/-	BD121	17/6	D16P4	8/-	OC28	8/6
2N1525	7/6	2N3858	5/-	AC176	5/-	BD123	21/6	GET102	6/-	OC35	6/6
2N1526	7/6	2N3858A	6/-	AC187	12/-	BD124	12/-	GET113	4/-	OC36	6/6
2N1527	7/6	2N3859	5/6	AC188	12/-	BF115	5/-	GET114	4/-	OC38	10/6
2N1605	9/6	2N3859A	6/6	ACY17	5/-	BF117	9/6	GET116	10/6	OC41	4/6
2N1613	5/6	2N3860	6/-	ACY18	5/-	BF167	5/6	GET118	4/-	OC42	5/-
2N1631	8/6	2N3877	9/-	ACY19	5/-	BF173	7/6	GET119	4/-	OC44	4/-
2N1632	8/6	2N3877A	9/6	ACY20	5/-	BF177	11/6	GET120	6/6	OC45	2/6
2N1637	8/6	2N3900	10/6	ACY21	5/-	BF178	10/6	GET873	3/-	OC46	3/-
2N1638	7/6	2N3900A	11/6	ACY22	4/-	BF179	11/6	GET880	6/-	OC70	3/-
2N1639	7/6	2N3901	19/6	ACY28	4/-	BF180	7/-	GET887	4/-	OC71	2/6
2N1711	6/6	2N3903	7/-	ACY40	4/-	BF181	6/6	GET889	4/6	OC72	2/6
2N1889	6/6	2N3094	7/-	ACY41	5/-	BF184	7/6	GET890	4/6	OC74	4/6
2N1893	8/-	2N3905	7/6	ACY44	8/-	BF185	5/6	GET896	4/6	OC75	4/6
2N2147	14/6	2N3906	7/6	AD140	8/-	BF194	5/-	GET897	4/6	OC76	3/-
2N2148	12/6	2N4058	5/6	AD149	11/6	BF195	5/6	GET898	4/6	OC77	5/6
2N2160	12/6	2N4059	5/-	AD150	16/6	BF196	5/6	MAT100	6/-	OC78	3/-
2N2193	5/6	2N4060	5/-	AD161	7/6	BF197	5/6	MAT101	6/-	OC78D	3/-
2N2193a	5/6	2N4061	4/6	AD162	7/6	BF198	5/6	MAT120	6/-	OC81	4/-
2N2194A	4/6	2N4062	4/6	AF106	9/-	BF200	10/6	MAT121	6/-	OC81D	4/6
2N2217	6/6	2N4244	9/6	AF114	5/-	BF224	6/-	MJ400	21/6	OC82	4/-
2N2218	6/6	2N4245	8/6	AF115	6/-	BF225	6/-	MJ420	22/6	OC82D	3/-
2N2219	6/6	2N4254	8/6	AF116	5/-	BF237	6/6	MJ421	22/6	OC83	4/6
2N2220	5/-	2N4255	7/6	AF117	5/-	BF238	6/6	MJ430	20/6	OC84	5/-
2N2221	5/-	2N4284	3/6	AF118	12/6	BFX12	4/6	MJ440	19/6	OC123	4/6
2N2222	6/6	2N4285	3/6	AF119	4/-	BFX13	4/6	MJ480	20/6	OC139	6/6
2N2287	21/6	2N4286	3/6	AF124	4/6	BFX29	12/6	MJ481	27/6	OC140	6/6
2N2297	6/-	2N4287	3/6	AF125	4/6	BFX30	9/-	MJ490	22/6	OC170	6/-
2N2302	12/6	2N4288	3/6	AF126	4/-	BFX43	8/6	MJ491	29/6	OC171	6/-
2N2303	5/-	2N4289	4/6	AF127	3/6	BFX44	8/6	MPF102	8/6	OC200	6/6
2N2368	5/-	2N4290	4/-	AF139	7/6	BFX68	13/6	MPF103	7/6	OC201	7/6
2N2369	5/-	2N4291	3/6	AF178	12/6	BFX68A	13/6	MPF104	7/6	OC202	10/6
2N2369A	5/6	2N4292	3/6	AF179	11/6	BFX84	7/6	MPF105	8/-	OC203	6/6
2N2410	8/6	2N4433	5/6	AF180	12/6	BFX85	9/-	MPS3638	6/6	OC204	6/6
2N2411	11/-	2N4434	5/6	AF181	8/6	BFX86	6/6	NKT0013	9/6	OC205	8/6
2N2412	12/-	2N4435	5/6	AF239	7/6	BFX87	6/6	NKT124	8/6	OC207	7/6
2N2483	5/6	2N5027	10/6	AF279	16/6	BFX88	5/-	NKT125	5/6	OCP71	8/6
2N2484	8/-	2N5028	11/6	AF280	16/6	BFX92A	12/6	NKT126	5/6	ORP12	8/6
2N2539	4/6	2N5029	9/6	AFZ11	5/6	BFY10	4/6	NKT128	5/6	ORP60	10/-
2N2540	4/6	2N5030	8/6	AFZ12	8/6	BFY11	4/6	NKT135	5/6	ORP61	10/-
2N2613	7/9	2N5172	3/-	ASY26	5/6	BFY17	4/6	NKT137	6/6	P346A	4/6
2N2614	7/6	2N5174	10/6	ASY27	8/6	BFY18	4/6	NKT210	6/-	TIS34	17/6
2N2645	6/-	2N5175	10/6	ASY28	5/6	BFY19	4/6	NKT211	6/-	TIS43	9/-
2N2646	11/6	2N5176	9/-	ASY29	5/6	BFY20	12/6	NKT212	6/-	TIS44	2/6
2N2696	6/6	2N5232	5/6	ASY36	5/-	BFY21	8/6	NKT213	6/-	TIS45	3/6
2N2711	6/-	2N5232A	6/-	ASY50	5/-	BFY24	9/-	NKT214	4/6	TIS46	3/6
2N2712	6/-	2N5245	12/6	ASY51	6/6	BFY25	5/-	NKT215	4/6	TIS47	3/6
2N2713	5/6	2N5246	12/6	ASY53	5/-	BFY26	4/-	NKT216	7/6	TIS48	3/6
2N2714	6/-	2N5249	13/6	ASY54	5/-	BFY29	10/-	NKT217	8/6	TIS49	3/6
2N2865	12/6	2N5249A	13/6	ASY62	5/-	BFY30	10/-	NKT219	6/-	TIS50	5/6
2N2904	8/-	2N5305	7/6	ASY63	3/6	BFY36	4/-	NKT223	5/6	TIS51	4/-
2N2904A	8/-	2N5306	8/-	ASY72	5/-	BFY37	5/-	NKT224	5/-	TIS52	4/-
2N2905	8/-	2N5307	7/6	ASY83	5/-	BFY41	10/-	NKT225	4/6	TIS53	6/-
2N2905A	8/-	2N5308	7/6	ASY86	6/6	BFY43	12/6	NKT229	6/-	TIS60	6/6
2N2906	6/-	2N5309	12/6			BFY50	4/6	NKT237	7/-	TIS61	6/6
2N2906A	8/-	2N5310	8/6	ASZ20	7/6	BFY51	4/6	NKT238	5/-	ZTX107	3/6
2N2907	8/-	2N5354	5/6	ASZ21	7/6	BFY52	4/6	NKT240	5/6	ZTX108	3/6
2N2923	4/-	2N5355	5/6	AUY10	20/-	BFY53	5/6	NKT241	5/6	ZTX109	3/6
2N2924	4/-	2N5356	10/6	BC107	3/6	BFY56A	11/-	NKT242	4/-	ZTX300	4/-
2N2925	3/6	2N5365	9/6	BC108	3/6	BFY75	6/-	NKT243	12/6	ZTX301	4/-
2N2926		2N5366	10/-	BC109	3/6	BFY76	8/6	NKT244	3/6	ZTX302	5/-
Green	3/-	2N5367	11/6	BC113	6/6	BFY77	11/6	NKT245	4/-	ZTX303	5/-
Yellow	2/9	2N5457	9/6	BC115	6/6	BFY90	12/6	NKT261	4/-	ZTX304	7/6
Orange	2/9	2S005	15/-	BC116	12/6	BFW58	5/6	NKT262	4/-	ZTX500	5/-
2N3011	12/6	2S020	37/6	BC118	6/6	BFW59	5/-	NKT264	4/-	ZTX501	5/-
2N3014	6/6	2S102	6/6	BC121	4/-	BFW60	5/-	NKT271	4/-	ZTX502	6/-
2N3053	6/6	2S103	6/6	BC122	4/-	BSX19	3/6	NKT272	4/-	ZTX503	5/-
2N3054	12/6	2S104	6/6	BC125	11/-	BSX20	3/6	NKT274	4/-	ZTX504	12/6

PANEL METERS

38 Series—FACE SIZE 42 × 42 mm. All prices for 1-9 pieces.

50	Microamp	37/6	10	Milliamp	25/-
100	,,	35/-	50	,,	25/-
200	,,	32/6	100	,,	25/-
500	,,	27/6	500	,,	25/-
50-0-50	,,	35/-	1	Amp	25/-
100-0-100	,,	32/6	5	,,	25/-
500-0-500	,,	25/-	10	Volts	25/-
1	Milliamp	25/-	20	,,	25/-
5	,,	25/-	50	,,	25/-
			300	,,	25/-
			500	,,	25/-

SPEAKERS (3ohm)

10" × 6"	37/6
9" × 4"	23/6
8" × 5"	19/6
7" × 4"	15/6
5" × 3"	12/6
3" 9/6 · 5"	14/6
8" 27/6 · 12"	39/6

Post and packing 1/6.

PRESETS

Miniature and Sub miniature (.2 watts) Vertical and Horizontal .. 1/6

CARBON POTENTIOMETERS

Log. and Lin. Less switch	3/3
Log. and Lin. With switch	4/6
Wire-wound Pots (3 watts)	6/6
Twin Ganged Stereo Pots. Log. and Lin.	7/6

HEAT SINKS

4.8" × 4" × 1" Finned. For Two To-3 Trans. .. 9/6
4.8" × 2" × 1" Finned. For One To-3 Trans. .. 6/6
For SO-1 6d. For TO-5 1/- Finned
For TO-18 1/- Finned For TO-1 1/- Finned

ZENER DIODES

400 m W (from 3.3v to 33v) .. 5/-
1 Watt (from 2.4 to 200v) .. 7/6
10 Watt (from 3.9v to 40v) .. 7/6

5 ft. × 5/16 in. and ⅛ in. .. 2/-
D.G. 30 W. Soldering Irons .. 17/6 each

SPECIAL OFFERS

Bag of mixed diodes + Transistors (New. Approx. 60 devices per bag) .. 7/6
Bag of ½W mixed resistors approx. (120 pieces) .. 5/-
Bag Miscellaneous Comps (trans. caps. Res. Switches etc.) .. 15/-

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	12000
1A	2/9	3/-	3/3	3/6	3/9	4/-	4/6	—
3A	3/-	—	—	4/6	—	6/-	—	—
6A	—	—	5/-	6/6	7/6	9/-	10/-*	—
10A	8/-	12/6	13/6	16/6	16/6	19/6	23/-	30/-
17A	—	15/6	16/9	21/-	21/-	26/-	32/6	43/6

*5 AMP only. 1 AMP Tyres are plastic.

DIODES & RECTIFIERS

1N461	1/6	AA119	2/-	BY103	4/6	OA70	1/6
1N914	1/6	AAZ13	2/-	BY122	7/6	OA73	2/-
1N916	1/6	AAZ15	2/6	BY124	3/-	OA79	1/9
1N4007	4/6	AAZ17	2/6	BYX10	5/6	OA81	1/6
1S010	3/-	BA100	2/-	BYX10	9/-	OA85	1/6
1S021	4/-	BA102	4/-	BYZ11	7/6	OA90	1/6
1S025	5/-	BA115	1/6	BYZ12	6/6	OA91	1/6
1S113	3/-	BAX13	2/6	BYZ13	5/-	OA95	1/6
1S120	2/6	BAX16	2/6	FST3/4	4/6	OA182	2/-
1S121	2/6	BAY18	3/6	FST3/8	6/-	OA200	2/-
1S130	2/6	BAY31	1/6	OA5	2/6	OA202	2/-
1S131	3/-	BAY38	2/6	OA9	2/-		
1S132	2/6	BY100	4/6	OA47	2/-		

RCA INTEGRATED CIRCUITS

CA3005	30/-	CA3021	42/6	CA3039	25/-
CA3011	20/-	CA3022	35/-	CA3041	32/6
CA3012	25/-	CA3023	32/6	CA3042	32/6
CA3013	30/-	CA3026	27/6	CA3043	35/-
CA3014	30/-	CA3028A	25/-	CA3044	32/6
CA3018	25/-	CA3028B	35/-	CA3045	32/6
CA3019	25/-	CA3035	35/-	CA3046	25/-
CA3020	30/-	CA3036	20/-	CA3051	25/-

Data and application sheets 2/- per type.

FAIRCHILD

FAIRCHILD	1-6	6-11	12+
L900 Buffer	11/-	9/6	8/4
L914 Dual Gate	11/-	9/6	8/4
L702C	40/-		
L923 JK Flip Flop	14/-	12/6	11/9
L709 Op Amp	27/6	23/-	21/-

MOTOROLA

MC724P Quad 2 Input Gates	19/6
MC789P Hex Inverter	19/6
MC790P Dual JK Flip Flop	32/6
MC792P	20/-
MC799P Dual Buffer	29/6

Quantity Prices on Application.

THYRISTORS

PIV	50	100	200	300	400
1A	5/-	5/6	7/6	8/-	9/6
3A	6/-	7/6	8/-	9/-	10/6
5A	—	8/-	9/-	—	12/6
7A	—	11/-	13/-	14/-	19/6
25A	27/6	30/-	33/-	—	37/6

Also 12 Amp 100 PIV 15/-, 600 PIV 35/6.

GENERAL ELECTRIC

PA230	Low Level Amplifier	27/6
PA234	Audio Amplifier	26/6
PA237	2 Watt Audio Amplifier	45/-
PA246	5 Watt Audio Amplifier	57/6

MULLARD I.C's

FCH 211	Hextuple DTL Inverter Gate	28/6
FCH 221	Triple 3 Input DTL Line	28/6
FCJ 101	3 Input JK Flip Flop	35/-
TAA 241	Operational Amplifier	47/6
TAA 243	Operational Amplifier	45/-
TAA 263	Linear A.F. Amplifier	18/6
TAA 320	Most L.F. Pre Amplifier	15/6

VEROBOARD

VEROBOARD	.15 Matrix	.1 Matrix
2½" × 3¾"	3/6	4/-
2½" × 5"	4/3	4/9
3¾" × 3¾"	4/3	4/9
3¾" × 5"	5/6	5/6
3¾" × 17"	16/-	21/6
3¾" × 17" (Plain)	—	11/6
5" × 17" (Plain)	17/-	—
Vero Pins (Bag of 36)	3/-	3/-

Vero Cutter 9/-.

RESISTORS

Carbon Film

½ watt 10% .. 4d. ½ watt 5% Hy-stab 6d.
½ watt 5% .. 5d. 1 watt 10% .. 6d.
2 watt 10% .. 1/-

Wire Wound

3 watt 5% (Up to 270 ohms only) .. 1/6
5 watt 5% (Up to 8.2k ohms only) .. 2/-
10 watt 5% (Up to 25k ohms only) .. 2/9

CAPACITORS

Polyester, ceramics, Polystyrene, silver mica, tantalum, trimmers etc.

Electrolytics

MFD.	V.		MFD.	V.		MFD.	V.	
1	40	1/9	25	50	1/6	320	10	1/6
1.6	25	1/6	32	40	1/6	400	16	2/9
2	350	2/-	32	450	3/9	500	6	2/6
2.5	16	1/9	40	6.4	1/6	500	25	3/9
4	10	1/6	40	16	1/6	500	50	4/9
4	40	4/9	50	12	1/6	640	16	3/6
4	350	2/3	50	25	1/6	640	25	5/-
5	18	1/6	50	50	2/-	1000	16	5/-
5	50	1/6	64	25	1/6	1000	25	5/-
6.4	6.4	1/9	80	16	1/6	1000	50	7/6
8	40	1/6	80	25	1/6	2000	25	8/6
8	450	3/-	100	6.4	1/6	2000	50	12/6
10	12	1/6	100	12	1/6	2500	25	9/6
10	25	1/6	100	25	1/9	2500	50	13/6
12.5	25	1/9	100	50	2/6	3000	25	10/6
16	10	1/6	125	10	1/6	5000	25	12/6
16	15	1/6	200	10	1/6	5000	50	19/6
16	450	3/3	250	25	2/9	16 + 16	450	7/6
25	6.4	1/6	250	50	3/9	32 + 32	450	7/6
25	10	1/6						
25	25	1/6						

THERMISTORS

VA1005	3/-	VA1034	2/6	VA1053	2/6	VA1091	4/6
VA1010	2/6	VA1037	2/6	VA1066	3/9	VA1096	4/-
VA1015	3/9	VA1038	2/6	VA1074	2/6	VA1097	4/-
VA1026	2/6	VA1039	3/-	VA1075	4/6	VA1098	4/-
VA1033	2/6	VA1040	2/6	VA1077	4/-		

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RA 17 Receiver **£165**. RA 4 Receiver **£25**. One KiloWatt Linear PA complete with power supplies in 6 ft. enclosed cabinet. 1.5 to 25 meg cycles requiring 100 milli watt drive. In brand new condition. Complete with spares. Full details on request. **£550.**
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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 × 1¼in. 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. **£18/10/-**.
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.

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Omron/Schrack octal based plug-in relays. 2 pole c/o 5A, 230v and 6v. State which. Brand new. Boxed. **12/6 ea.**
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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.**
S.T.C. sealed 2 pole c/o 48V. 2.500 ohm **3/6** ea.
CARPENTERS polarised Single pole c/o 20 and 65 ohm coil as new, complete with base **9/6** ea. Single pole c/o 680, 1,110 and 1,570 ohm coil. As new **6/6** ea. Synchronous chopper AEI type CK4. As new **17/6** ea. Top connector **2/6** ea.
COLVERN Pots. Brand new. 10; 50; 100; 250; 500 ohms; 1; 2.5; 5; 10; 25; 50k all at **2/6** ea. Special Brand new **MORGANITE** 250K Lin. sealed. Normal price 9/-, our price **3/6** ea.

INSTRUMENT POTENTIOMETERS. 3" Colverns. 5, 25, 50, 100 ohms; 2·5, 25K. All at **7/-** ea.

HIGH RESOLUTION Potentiometer. 25K. 80 turns. Complete with knob. **6/6** each.

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3.25 K 0.1% **4/-** ea.

DUBILIER Electrolytic Capacitors. 32mfd 350v. DC. Brand new, **1/9** ea.

EL84 VALVES. Ex. eq. Tested. **7/-** pair.
PANEL SWITCHES. All high quality. SP, **1/-** ea.; DP, **2/-** ea.; DP 2w, **3/6** ea.

COURTENAY TIMER unit. Accurate 1 sec timer. Variable mark space ratio. Input 12v AC or DC. Heavy duty relay contacts to switch external equipment, eg., flashing lights. Chassis mounting. Size 6 × 3½ × 3in. Tested with circuit diagram. **22/6** ea.

TRANSISTORISED stabiliser unit. High quality. Input 24v raw DC, output 20v smoothed, and 12v ½ amp. Brand new. Superb value at **25/-** ea.
Geared Motors. 240v 50c/s synchronous. Geared down to 60 r.p.m. Brand new. **50/-** ea. P. & P. 7/6 ea.
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BURGESS Micro Switches V3 5930. Brand new **6/6** ea.
BULGIN panel mounting Lamp holders. Red. Brand new **2/3** ea.
Brand new **PLESSEY** plugs and sockets. Mark 4 and 7. Your requirements please.
TRANSISTOR Stabilised Power Unit. 48v, 4 amp. Manufactured by E.M.I. Open chassis. Brand new. Highest quality. Size 10½ × 5½ × 6½in. high. **£6** ea.
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POLARAD SPECTRUM ANALYSER. 5" display. 3 plug in tuning units. 20 mc/s to 44,000 mc/s. Superb condition. Write or phone for details.

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D.B. Oscilloscope. Type CD 711S.2, **£55.**
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3kV 4·5mA. 4v 0·5 amp × 2. 4v 1·1 amp. Brand new. **£5** ea., ex. eq., **£3/10/-** ea. 350-0-350 75mA, 5v 2 amps × 2, **21/-** ea.
Gardners 6·3v 2A; 6·3v 1·5A; 6·3v 0·1A. Size 3 × 1¾ × 4¾in. As new. **14/-** ea.
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Parmeko 65v 1 amp. Separate 0-18-24v at 0·5 amp. **30/-** ea.
Gard/Parm/Part. 450-400-0-400-450. 180 MA. 2 × 6.3v. **£3** each.

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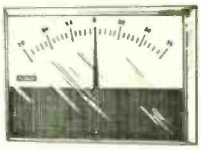
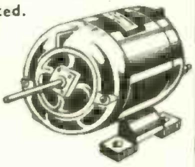
New 75-0-75 Micro-ammeter by Sifam. 750 ohm movement, clear reading, 5μa divisions × ⅛"; plastic front, projection ½" (tapering forward). Size: 4¾"×3¾". 57/6 each. P. & P. 2/6.



New "Croydon" 1/50th HP, cont. rating 240v. A.C. motor, 1500 RPM, foot mounted. Size: 3⅞" high × 5" long + spindle length 1⅞"×¼" dia. A really beautiful motor at less than half maker's original price. £6.10.0 each. P. & P. 5/-.

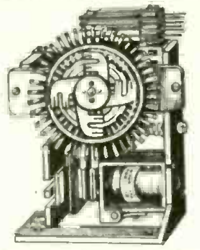


Robust M.E.S. Dual-circuit Panel Lamp by Thorne, adjustable length with press-to-test dome. 1" fixing hole. Available red, green, amber. 10/6 each. P. & P. free.

Isolation Transformers. 1 to 1. 250v. input, 250v. centre tapped out, at 2 K.V.A., mounted in metal case measuring 8¾"×8½"×11" high. Weight 65lb. £18.10.0. P. & C. 25/-.

We have a large quantity of Mullard Pot Cores, certain types only, also a very large quantity of Denco Neosid iron-dust cores. These items are suitable for industrial users and we would be pleased to give details upon request. Also in stock very large quantity of Torroid rings. Samples upon request.

SCHRACK ROTARY STEPPING RELAY RT304 48v. coil (28 ohm). The relay has 48 basic segments shorted in step by the 4 sweep contacts to 4 pole-plates (banks of 12). There are 2 secondary switches: (1) one c/o H/Duty contact set which changes over and back with each step; (2) two H/Duty changeovers which changeover on each 12th step and return on the following pulse. Size: Base 3½"×1¾"×4½" high. New in maker's packing, limited supply, also few only, as above, but 110v. (1,290 ohm coil), £6.10.0 each. P. & P. free.



Precision Motor-driven Potentiometer By "Precision Line" (U.S.A.). Continuous track with 2 platinum contact wipers set at 90° C.W. resistance 300 ohm only, ± 5% LIN ±0·5%, ball bearing spindle column. Size: dia. 1 13/32", height 1 1/32", spindle length 11/32" by ⅛" dia. These potentiometers were purchased by the importer at a cost of approx. £25 each. Our price £6.15.0 each. P. & P. free

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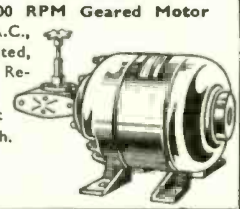

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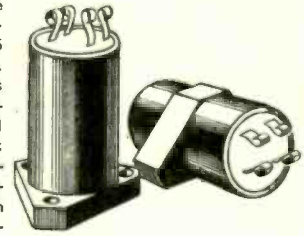

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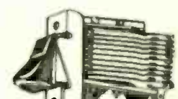

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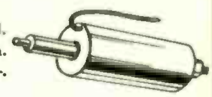

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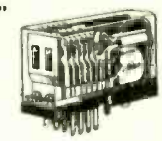

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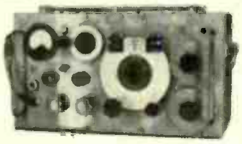

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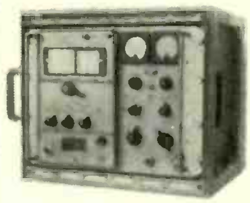

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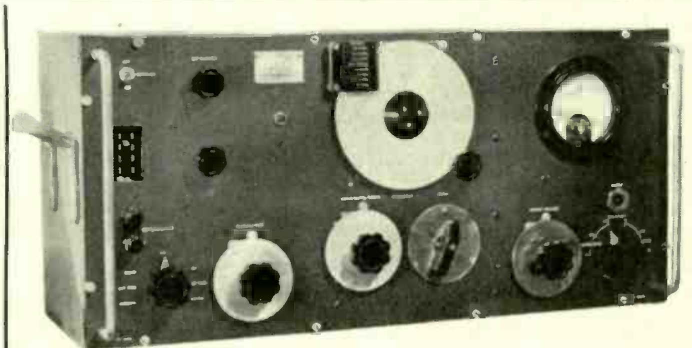

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COSSOR 1035 OSCILLOSCOPE, £30 each, 30/- carr.
COSSOR 1049 Mk. 111, £45 each, 30/- carr.

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/-.

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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
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	TF-934	Deviation Test Meter	£35 each
	6075A	Deviation Test Meter	£85 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
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SOLATRON	CD-513	Oscilloscope	£45 each
	CD-513-2	Oscilloscope	£47/10/- each
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POLARAD	Type MSG-1 Microwave Signal Generator, 950-2400 Mc/s		£100 each
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DAWE	Type 402C Megohm Meter		£12 each

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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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All at 3/6

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QY3-125A 160/-, QY4-250A 230/-, QY4-400A 300/-, R10 20/-, R18 9/-, RG3-250A 14/-, RL18 10/-, S130 35/-, S130P 35/-, SP2 9/-, SP4 9/-, SP41 7/-, SP42 12/-, SP61 7/-, TP22 11/-, TP25 6/-, TT21 48/-, TT22 50/-, U17 10/-, U18/20 13/6, 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, UB41 11/-, UBC41 9/6, UBC81 8/-, UBF80 7/3, UBF89 7/-, UBL1 10/-, UBL21 12/-, UC92 6/6, UCC85 8/-, UCF80 10/6, UCH21 11/-, UCH42 13/-, UCH43 12/-, UCH81 6/6, UCL81 11/-, UCL82 7/-, UCL83 12/-, UD143 15/-

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WE WANT TO BUY:

723A/B; 2K25; 4C35—50/- paid subject to test. Please offer us your special valves and tubes surplus to requirements.

WW—140 FOR FURTHER DETAILS

APPOINTMENTS VACANT

We're young, successful, and expanding —

The Dolby Audio Noise Reduction System has in only three years changed international studio practice, providing a new master recording standard. The system is briefly described in our advertisement on page 40 of this issue.

As well as designing and manufacturing professional equipment (of which 80% is exported), we research into consumer applications, and recently the first domestic tape machines using a simplified version of the system were released under license in the U.S.A. But this is only the beginning of a long line of new applications.

We are situated in south London in a modern four-storey building which includes laboratories, offices and production facilities. We are still small – just 60 people – but are expanding rapidly in all departments; the search is for people who have the capability of growing with us. Prospects are excellent and the rewards attractive. We have these immediate technical vacancies:

ELECTRONICS ENGINEERS

We are looking for several top-flight engineers under 30, with a university degree in physics or electrical engineering and at least two years' experience in electronic circuit design. The jobs involve not only research and development, but in addition the design of both professional and consumer products, based on Dolby noise reduction techniques. Where products are concerned, the designer will liaise with the production department during all stages of manufacture.

Candidates should be familiar with modern techniques – ICs and FETs, for example – and should be experienced in both linear and non-linear circuitry as applied in the frequency range dc to 20 MHz.

Salaries from £1,800 to £2,500. Write or phone with brief details to David Robinson, Chief Engineer.

ELECTRONICS ENGINEER (PRODUCTION)

The candidate will be a graduate engineer under 30, with a university degree in physics or electrical engineering. He will be responsible to the Production Manager for electronic aspects of production. These will include the design and introduction of specialized test equipment and procedures, together with the provision of general technical advice to the electronic test department. He will liaise with the engineering department on technical matters and will have the opportunity of investigating and introducing new production techniques. He will have a minimum of two years' design experience and preferably experience also in giving technical support in a production department.

Salary from £1,800 to £2,500. Write or phone with brief details to Bob Tallon, Production Manager.

DESIGN DRAUGHTSMAN

Flexibility is the keynote in our requirement for a design draughtsman under 30 for a position in the Design Department, which is responsible for all design aspects of the company.

His primary duties will be to interpret details from design schemes and prepare complete mechanical manufacturing drawings for the production of light electro-mechanical units. In due course, he will be expected to produce his own design schemes from initial sketches or proposals. He must have some understanding of electronic circuits and be capable of developing, from initial circuit information, the necessary tape masters and associated details for printed circuit production.

The candidate must also have an artistic inclination, for as a secondary activity he will assist in the layout and preparation of artworks for advertising, technical literature and exhibitions.

It is essential that his draughting and presentation should be of the highest standard.

Salary from £1,500 – £2,200. Write or phone with brief details to Ron Free, Senior Designer.

DOLBY LABORATORIES

346 Clapham Road,
London, S.W.9
Telephone: 01-720 1111

ELECTRONICS AUTHORS ARE V.I.P. AT REDIFON

if they know something about radio transmitters, receivers, ancillaries or systems.

If you have been in the business anywhere from two to twenty years we've a place for you at our Communications Division, London, S.W.18.

For details of our red carpet treatment ring Ted Jackson, our top man in handbooks, at 01-874 7281 (he *thinks* he is ex-directory so try 01-399 1917 if it's more convenient out of office hours).

REDIFON

A Member Company of the Rediffusion Organisation

2540

SERVICE ENGINEERS

Our Instruments Company is currently expanding its activities and range of products.

Senior and Intermediate vacancies exist at the Service Department situated in Reading Berks.

The Department is furnished with modern test and fault finding equipment and the work is varied and interesting. Equipments are modern analogue and digital devices incorporating the latest techniques in instrumentation.

Previous servicing experience is desirable but our main requirement calls for an enthusiastic sound approach to the servicing of our wide range of products.

Applications in writing please to:

Mr. L. A. Jemmett.
Racal Instruments Ltd.,
Bennet Road,
Reading,
Berks.

RACAL
THE ELECTRONICS GROUP

2538

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

Rank Precision Industries Limited

BROADCAST DIVISION

RANK CINTEL

The Cintel section is rapidly expanding its Development and Research Departments of professional television studio equipment. To strengthen their teams the following engineers are required.

senior electronic design engineer

To work on development work on T.V. studio equipment. Successful applicant should have experience in this field together with B.Sc. or Dip. Tech. qualification. Salary up to £2,500.

senior mechanical designer

To work on colour telecine machines and other allied broadcasting equipment. The work which is varied involves the development of small mechanisms and electromechanical devices. Salary up to £2,500.

intermediate engineers test engineers

Are also required to assist in the Cintel programmes.

works staff

Bench Testers: To work on the professional T.V. studio equipment. No special qualifications are required for these positions but some experience in the T.V. field is preferable.

TELECOMMUNICATIONS

The Telecommunications section has been in the field of communication for many years and holds major contracts. Increased activity demands new teams for work on Military Communication Equipment.

section leader—military communications

Will be required to build up a team for the following projects. New lightweight man portable equipment, H. F. and V.H.F. channel generator by frequency synthesis. Initially the work involves responsibility for design aspects of an H.F. equipment undergoing a quality assurance programme. Age immaterial. Salary up to £2,500.

senior development engineers

To assist the section leader on the above projects. Successful applicants should have experience in this field together with the ability to lead in an objective fashion.

intermediate engineers test engineers

Are also required to assist in the Telecommunications programmes.

works staff

Testers: To work in the Test and Inspection department on the Telecommunications programmes. Experience in this field is necessary for most positions.

These positions carry good salaries together with the excellent fringe benefits available to all Rank Organisation employees. Sick Pay entitlements and holiday entitlements have recently been increased.

Location initially at Welwyn Garden City, moving to the new factory at Ware, Herts. before June 1970.

Applications to:

The Rank Organisation

Holders of The Queen's Award to Industry for 3 successive years.

RANK PRECISION INDUSTRIES

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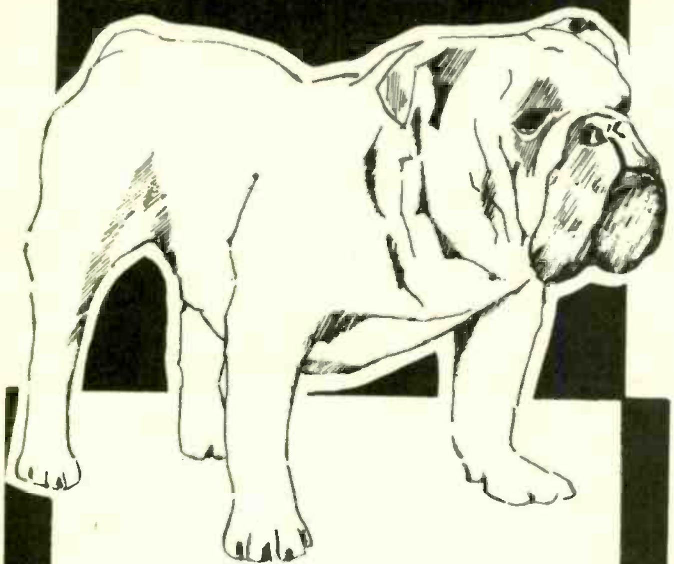
Welwyn Garden City, Herts.
Tel: Welwyn Garden City 23434

TOP DOGS



That's Burroughs. And choosy about the company we keep. Are YOU a top dog? With the right sort of pedigree? Degree in engineering, (Honours Graduate or Ph.D.) with inbred ability and the stamina to hold your top place in a highly competitive field? Then BURROUGHS is the place for you.

DEVELOPMENT ENGINEERS

(Mechanical or Electronic)

to join one of the foremost companies in Britain's fastest growing industry. In addition to your degree you will have a minimum three to five years' experience in one or more branches of a light engineering industry and require to have the ambition and talent to go to the top in one of the world's greatest companies.

The positions on offer give an opportunity for top dogs to get in at the beginning of an engineering expansion programme in Burroughs, Cumbernauld and further develop personal engineering skills and promotion prospects.

Salary is no stumbling block—we know we have to pay top salaries for top dogs.

Our plant is located in the green belt between Stirling, Edinburgh and Glasgow. You can readily commute from a rural village or market town with facilities for golf, angling, yachting or ski-ing and still be within easy reach of excellent schools and universities.

Please write or telephone (reverse charges) to:—

Tom Bennett,
Engineering Division,
Burroughs Machines Ltd.,
Cumbernauld,
Scotland.
Tel. 22111 (ext. 29)

2533

DESIGN ENGINEERING

New opportunities in electronics

E.M.I. Limited offer worthwhile careers to experienced Design Engineers in the following categories:–

MICROELECTRONIC DESIGN

Working in close liaison with Production Engineers with the responsibility for the design of new tooling methods. A good knowledge of Jig and Tool work is required.

TELEVISION DESIGN

The work involves the design of custom-built T.V. Studio and Outside Broadcast Vehicle Equipment and would be of interest to persons familiar with Commercial Quantity Production Methods.

JIG & TOOL DESIGN

A vacancy has occured for an experienced Jig and Tool Designer to undertake Jig and Tool Design in all its aspects.

SPECIAL PURPOSE MACHINERY DESIGN

For interesting and varied work on the design of new special purpose Machinery and Tools.

There are also vacancies for Draughtsmen to carry out the design of printed circuit boards from diagrams and experience of packaging techniques would be an advantage.

For all the above positions a minimum of O.N.C. or equivalent qualification is required. Starting salaries are attractive, being commensurate with qualifications and experience.

Working conditions are excellent and full social and welfare facilities including a contributory pension scheme with free life assurance are available.

Apply in writing stating area of interest to:

EMI
M. A. JONES
PERSONNEL OFFICER,
GROUP PERSONNEL DEPARTMENT, E.M.I. LTD.,
BLYTH ROAD, HAYES, MIDDLESEX.

EMI CAREERS

RADIO ENGINEER FOR UGANDA

We have a vacancy for a well trained radio engineer with a good knowledge of electrical and electronic problems.

The person we are looking for should be a good organiser, must have real interest in his work and must be willing to train local staff. There are unlimited opportunities as the successful applicant will receive on the spot training in our medical and X-ray dept. This will necessitate regular journeys to all parts of Uganda. Our terms of service are good, the climate is wonderful and the work unusual. We offer good local and overseas leave facilities.

Those interested should write to:

Twentsche Overseas Trading Co. (Uganda) Ltd.,
P.O. Box 7160,
KAMPALA,
Uganda,

giving details of previous experience, age and marital status.

2580

THE DEPARTMENT OF CIVIL AVIATION, ZAMBIA

Require

Radio Engineers

Salary in scale up to £2782.
Tour of 36 months offered.
Generous leave on full salary.
25% End-of-Tour gratuity.

Commencing salary according to experience in scale Kwacha 2736 (£Stg.1596) rising to Kwacha 3216 (£Stg.1876) a year, plus an Inducement Allowance of £Stg.568 – £Stg.615. A Direct Payment of £Stg.268 – £Stg.291 is also payable direct to an officer's U.K. Bank account. Both gratuity and direct payment are normally TAX FREE. Free passages. Quarters at low rental. Children's education allowances. Generous leave on full salary or terminal payment in lieu. Pension scheme available under certain circumstances.

Candidates must be under 55 years of age and should possess 8 years relevant experience following:—

(i) an apprenticeship of 5 years, or
(ii) possession of a Service Trade Certificate, or
(iii) possession of an I.C.A.O. certificate or
(iv) equivalent.

In addition, candidates should have a sound experience of the theoretical principles of and experience in the maintenance of the first two and at least one other of the following groups of communications and navigational aid systems:

1. Medium powered H.F. Transmitters and associated Receivers: Frequency Shift Keying; S.S.B. and D.S.B. Equipment; Medium Frequency Non-Directional Radio Beacons.
2. Low and High powered V.H.F., A.M. Equipment.
3. V.H.F. Omni range; Automatic VHF Direction Finders. Distance Measuring Equipment.
4. Instrument Landing System.
5. Radar X Bank Terminal and P.P.1 Talk Down Equipment.
6. Audio and Remote Control Equipment; Public Address Equipment; Airport Magnetic Tape Recorders; Inter Office Communication; Underground Control Cables; Impulse and D.C. Switching System.
7. Teleprinter Telegraphy (torn tape) and associated Page Printers; Tape Recorders (autoheads); Semi-Automatic Message Switching System.

Duties include the maintenance, overhaul and installation of ground terminal radio communication equipment and navigational aids at Airports and Flight Information Centre. Possession of a valid driving licence will be an advantage.

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1, for application form and further particulars stating name, age, brief details of qualifications and experience and quoting reference number M2Z/690315/WF.

2532

BBC television requires ENGINEERS

with one of the following qualifications:

B.Sc.
H.N.D.
H.N.C.
C. & G. Full Tech. (Telecommunications)

Based at Television Centre and other London studios and Outside Broadcast bases. Applicants must have normal colour vision and be permanently resident in this country.

SALARY: £1,205-£1,775 p.a.

TRAINING: Full-time residential training course on television engineering techniques given on appointment. Excellent opportunities for promotion. 3-4 weeks annual leave (according to salary). Generous shift allowances paid.

For application form and further details write to:

The Engineering Recruitment Officer,
BBC · Broadcasting House · London · W1A 1AA
quoting reference 69.E.4037 W.W.

1969

2559

join the men who lead

Device Technology Engineer

A qualified man is urgently required to work as a senior member of a team at present engaged on the aspects of choice and design of solid state devices. These include microcircuits and hybrid circuits for use in high reliability equipment.
Applications are invited from Electronics Engineers or Physicists with a sound knowledge of microcircuit technology and design. At least three years' experience in the application of the above mentioned devices is essential.

Please write or 'phone for an application form, quoting Ref. 1462, to:
Mr. E. Buckmaster,
1462 Personnel Department,
British Aircraft Corporation, Guided Weapons Division,
Stevenage, Herts. Tel: Stevenage 2422.

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RESEARCH and DEVELOPMENT

ELECTRONIC ENGINEERS

...OUR WORK

Expanding exports and the increasing complexity of our products have intensified our development programmes for digital and analogue computers, linkage and special purpose computer peripherals. We wish to establish new teams of electronic engineers and if you are interested in joining us . . .

...YOUR QUALIFICATIONS

should include a degree, H.N.C. or equivalent. You should have relevant experience, coupled with enthusiasm and ability and . . .

...YOUR REWARDS

with Redifon will be a good salary, stability of employment, a wide range of interesting work and an opportunity to expand your experience into new fields in . . .

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We design and manufacture flight simulators and electronic teaching machines for world-wide markets. The laboratories are situated in a pleasant part of Sussex at Crawley, mid-way between London and the South Coast.

Application forms may be obtained from:

H. C. Hall, Personnel Manager,
REDIFON LIMITED,
Flight Simulator Division,
Gatwick Road, Crawley, Sussex.
Telephone: Crawley 28811

REDIFON

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TESTERS AND TEST TECHNICIANS

We require all grades of Test Engineers who are experienced in the testing and fault-finding of complex electronic equipment, including control systems. We offer Staff positions to suitable applicants and four weeks holiday after three years service. High rates of pay, good working conditions, canteen, social and sports club.

Please write or phone:

The Personnel Officer (Ref. 170),
ULTRA ELECTRONICS LTD.,
Western Avenue, Acton, London, W.3
Tel.: 01-992 3434

UEL

Computicket want

MAINTENANCE TECHNICIANS

Computicket are moving rapidly towards the full implementation of their entertainment seat booking system. This service, which operates in real-time, will ultimately involve hundreds of on-line C.R.T. terminals sited in a wide variety of public places.

Computicket are now recruiting Maintenance Technicians for the Greater London area to perform a vital role in this exciting new service.

Applicants should have had experience in the maintenance of electro-mechanical and electronic equipment situated in the field and should be happy to find themselves part of a technically advanced but none-the-less consumer orientated team.

Conditions of employment are attractive and salary will be in the region of £1,500 p.a.

Write with resumé of career to: Colin Roberts, Chief Engineer,

Computicket Limited

30 FINSBURY SQUARE, EC2
Member company of International Publishing Corporation

2549

Electrical Engineers

Rolls-Royce and Associates Limited is engaged in an extensive programme of design, development and procurement of nuclear propulsion plant. We have immediate vacancies for:-

Electronic Engineers
to be responsible for the design, development and engineering of nuclear reactor control and instrumentation systems. Applicants should be of graduate status.

Electrical Designers
to be responsible for the preparation of design schemes. Applicants should have H.N.C. in Electrical Engineering and have completed an engineering apprenticeship. A minimum of 2 years' drawing office experience is essential.

Salaries are commensurate with age, qualifications and experience. A generous proportion of relocation costs will be met by the Company with special assistance for house purchase where necessary.

Please apply in writing, or by telephone for an application form to The Personnel Manager,

Rolls-Royce and Associates Limited,
P.O. Box 31, Derby DE2 8BJ or telephone Derby 61461 extension 213.

University of Reading
DEPARTMENT OF PSYCHOLOGY
Electronic Engineer (A.E.O.)

Applications are invited for the post of ASSISTANT EXPERIMENTAL OFFICER in the Department of Psychology. Applicants must have an H.N.C. in Electronics or equivalent qualification. The successful applicant will be expected to be familiar with the design and assembly of simple analogue and digital electronic equipment, such as Timers. Logic for automation of experiments, High Sensitivity Audio and D.C. Amplifiers for electrophysiological work. Experience in the use of semi-conductor devices and integrated circuits would be an asset. The applicant will be expected to supervise the servicing of existing equipment; there will be a good opportunity to gain experience in servicing a small computer. The initial appointment will be made at A.E.O. level. Salary £872-£1,454 per annum. The point of entry will depend on qualifications and age. **Applications, quoting M.62, to Assistant Bursar (Personnel), University of Reading, Reading, Berks.**

2556

HENRY'S RADIO LTD.
303 EDGWARE ROAD, LONDON, W.2
HAVE THE FOLLOWING VACANCIES IN THEIR ORGANISATION

ORGAN DEPARTMENT
Young man interested in Electronic Musical Instruments with a good general knowledge of electronics required for this expanding Dept. Write, or Telephone 723-1008/9 Extn. 1 or 2.

SALES ASSISTANTS
Young man with a good general knowledge of HIGH FIDELITY EQUIPMENT required for our retail HI-FI SALES DEPT. Please contact MR. STEVENS, Telephone 723-6963. 2585

CHIEF TELEPHONE ENGINEER
OVERSEAS

International Aeradio Ltd are a thriving world-wide organisation of some 3500 employees engaged in the fields of communications and with 18 overseas subsidiary and associate companies. Major expansion has created the requirement for a Chief Telephone Engineer for one of the group's associated Telephone companies in the Arabian Gulf area. He will supervise a team of expatriate engineers and be responsible for the engineering administration and short-term carrying functions. A good theoretical background is essential together with specialist practical knowledge in at least two of the following fields:

a) Electronic Common Control Exchanges.
b) Local junction and subscriber's distribution network.
c) Subscriber's apparatus including PABX's.
d) Telex systems.
e) Coaxial cable transmission systems.
f) VHF radio relay transmission systems.

The position offers unusually good career prospects to the right man. A substantial tax-free starting salary will be offered including in addition, free furnished accommodation, marriage, child and educational allowances, free leave passages and medical attention, and concessions on holiday air fares after a year's service.

Please apply stating briefly details of age and qualifications to:

IAL
General Manager Personnel,
INTERNATIONAL AERADIO LIMITED,
Aeradio House, Hayes Road, Southall, Middlesex.

PYE TVT the leaders in closed circuit television

PYE TVT the experts in sound engineering·PYE TVT

leaders in broadcasting equipment·PYE TVT sound amplification

Supervisory Test Engineers

Studio Equipment—Audio

Two competent men are required for sections engaged on fault-finding and testing to specification of a wide range of professional audio equipment including mixing desks, power amplifiers and ancillary units for O.B. vehicles.

Good experience with solid state amplifiers and ability to carry out measurement are essential.

We offer attractive salaries and conditions of employment. Local housing may be made available.

Please apply with brief details of experience to:

Personnel Officer,
PYE TVT LIMITED
Coldhams Lane, Cambridge,
Telephone Cambridge (0223) 45115

QUAD

If you think:

a. You'd like to work for Quad,
b. You have the right qualifications,
c. It would be better to work in Huntingdon* than in the big city rat-race,

drop us a line. We urgently need technicians and engineers for both Audio and VHF, and would be pleased to discuss the prospects with you.

Write initially, giving full details of your training and experience to:

Mr. J. H. Walker,
The Acoustical Mfg. Co. Ltd.,
St. Peter's Road,
Huntingdon.

* Look it up on the map: Quad helped to put it there!

2553

THE GENERAL POST OFFICE has VACANCIES for RADIO OPERATORS II at its COAST RADIO STATIONS

Applications are invited from men between 21 and 35 years of age who must hold either the Postmaster General's First or Second Class Certificate of Competence in Radiotelegraphy or an equivalent Certificate issued by a Commonwealth Administration or the Irish Republic.

SALARIES HAVE BEEN INCREASED and the scale now begins at £807, for those entering at the age of 21, rising to a maximum of £1,188. There will be a further increase on 1st January, 1970.

The posts will be temporary in the first place but successful applicants will be eligible to enter the open competitive selection for permanent appointment.

Applicants should write to: The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London, E.C.1 or telephone 01-432 5628 for further information.

2554

Ex-Service TECHNICIANS

A number of ex members of H.M. Services have joined us recently as prototype engineers working successfully on complex electronic equipment. We have three more vacancies and would like to hear from those who have left H.M. Service or are about to leave.

Apply:
Personnel Officer,
Pye TVT Limited,
Coldhams Lane,
Cambridge.

Telephone Cambridge (0223) 45115

2557

THE UNIVERSITY OF HULL

AUDIO-VISUAL CENTRE

SOUND SUPERVISOR

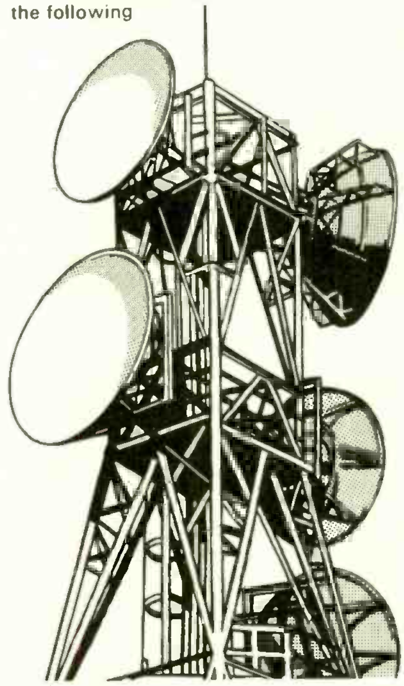
The Audio-Visual Centre in the University is engaged in the production, to fully professional standards, of television programmes, films and sound recordings for educational purposes. Applications are invited for the post of Sound Supervisor. Preference will be given to candidates with an H.N.C. or equivalent qualification together with experience in the operational and maintenance aspects of professional sound broadcasting and recording equipment. The duties will be to assist in both operations and maintenance of the equipment used in the Centre.

Salary range: £1,578-£2,006.

Further particulars may be obtained from the Registrar to whom applications (3 copies) should be sent by 27th October, 1969. 2592

CONTINUOUS EXPANSION

Standard Telephones & Cables, Microwave and Line Division based at Basildon are growing fast. In order to keep pace with this consistent growth rate we require the following



Installation Engineers Technicians & Testers

Ref. 25720

To test and commission Multiplex, Co-axial Line and Microwave Radio Systems.

Ideal candidates will be less than 45 years of age with practical experience on some of the above equipment. These challenging posts call for drive, initiative and common sense. It is necessary for applicants to be prepared to work anywhere in the U.K.

Test Technicians

Ref. 27221

The diversity of products manufactured at the Basildon Plant demands experienced testing staff for work on complex transmission systems.

Candidates should hold an ONC in electrical engineering and be able to offer considerable practical experience in the field of testing and fault clearing all types of land-unit, pcm and microwave equipment.

Applications should be addressed to
**The Personnel Officer,
STC Chester Hall Lane,
Basildon, Essex.**

STC

2605

University of Birmingham
Department of Medicine

ELECTRONICS TECHNICIAN

required for work concerning the development and maintenance of electronic and physical apparatus used in medical research. Qualifications: O.N.C. or equivalent. Experience in digital forms of data acquisition desirable but not essential.

Salary: £773—£1,077.

Apply: Assistant Secretary (Personnel), Personnel Office, University of Birmingham, P.O. Box 363, Edgbaston, Birmingham, 15, quoting reference: 417/T/143.

2555

LEC

RADIO & TELEVISION SERVICING RADAR THEORY & MAINTENANCE

This private College provides efficient theoretical and practical training in the above subjects. One-year day courses are available for beginners and shortened courses for men who have had previous training.

Write for details to: The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. Tel.: 01-373 8721.

84

TEST ENGINEERS AND INSPECTORS

Owing to rapid expansion due to large export orders on Marine Radar we have urgent vacancies for

TEST ENGINEERS

with a good electronic background, and preferably with radar experience.

ELECTRO MECHANICAL INSPECTORS

MECHANICAL INSPECTOR

Please apply in writing to the Personnel Officer

The Plessey Company Limited
Martin Road, West Leigh, Havant
Hampshire
quoting ref. HAV/169/B

2560

CAREERS IN RECORDING

PHILIPS PHONOGRAPHIC INDUSTRIES in Baarn, Holland, offer excellent career possibilities to young men between 22 and 30 years of age to join the Classical Recording Department as trainees.

Candidates will be required to reside in Holland and should have a thorough knowledge of at least one European language, ideally German or French.

A good musical knowledge is essential and experience in the audio field would be an advantage.

Duties will include editing recorded tapes according to instructions in the score and responsibility for the installation and maintenance of recording equipment.

Please apply in writing, sending brief details of age, education and work experience to:—

**The Personnel Officer,
Philips Records Limited,
Stanhope House,
Stanhope Place,
LONDON, W.2.**

Initial interviews will be held in London.

2571

PYE TVT the leaders in closed circuit television

PYE TVT the experts in sound engineering·PYE TVT

leaders in broadcasting equipment·PYE TVT sound amplification

Electronic Design Engineer

Pulse and Logic Circuitry

A vacancy of exceptional interest for a young design engineer has arisen. He will join a team working on television studio equipment using digital techniques of an advanced nature.

Applicants will be of at least H.N.C. standard and have three years or more of design experience using transistor and integrated circuits

Age preferably 24/30.

Attractive conditions of employment and commencing salary will be offered.

Please apply with brief employment details to:

Personnel Officer,

PYE TVT LIMITED

Coldhams Lane, Cambridge.

Telephone: Cambridge (0223) 45115

2543

Test Engineers

Due to expansion there are excellent opportunities for Test Engineers in our laboratories and production departments, testing Radio, Navigator and Survey equipment.

Applicants with first-class background of T.V. and Radio Servicing or Telecommunications, Electronic and Control Circuiting should apply giving details of experience. Conditions are excellent and salaries will be commensurate with ability and experience.

DECCA

Apply quoting Ref. NAV/29/C to
**The Personnel Officer,
The Decca Navigator Company Ltd.,
88 Bushey Road, Raynes Park, London, S.W.20.
Tel : Wimbledon 8011.**

2541

THE UNIVERSITY OF LEEDS

British National Cosmic Ray Experiment, Haverah Park, Near Leeds.

Required immediately an EXPERIMENTAL OFFICER to assist with the design and development of electronic apparatus. Minimum qualifications: degree or equivalent in physics or electronic engineering.

Salary in range £995-£1,460. Applications should be made in writing, giving details of qualifications and experience, to the Administrative Assistant, Physics Department, University of Leeds, Leeds, LS2 9JT.

2581

DUBLIN

BROADCAST ENGINEER

With experience of maintenance and development of TV and sound studio equipment.

Required for radio and TV production and training studios.

Applications with a resumé of relevant experience should be sent to the Director, The Communications Centre, Booterstown Avenue, Co Dublin. Terms of contract negotiable.

2583

ELECTRONICS TECHNICIAN

to be responsible to Group Engineer for maintenance, calibration and installation of a wide range of electronic equipment used in medical and engineering fields of Hospital work. Qualifications to level of H.N.C. desirable with wide experience in maintenance and calibration of electronic equipment.
Salary range £1030 to £1365 p.a. Starting salary may be above minimum. Post offers ideal opportunity for man to join vital and growing service with prospects for advancement.

**Application forms from Group Engineer, Reading and District Hospital Management Committee
3 CRAVEN ROAD · READING · BERKS.**

2584

TECHNICAL ASSISTANT

Men under 30 with science or engineering degree or equivalent required to work in London office of large firm of patent agents, to deal with inventions covering a wide range of subjects and to be trained to join the surprisingly highly-paid ranks of Chartered Patent Agents.

Write Mr. R. L. Andrews, 28 Southampton Buildings, Chancery Lane, London, W.C.2, or telephone 405 5611.

2588

URGENTLY REQUIRED

ALL TYPES OF RADIO TELEPHONE EQUIPMENT

ESPECIALLY PYE CAMBRIDGE AND VANGUARD MOBILES. ALSO BASE STATIONS ANY CONDITION, WORKING OR NOT. *Top prices paid.*

WE ALSO REPAIR ALL TYPES OF RADIO TELEPHONE EQUIPMENT

SOUTHERN RADIO & T.V. SERVICE
**1 BACK HAMILTON STREET
SALFORD 7 LANCS.**
Telephone 061-792 4929

GOVERNMENT OF UGANDA

REQUIRES

BROADCASTING ENGINEERS

to serve on contract for one term of 21-27 months in the first instance. Salary according to experience in scale Uganda Shg.21120-27780 (£Stg.1232-1620) a year, plus an Inducement Allowance, normally tax free, of £Stg.778-886 a year, paid direct into the officer's bank in U.K. Gratuity 25% of total emoluments drawn. Liberal paid leave. Accommodation provided at reasonable rental. Outfit and education allowances. Free passages. Contributory pension scheme available in certain circumstances.
Candidates must possess the City and Guilds Final Certificate in Telecommunications (with Radio) or an equivalent qualification and have wide practical experience of technical broadcasting equipment including transmitting and studio control equipment.
The officer will be required to undertake senior operational duties including the maintenance of broadcasting equipment in transmitting stations and studios; outside broadcasts and recordings in remote districts, and to give assistance with the training of junior engineering staff.

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1, for application form and further particulars stating name, age, brief details of qualifications and experience and quoting reference number M2K/690995/WF.

CLARKE & SMITH MANUFACTURING CO. LTD.

have vacancies for

Audio Electronics and Small Mechanism Design Engineers

to work on Language Laboratory Systems and Electronic Equipment for Education Projects. Good salaries and progressive positions. Applicants, who should have qualifications equivalent to H.N.C. standards, should apply to:

**Mr. T. A. Julian,
Wallington,
Surrey.
Tel: 01-669 4411**

2589

West Sussex County Education Committee

BOGNOR REGIS COLLEGE of EDUCATION

Upper Bognor Road · Bognor Regis · Sussex

Applications are invited for the post of

TECHNICIAN

for Closed Circuit Television

Person appointed will be expected to have sound practical knowledge of cameras, control and recording equipment used in Closed Circuit Television and be capable of carrying out day to day maintenance. Applications will be considered from those with relevant experience in the electronics field who desire to extend this to Television. Salary scale: £930-£1,095 per annum, according to experience. Additional remuneration payable in respect of certain specialist qualifications.
Application form and further details from the Administrative Officer at the College.

2590

Radio Technicians

INSTALLATION AND MAINTENANCE

£1,100-£1,500

YOUR WORK

Will be concerned with the maintenance and installation of equipment at airfields. inland and marine mobile networks and on North Sea drilling rigs. You will be basec at Southall and London Airport and you may also be required to make brief trips overseas.

OUR REQUIREMENT

You should have experience in one or more of the following types of equipment—

* VHF/UHF Base Station Mobile Equipment:
* HF Receivers and Transmitters up to 1 KW using SSB. ISB and FSK techniques:
* Remote control systems operating over G.P.O. landlines:
* Teleprinters and Telegraph machines and error correction equipment.

You must have a U.K. driving licence and be willing to work outside working hours on a call-out roster basis.

OUR OFFER

Includes membership of an excellent contributory pension and life assurance scheme and concessions on holiday air fares can be obtained at nominal cost to most parts of the world. after a year's service. Salary will be negotiated and range from £1.100-£1.500.

YOUR FUTURE

Excellent long-term career prospects are offered for both U.K. and Overseas employment.

IAL are a fast-expanding world-wide Company. engaged in the field of communications. aviation services and engineering with over 3.000 employees around the world.

Please write stating briefly age and experience to the

Personnel Officer (R),

IAL **INTERNATIONAL AERADIO LIMITED**

AERADIO HOUSE · HAYES ROAD · SOUTHALL · MIDDLESEX

PYE TVT the leaders in closed circuit television

PYE TVT the experts in sound engineering·PYE TVT

leaders in broadcasting equipment·PYE TVT sound amplification

Electronic Test Engineers

TV Broadcast Equipment

Due to rapid expansion we have several additional vacancies for test engineers to work on a variety of units making up an advanced system of TV broadcast equipment.

Applicants will preferably have several years' experience of testing TV transmission broadcast equipment and be thoroughly familiar with the use of complex oscilloscopes for critical measurements of test parameters.

Attractive conditions of employment and commencing salary will be offered.

Please apply with brief employment details to:

Personnel Officer

PYE TVT LIMITED

Coldhams Lane, Cambridge.
Telephone Cambridge (0223) 45115

2544

Electrical Engineer

The Industrial Applications Department of the Electrical Research Association has a vacancy for an Electrical Engineer.

The successful applicant will be working with a group required to make investigations into the generation, propagation and measurement of high frequency transient disturbances in control and computer systems.

QUALIFICATIONS required are a degree, H.N.C. or equivalent in Electrical Engineering, with preferably industrial or research experience, in high frequency pulse techniques or electronic circuitry.

SALARY: this appointment will be in a grade with a salary range of £1,110–£1,750, the commencing salary depending on qualifications and age which is likely to be between 22 and 28 years.

Please apply to:
The Personnel Officer, Ref: 1A2,
Electrical Research Association,
Cleeve Road, Leatherhead, Surrey.

2534

THE UNIVERSITY OF HULL
AUDIO-VISUAL CENTRE
STUDIO ENGINEER
(Videotape and Telecine)

Applications are invited for the post of Studio Engineer (Videotape and Telecine) in the Television Studios of the University's Audio Visual Centre. Preference will be given to candidates with an H.N.C. or equivalent qualification, together with experience in the maintenance and operational aspects of magnetic recording equipment (either one inch helical scan or two inch broadcast) and/or Telecine equipment. The duties will be to operate and maintain videotape recording and Telecine equipment used in the Centre and if necessary further training will be given.

Salary range: £1,056-£1,311.

Further particulars may be obtained from the Registrar to whom applications (3 copies) should be sent by 27th October, 1969. 2593

UNIVERSITY OF BIRMINGHAM
Department of Electron Physics
Electronics Engineer

required to join the space research group in the Department of Electron Physics. The work is concerned with the design of electronic instrumentation for scientific rockets and satellites. The successful candidate will be expected to follow a project from initial design through environmental testing and space vehicle installation to pre-launch count down. This programme involves travel within the U.K. and to overseas launch sites. The post requires specialist experience in complex analogue solid state circuits and applicants should possess Grad. I.E.E.E., H.N.D., H.N.C. or equivalent qualifications. Those wishing to see something of the work before making a formal application are invited to telephone Professor J. Sayers, 021-472 1301, Ext. 1801.

Salary £1380—£2045.

Applications should be sent to the Assistant Secretary (Personnel), Personnel Office, University of Birmingham, P.O. Box 363, Birmingham 15, reference 105/TO/155. 2561

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

DEPUTY SUPERINTENDENT OF POLICE
(Signals Branch)
Government of Brunei

Candidates, must have City and Guilds Telecommunications Intermediate Certificate, with not less than five years' experience. Experience in a Police Force or Armed Forces is desirable.

The Officer is to assist the Force Signals Officer in installation, maintenance and servicing of V.H.F. and H.F. equipment, supervision of Signals Stores and Workshops and Staff.

Salary range £2,125-£2,518 P.A. plus inducement allowance (£441-£474) P.A. The Appointment is on contract with gratuity for one tour of three years.

Candidates, who should be Nationals of the United Kingdom or Republic of Ireland, should apply quoting RC216/28/02 giving full name, age, qualifications and experience to:

The Appointments Officer,
MINISTRY OF OVERSEAS DEVELOPMENT,
Room E301, Eland House,
Stag Place, London, S.W.I. 2600

THE
COLLEGE OF AERONAUTICS

The following appointments are to be made in the High Frequency Section of the DEPARTMENT OF ELECTRICAL AND CONTROL ENGINEERING and are open to candidates who have experience in waveguide techniques.

TECHNICAL OFFICER

LABORATORY STEWARD

The vacancies are in the high frequency and radar laboratories which are concerned with postgraduate teaching and research in radar, radio and microwaves. Experience in the aviation field is not an essential requirement.

The TECHNICAL OFFICER will supervise the day-to-day activities in the laboratories and be responsible for the construction of specialised experimental equipment. Candidates should have passed the graduateship examination of the I.E.E., I.E.R.E., or possess a H.N.C. or equivalent qualification. Salary in scale rising to £1,623 p.a.

The LABORATORY STEWARD, who should have relevant training and experience, will be appointed in a scale rising to £1,077 with a supplementary allowance of £50 p.a. for possession of a H.N.C. or equivalent qualification.

37 hour week of five days, generous holidays, staff superannuation and sick pay schemes.

Application form from Staff Records Officer, The College of Aeronautics, Cranfield, Bedford.

2601

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

ASSISTANT MAINTENANCE ENGINEER required by the CENTRAL OFFICE OF INFORMATION for their Radio Division. Candidates should have had wide experience in maintenance of professional tape recording and studio equipment Theoretical knowledge to City and Guild Intermediate level would be an advantage, as would experience in sound recording. Salary according to experience and qualifications on a range £1,215 to £1,560 p.a. Five-day week of 41 hours (inclusive of meal breaks). 18 days' paid annual leave. Please send postcard for application form to Manager (PEA/274/EW), Wireless World, Department of Employment and Productivity, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.1. Closing date for completed application forms, 30 October, 1969. [2602

AUDIO DEVELOPMENT ENGINEER. Electro-Musical Industry. Watkins Electric Music Ltd., 66 Offley Road, London, S.W.9. Tel. 01-735 6568. Please write in first instance. [2574

CHESTER. Experienced TELEVISION ENGINEER with a liking for the occasional quality Hi Fi job required for inside work. Also vacancy for experienced TV field mechanic. 5-day 40-hour week. Independent firm. Please write giving past experience to Mr. P. K. Caveen, PETERS (ELECTRICAL) LTD., 2 Charles Street, Hoole, Chester. [2570

NORTH STAFFORDSHIRE COLLEGE OF TECHNOLOGY

A Constituent College of the Proposed North Staffordshire Polytechnic. ENGINEERING DEPARTMENT (Electrical and Electronic Division). Applications are invited from candidates with a University Degree or an equivalent qualification for the following posts: (a) SENIOR LECTURER IN ELECTRICAL ENGINEERING; (b) LECTURER GRADE II IN ELECTRICAL ENGINEERING. The successful candidate for post (a) will be responsible for subjects in the field of communications engineering, including Telecommunications, Television and Radio. He will be required to undertake the organisation of short courses in Telecommunications, Colour TV and allied subjects. In addition, he

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

2530

For some of our distributors in AFRICA we require

SERVICE MANAGERS

They will be responsible for the organisation, administration and promotion of our distributors' Service Departments, including spare parts management.

A good practical and theoretical technical background in radio and television is necessary and experience of service and spare parts administration is important.

Further requirements are a background in Service Workshop management and training of repairmen.

Products to be serviced include television, radio and household appliances.

Salary commensurate with qualifications and experience.

Applicants should submit full background details.

Apply to Box No. W.W.2558.

MICROWAVE ENGINEERS

OVERSEAS

THE POSTS

Excellent career opportunities exist for Microwave Engineers to join the International Aeradio worldwide organisation for overseas employment.

OUR REQUIREMENTS

The men selected will be responsible for the maintenance of a solid set wideband multihop microwave system. Applicants should have experience in the following:

★ Overall system appreciation.

★ Alignment and testing procedures of solid state microwave systems and the associated supervisory and terminal carrier channelling equipment.

★ Preventive maintenance procedures and rapid and accurate fault diagnosis on the above types of system.

YOUR FUTURE

IAL offers first-class career prospects. The company is fast expanding with over 3,000 employees engaged in the fields of telecommunications at more than 50 bases around the world. The present turnover is in the region of £8 million per annum and is expected to exceed the £19 million mark within 10 years.

OUR OFFER

Includes a substantial tax-free salary: marriage, children's and educational allowances, free furnished accommodation, medical attention and leave passage.

To apply for one of these positions please write giving brief details of age, qualifications and career to date to:

General Manager Personnel,

IAL **INTERNATIONAL AERADIO LIMITED**

AERADIO HOUSE · HAYES ROAD · SOUTHALL · MIDDLESEX

AIRTECH TEST ENGINEER ELECTRONICS

To undertake testing and fault finding on UHF and VHF communication equipment.
Qualifications to O.N.C. standard or similar experience as ex-regular H. M. Forces.
Excellent opportunity for promotion within a small team working to rigid specifications.
Free transport from approximately a 15-mile radius.
Pension and life assurance scheme.

Write giving details to:—
Personnel Officer,
AIRTECH LIMITED, Haddenham, Near Aylesbury, Bucks.

---

will be expected to encourage research in these fields and to accept a share of the departmental administrative duties. The successful candidate for post (b) will be required to teach Radio and Television Servicing subjects, and should have some experience in Colour TV work. In addition, he will be expected to assist with the normal range of Telecommunications and Electronic subjects covered by the Department. Salary Scale: Senior Lecturer, £2,417-£2,752; Lecturer II, £1,827-£2,417. Further details and application forms may be obtained from the Registrar, North Staffordshire College of Technology, College Road, Stoke-on-Trent. [2577

ELECTRONIC PROTOTYPE WIREMAN, wide technical knowledge, seeks position overseas; permanent or contract.—Reply Rex. W. Harris, 36 Clifton Road, London, N.8. [2603

RADIO ENGINEER for installation/service Yacht R.T., Automatic Pilots, some Radar. Clean driving licence essential. Must live in or near London. Knowledge and liking of boating an advantage. Telesonic Ltd., 243 Euston Road, N.W.1. 01-387 7467. [2573

REDIFON LTD. require fully experienced TELECOMMUNICATIONS TEST ENGINEERS and ELECTRONICS INSPECTORS. Good commencing salaries. We would particularly welcome enquiries from ex-Service personnel or personnel about to leave the Services. Please write giving full details to—The Personnel Manager, Redifon Ltd., Broomhill Road, Wandsworth, S.W.18. [26

SERVICE ENGINEER. We specialise in the repair and maintenance of 16 mm Sound Projectors. Tape Recorders and similar Visual Aids Equipment. We need another engineer with some knowledge of Audio Amplifiers. Must be able to drive. Write: Burgess Lane & Co. Ltd., Thornton Works, Thornton Avenue, Chiswick, London, W.4. [2578

TAPE RECORDER ENGINEER required for workshop repair of DICTATING MACHINES in Central London. Write to PAXDICTATOR (SOUTHERN) LTD., Lysons Ave., Ash Vale, Aldershot. [2576

THE UNIVERSITY OF LEEDS: Department of Physics. Electronics Technician required for post in electronics workshop involving maintenance and building of a wide range of prototype apparatus. Qualifications: O.N.C. or equivalent. Salary on scale £773-£1,077. Please apply in writing, giving details of qualifications and experience, to the Administrative Assistant, Physics Department, The University, Leeds, LS2 9JT. [2564

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

15 MeV LINEAR ACCELERATOR. Assistant to help to operate and maintain. General electrical and mechanical knowledge; accelerator experience not essential. Salary up to £1,200. Applications to Secretary, Department of Radiotherapeutics, University of Cambridge, Tennis Court Road, Cambridge. [2575

ARTICLES FOR SALE

BRAND NEW ELECTROLYTICS, 15/16 volt 0·5, 1, 2, 5, 6, 8, 10, 15, 20, 30, 40, 50, 100, 200 mfds., 8d. Mullard 25 volt 6·4, 12·5, 25, 50, 80 mfds., 10d., 1·6, 160 mfds., 1/-. Minimum order 7/6., postage 1/- per order.—The C.R. Supply Co., 127 Chesterfield Road, Sheffield, S8. [2587

BUILD IT in a DEWBOX quality plastics cabinet. 2 in. × 2¼ in. × any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76

COLOUR T.V. Large-Screen Projectors, Cintel Model 20630, 6-ft. picture from RGB video inputs. 2 units plus spare CRTs. Partly dismantled for storage. £400 lot as seen or offers. Box W.W. 2569 Wireless World.

COLOUR T.V. PARTS for W.W. Colour Set; large range of specialist parts.—Forgestone Components, Ketteringham, Wymondham, Norfolk. [2586

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

INTEGRATED CIRCUITS at lowest price. GE Type PA 234, 1 Watt Audio Amplifier 17/6 each inc. data. Newest GE Silicon NPN planar transistor 2N5172, 25 Volt, 200 mW, hfe 100 min. Epoxy for economy. Passivated for reliability, 1/9 each. C.W.O. P. & P. 1/- per order. JEF ELECTRONICS, 12 York Drive, Grappenhall, Warrington, Lancs. Mail Order Only. [2565

SOLARSCOPE OSCILLOSCOPE, Type CD 513.2. £40. Ring 01-723 4143, weekday evenings. [2594

TELESCOPIC AERIAL MAST, ex Government, all brass, winds up 30 ft. Weight 65 lbs., Bargain, £14. Buyer collects. ROPER, 84 Goldthorn Hill, Wolverhampton. [2567

UFO DETECTOR CIRCUITS, data, 10s. (refundable). Paraphysical Laboratory (UFO Observatory), Downton, Wilts. [396

UHF 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, PLESSEY 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. SOBELL/GEC 405/625 IF & output chassis incl. circuit 32/6, 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 popu-

Commercial Product Engineer for Gas Discharge Tubes

This vacancy should prove attractive to a professionally qualified engineer with industrial experience, preferably in development and production or the design of electronic equipment, who now wishes to embark on a commercial career.
He would be responsible to the Commercial Product Manager for the Technical/Commercial product policy for a wide range of hot and cold cathode gas discharge tubes and similar devices, such as Numerical Indicators, Counters, Thyratrons and Reed Inserts. He should be prepared to travel frequently, both within the U.K. and overseas. Expected to negotiate on technical and commercial matters, he must be able to work together with Market, Production, Development and Research Personnel at all levels. This job is located at Mitcham, Surrey.
Please write to the Personnel Manager, Mullard Limited, Mullard House, Torrington Place, London, W.C.1., quoting reference RBT/ 1019

Mullard Mullard

UNIVERSITY OF CAMBRIDGE
CAVENDISH LABORATORY

ELECTRONICS ENGINEER

To collaborate with physicists in design, construction and implementation of electronic circuitry incorporated in experimental apparatus in the Surface Physics research group of the laboratory.

Experience in solid state circuitry essential.

Degree or equivalent in electronic engineering or physics desirable.

Salary in range up to £1,400 p.a. depending on experience, qualifications and age.

Applications to:
The Secretary,
Cavendish Laboratory,
Free School Lane,
Cambridge.

2582

OXLEY®

Applications are invited for the position of

Assistant to the Works Director

of Oxley Developments Company Ltd., Ulverston.

Applicants must be about 30 years of age and have Higher National Certificate or a degree in Science. Preference will be given to someone with all or part of the following experience or qualifications:-
(1) Knowledge of modern manufacturing methods in electronics, small mechanical components and mechanisms.
(2) Assistant or deputy to a Works Manager in a thriving concern.
(3) Experience in dealing with people, production control, and shop floor conditions; experience in cost accounting.
Oxley Developments is a vigorous and expanding Company offering scope and opportunity for the right man. The Works are located in open countryside at the southern end of the Lake District.
Applications giving details of education, qualifications, experience and salary and including copies of two references or names and addresses of referees to be addressed to:

The Personnel Manager,
Oxley Developments Company Ltd.
PRIORY PARK · ULVERSTON · NORTH LANCASHIRE

2563

NCR SYSTEMS TESTERS

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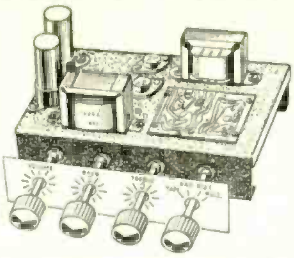

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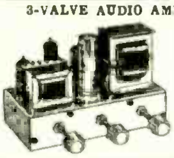

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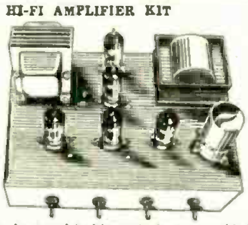

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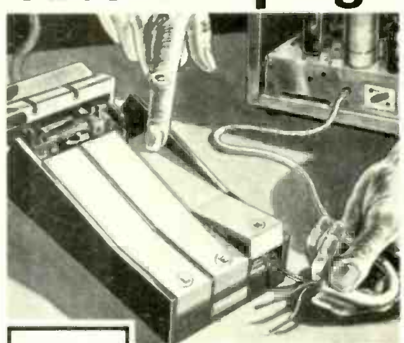

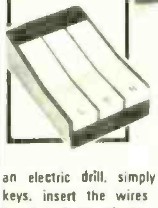

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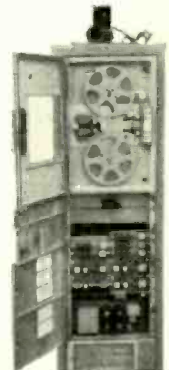

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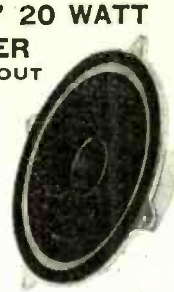

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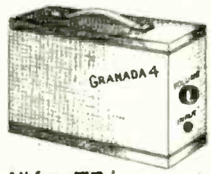

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