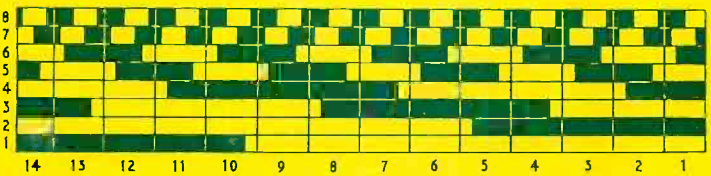
SILICON TRANSISTOR MILLIVOLTMETER

MARCH 1966
Three Shillings

Wireless World

ELECTRONICS • TELEVISION • RADIO • AUDIO



Coded Television Signals

Only one-fifth of the story!

Yes, STC Components Group is able to supply you with about five times the number of different types of components shown—*off the shelf*. And the range of components is being extended all the time. If your requirements are urgent, STC Electronics Services Division offers *same day despatch*.

Each STC Division maintains an Applications Department with Engineers ready to help you choose the most suitable and most economic components and circuits for your equipments or systems.

Wherever your location on the map, STC Components Group, made up of nine successful Divisions and a single mobilized field force, can put the finest components service right on your doorstep. The Group is represented in practically every country through ITT (International Telephone and Telegraph Corporation).

To obtain your copy of the STC 'Designers Digest' write, phone or telex STC Components Group, Footscray, Sidcup, Kent. Telephone: FOOtscray 3333. Telex: 21836.

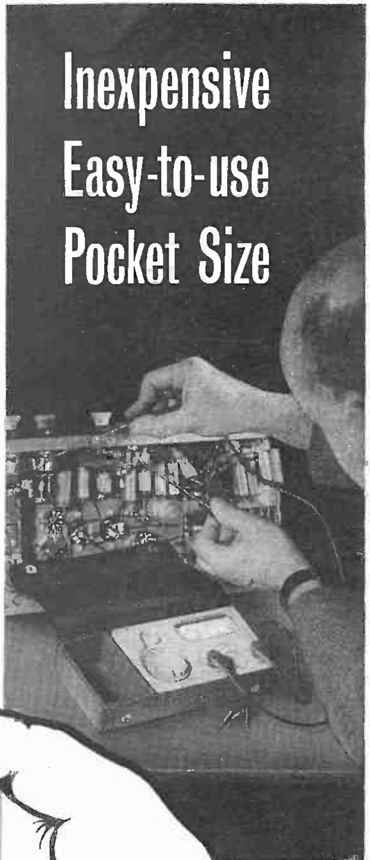
high-grade components by **STC** COMPONENTS GROUP

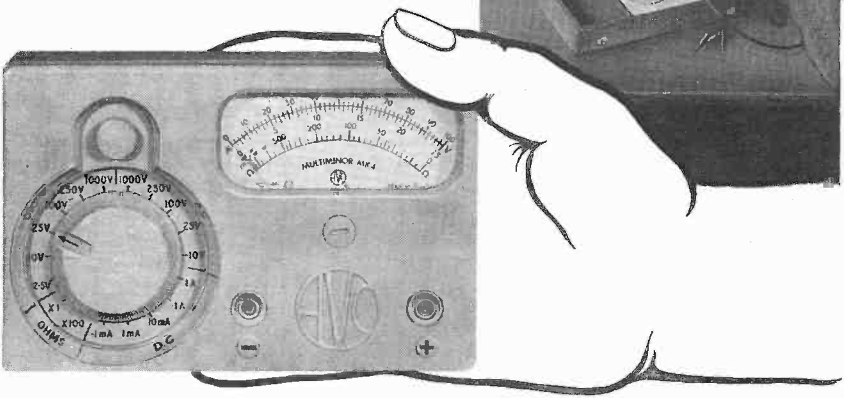
MULTIMINOR *Mk4*

The Avo Multiminor Mk4 is the latest version of this well-proven multi-range measuring instrument. Designed and assembled to high standards of reliability, the Avo Multiminor offers simple yet instant range selection with a single rotary switch. There is only one pair of sockets for all measurements, and the scale plate is clearly marked for easy reading.

Accuracy is within the limits laid down in B.S.S. 89/1954 for up to 3¼" scale length industrial portable instruments.

Panclimatic construction enables the Multiminor to be used in all types of climatic conditions. The instrument is supplied in an attractive black carrying case, complète with interchangeable test prods and clips, and a multi-language instruction booklet.



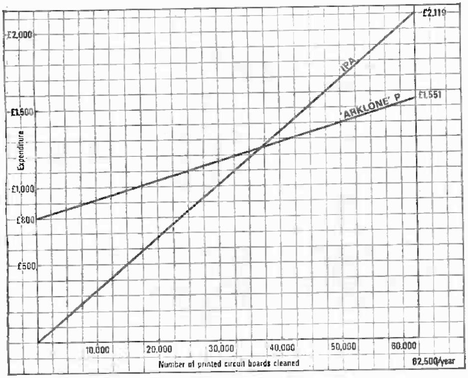


Write for full details.

AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON S.W.1 *Telephone: VICtoria 3404*

First things first: 'ARKLONE' is a pure liquid, boiling point 47°C, chemical nomenclature 1.1.2. trichlorotrifluoroethane; non-flammable, non-toxic.

Now for the graph. Well, there was this customer who converted his cleaning process from hand cleaning, using isopropyl alcohol and a team of girls, to a total immersion process using 'ARKLONE' ultrasonically irradiated in a suitably designed plant.



BEFORE

Hand cleaning, by girls using alcohol:

	£	s
Capital cost and depreciation	nil	
Labour charges	**2083**	
Solvent consumption (4 gals. per week at 3/6 per gal.)	**36**	8
Services	**nil**	
Total/year	2119	8

AFTER

Immersion cleaning with 'ARKLONE', cleaning in batches in an ultrasonic plant operated by one man:

	£	s
Capital cost (plant written off in one year)	800	
Labour charges	500	
Solvent consumption (1 gallon/week at £4.13.9 per gallon)	234	
Services (electricity and water)	17	
Total/year	**1551**	

This customer saved £570 on the first year's working after deducting capital cost. And, in fact, probably rather more than this, because the number of rejects formerly produced by harsh solvent action and handling was not known, nor the cost of insurance premiums (isopropyl alcohol is highly flammable and toxic—'ARKLONE' is neither, and makes working conditions safer and more pleasant). His operations are concerned with cleaning printed circuit boards, and 'ARKLONE' is particularly good at that, because it does not attack the metals, plastics, resins and elastomers normally used in this kind of construction.

'ARKLONE' is also first-class at cleaning computer core memories, tape recording and play-back heads, and other components consisting wholly or partly of plastics materials, or containing resins or elastomers—spectacle frames, for instance.

We'll say it again: 'ARKLONE' is a costly cleaning solvent that would be cheap at twenty times the price!

If you want to work out the cost of changing your cleaning process to 'ARKLONE'—get in touch with ICI. One of our representatives will be glad to assist you.

'ARKLONE'

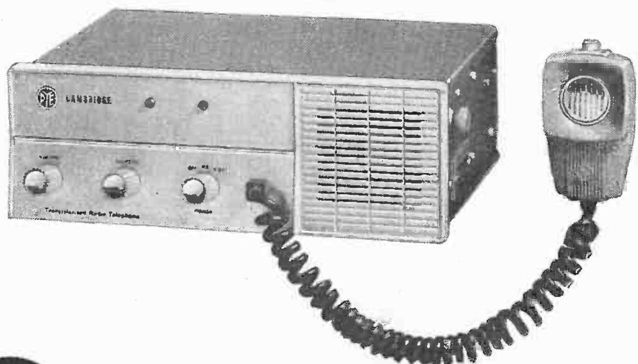
'ARKLONE' is the ICI registered trade name for 'ARCTON' 113

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON S.W.1

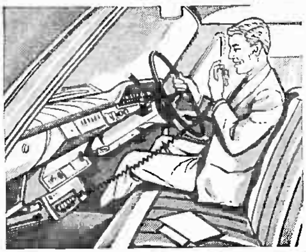
AR88

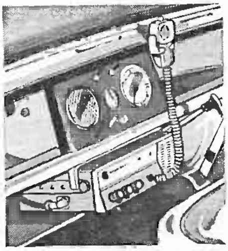
BY APPOINTMENT TO
H.R.H. THE DUKE OF EDINBURGH

SUPPLIERS OF MOBILE
RADIOTELEPHONE EQUIPMENT



'CAMBRIDGE' transistor Mobile Radiotelephone





A new high standard in Mobile Radiotelephone design

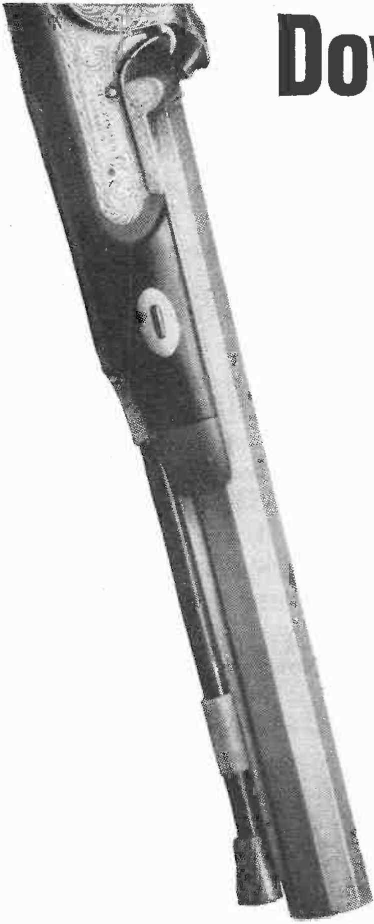
■ Fully transistorised receiver ■ Printed circuit sub-assemblies ■ Sealed I.F. block filters ■ Dustproof and splashproof
■ GPO approved and meeting American and European specifications ■ 100 Milliamps receiver drain ■ A.M. or F.M. versions
■ 25 Kc/s or 50 Kc/s channelling ■ Single or six channel

PYE TELECOMMUNICATIONS LIMITED

CAMBRIDGE · ENGLAND · TELEPHONE: TEVERSHAM (CAMBRIDGE) 3131 · TELEX No. 81166

WW—006 FOR FURTHER DETAILS.

Down to 300 µV



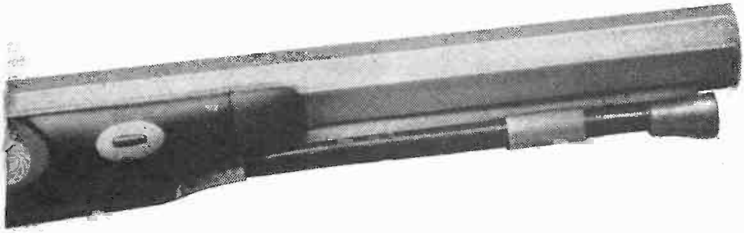
Marconi Instruments present a new challenge in VHF voltage measurement

VHF ELECTRONIC VOLMETER TYPE TF 2603

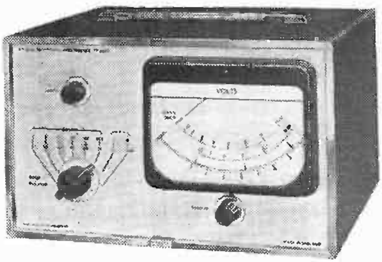
An entirely new, fully transistorised millivoltmeter for direct voltage measurement from 300 µV to 3V at frequencies up to 1,500 Mc/s, and up to 300V at 500 Mc/s. The ½-inch diameter probe uses a pair of fast germanium diodes in a full-wave circuit. Response is close to r.m.s. with inputs of less than 30 mV and peak in the 0.5V to 3V region. Accessories include a 100:1 multiplier for measurements up to 300V.

WW—008 FOR FURTHER DETAILS.

up to 1500 Mc/s



Targeted for the real needs of the electronic industry



Price: £290 including 100:1 multiplier

Low-level signal measurement in semi-conductor circuits

Measurement of transistor parameters

Voltage measurement on strip-line circuits

Measurements at locations remote from mains supplies

Elimination of measurement errors due to circuit earth loops

Noise measurements. Distortion measurements

Impedance measurements at low voltage using a Circuit Magnification Meter

Detection of unwanted oscillations in wide-band amplifiers

Tuning narrow-band amplifiers

Testing frequency response in filters

Null detection in wide-band bridge measurements

Please write or telephone for full technical and commercial information about this new instrument. On specification, performance and value-for-money, Marconi instruments challenge comparison with any in the world.

A GOOD NAME FOR GOOD MEASURE

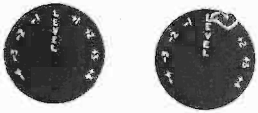
MARCONI INSTRUMENTS

Marconi Instruments Limited
Longacres, St. Albans, Herts.
Tel: St. Albans 59292 Telex: 23350

TC309

WW—009 FOR FURTHER DETAILS.

TREBLE BASS



musical balance

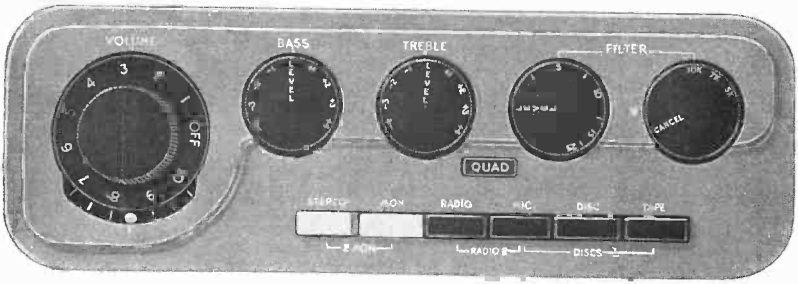
All amplifiers—or nearly all—have bass and treble controls. All bass and treble controls, not unnaturally, increase and reduce the bass and treble, but here the similarity ends!

The bass control on the QUAD varies both slope and turnover in four frequency discriminative networks of equal impedance. The channels are locked to eliminate phase-shift so that the stereo image is maintained at all settings.

The treble operates midway between variable slope and variable step so that it is possible to adjust musical brilliance while maintaining natural harmonic balance.

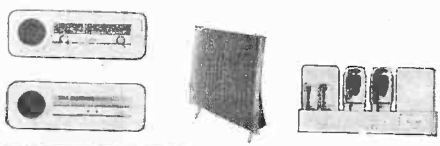
A Level position may be selected within 0·5 dB 20-20,000 c/s. while other settings are guaranteed within ±1·5 dB of the published calibrations.

Of course, when programme sources become consistently good, tone controls will not be necessary, but meanwhile how is musical balance achieved on your amplifier?



For the closest approach to the original sound.

Our slogan for fifteen years and our design objective for twice that long. Ask your dealer for details of the QUAD range of high fidelity units or write direct to Ref. W.W. Acoustical Manufacturing Co. Ltd., Huntingdon. Huntingdon 361.



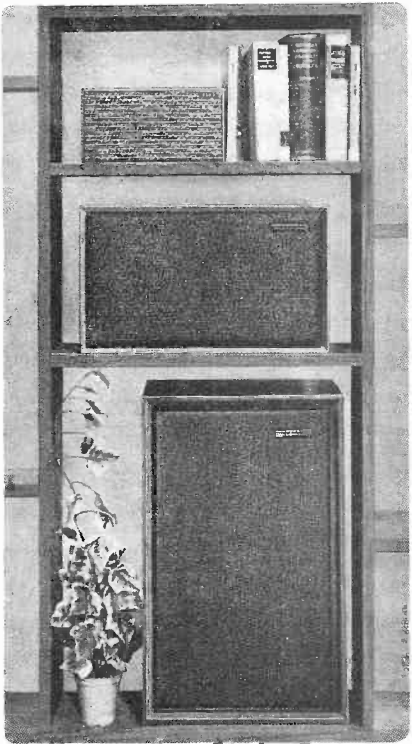
QUAD

WW—010 FOR FURTHER DETAILS.

GOODMANS 'M' RANGE

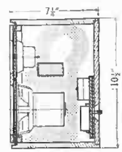
HIGH FIDELITY LOUDSPEAKER SYSTEMS

There is a Goodmans Complete High Fidelity Loudspeaker System to meet your requirements—to fit unobtrusively into your living room—to blend with your furnishings—enabling you to enjoy the finest quality sound reproduction, whichever System is your choice.



MAXIM

A true High Fidelity Loudspeaker system complete, the size of a shoe box—$10\frac{1}{4}$" x $5\frac{1}{2}$" x $7\frac{1}{4}$". The meticulously finished cabinet in hand-rubbed teak (or walnut) houses two tiny precision direct radiator drive units which cover the frequency range—45–20,000 c/s with *less* deviation from level response than almost any other High Fidelity Loudspeaker—and handle 8 watts of power easily. No problems in finding room for it—just move a couple of books.



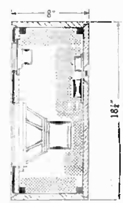
Specification

Dimensions	$10\frac{1}{4}$" x $5\frac{1}{2}$" x $7\frac{1}{4}$" deep
Range	45–20,000 c/s
Power	8 watts
Impedance	15/16 ohms
Finish	Teak or Walnut

Price: £17. 10. 6. (inc. P.T.)

MEZZO

Handles 15 watts of power—yet measures only $10\frac{3}{4}$" x $18\frac{1}{2}$" x 8" deep—the MEZZO really *will* go on your bookshelf. The styling is restrained yet distinctive, making MEZZO an "easy" addition to any design-conscious furnishing scheme. The frequency range is a clear and clean 40–20,000 c/s with a control and smoothness accounted for by two new specially developed and patented loudspeakers. The 8" bass unit is of very advanced design and construction, and is particularly notable for its very low distortion and extraordinary smoothness of performance. It is claimed to be the smoothest bass reproducer of its size ever produced. The treble unit completes the quality picture to give an overall performance unrivalled in a reproducer of of this size. The L.C. crossover network operates at 2,200 c/s. The distortion level is extraordinarily low. The perfectly controlled balance of the MEZZO sound make it—The Loudspeaker to Live With.



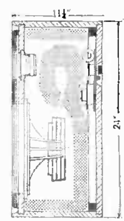
Specification

Dimensions	$10\frac{3}{4}$" x $18\frac{1}{2}$" x 8" deep
Range	40–20,000 c/s
Power	15 watts
Impedance	Suitable for 8 ohm—15 ohm amplifiers
Distortion	Less than 1% total harmonic at 55 c/s and above, for sound pressure level of 80 db at 6 ft.
Finish	Teak or Walnut to order

Price: £26. 5. 0. (inc. P.T.)

MAGNUM-K

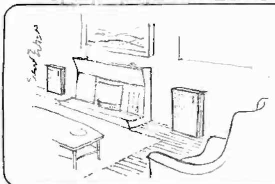
Designed to a very high standard for professional purposes, the MAGNUM-K brings this same standard to the audio enthusiast at home. It is a three-way system, and although reasonably compact (15" x 24" x $11\frac{1}{4}$") no performance compromises have been accepted. Every detail that could contribute to really accurate sound reproduction has been included. A new and patented 12" Bass reproducer gives minimal distortion down to 20 c/s. The Mid-range and High Frequency units are high efficiency direct radiators outstandingly smooth in performance. Multiple-section cross over network operates at 1,500 and 6,000 c/s and constant impedance controls for both middle and high frequency units permit individual balancing of the system. Power handling is 25 watts, but for domestic use amplifiers from 6 to 12 watts are quite adequate.



Specification

Dimensions	24" x 15" x $11\frac{1}{4}$" deep
Range	30–20,000 c/s
Power	25 watts
Impedance	4–8 ohms
Finish	Teak or Walnut to order

Price: £36. 15. 0.



ELEGANZIA II

A full-sized 15 watt 2-speaker High Fidelity Loudspeaker system with the enormous advantage of a depth of ONLY $6\frac{1}{4}$". A classic example of slim graceful efficiency, its exceptionally accurate performance was designed for the connoisseur. The 12" bass unit employs Goodmans exclusive SUPRFOAM diaphragm. An L.C. crossover network transfers the electrical drive above 900 c/s to a back-loaded mid-range and high-frequency unit.

Specification

Dimensions	27" x 20" x $6\frac{1}{4}$" deep
Range	35–15,000 c/s
Power	15 watts
Impedance	15–16 ohms
Finish	Teak or Walnut

Price: £27. 10. 0.

SEE AND HEAR them at your Goodmans Dealer

FREE Please send me a free copy of Goodmans High Fidelity Manual.

Name ....

Address ....

WW3/

GOODMANS INDUSTRIES LIMITED AXIOM WORKS · WEMBLEY · MIDDLESEX · Tel: WEM 1200. A Member of the Rentaset Group

WW—013 FOR FURTHER DETAILS.

NEW SHAPES OF SOUND

The Goldring-Lenco GL 68

The many proved features of Goldring-Lenco transcription units such as infinitely variable speed adjustment, pick-up lowering device, automatic idler wheel disengagement are retained on the GL 68, which is the first unit to incorporate the new G.65 arm. This is of low mass tubular construction with stylus pressure adjustment by sliding counterweight, and provision for height adjustment to suit any chosen cartridge. The interchangeable head slide (taking all cartridges with standard ½" fixing centres) makes use of self-cleaning wiper contacts. Swiss precision motor. Continuously variable speed adjustment. Less than 1% speed variation for 13% mains voltage variation. Adjustable click-in positions for the four standard record speeds. Pick-up raising/lowering device coupled to on/off switch. Automatic disengagement of idler wheel. Full 12" diameter turntable. Wired for stereo.

GL 68 Transcription Unit £16.16.0d. + £2.14.7 P.T.

Recommended cartridges for the GL68 are: Pickering V15 (AM1 and AME1) Pickering 380A, Goldring CS90 & CS91 E.

Pickering V15 AM1 and AME1 Micro-Magnetic Cartridge
Weighing only 5 gm., these high output, high compliance stereo—mono cartridges are perfect for low mass arms. 15° tracking angle gives minimum distortion. Hermetically sealed. Replaceable push-in diamond stylus assembly, with retracting stylus arm for added protection to records. (0.0007" tip radius for V15/AM1 and elliptical, with even higher compliance, for V15/AME1).
V15/AM1 £9.9.0d. + £1.10.9d. P.T.
V15/AME1 £13.15.0d. + £2.4.8d. P.T.

Pickering 380A Cartridge
Moving-magnet for exceptional mono or stereo reproduction. Features the exclusive V-guard push-in diamond stylus unit which prevents damage through accidental dropping of arm on record. The Pickering 380A ensures high channel separation and virtually eliminates needle talk, hiss or distortion. Hermetically sealed. It tracks at 2 gm., faultlessly reproduces the most exacting records.
£12.12.0d. + £2.0.11d. P.T.

Goldring CS90 and CS91E Cartridges
These are stereo ceramic cartridges with excellent frequency response and cross-talk separation. Low tip mass, replaceable diamond stylus (CS90 —0.0005" or 0.0007" tip radius; CS91E—elliptical) coupled with high compliance enables these cartridges to be played at light tracking weights. CS 90 £4.4.0d. + £0.13.8d. P.T. CS91E £6.6.0d. + £1.0.6d. P.T.

C68 Cabinet and Cover for GL68. Elegant sapele mahogany cabinet with removable, clear Perspex dust cover. Size: 14" x 17" x 7".
£8.19.6d. + £1.12.0d. P.T.

Goldring Manufacturing Company (G.B.) Ltd., 486-488 High Road, Leytonstone, London, E.11
Telephone: Leytonstone 8343

WW—014 FOR FURTHER DETAILS.

CLARK

LOW PRICED
ELECTRICALLY OPERATED
TELESCOPIC MAST

In introducing this new SUPER E Series Telescopic Mast Clark takes a stride forward. This is the equipment for which the World of Mobile VHF has been waiting. Based on the well tried QT and ST series, an entirely new concept of operation revolutionises the field of application. These telescopic masts provide the simple improvement in communication reliability for which Radio Telephone users have been searching. The power source is the vehicle battery. The control is a small panel easily attached to the dashboard. An electrical interlock makes it impossible for the mast to remain extended if the vehicle ignition is switched on—a great safety feature.

Clark SUPER E Series Masts are available with extended heights from 16 to 40 feet and head-load capacity up to 10 lb. There is, of course, also the full range of Clark Accessories. Send for more details today.

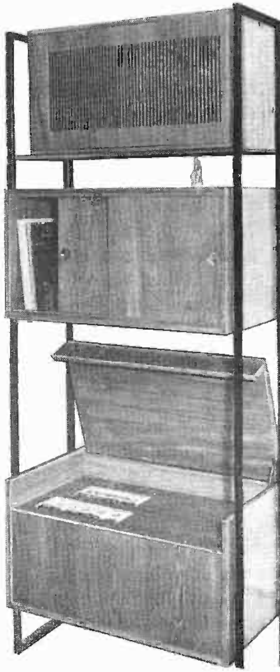
for further details write to:

A. N. CLARK (ENGINEERS) LIMITED
BINSTEAD — ISLE OF WIGHT
Telephone: RYDE 3691 Telegrams: TELEMAST RYDE

WW—022 FOR FURTHER DETAILS.

HOUSING HI-FI?

If the problem of finding room for all your equipment is just about sending you up the wall, then why not go up the wall! This way you can enjoy the open, full range sound only a large enclosure can really give you, unimpeded by any furniture; house about 250 records (bottles, telephone books, tape spools, etc.) and operate your turntable, amplifier and tuner at just the height that suits you personally. An extra Hi-Flex shelf will take your tape recorder, or " shelf mount " your tuner and amplifier, if you prefer. Each Hi-Flex Unit is 32in. wide. There is a choice of teak, walnut or mahogany.
Even more space saving are the Scan Units; these are 20in. wide and cost a little over half the price of the Hi-Flex. All these models and a dozen more are illustrated in our latest brochure which is full of bright ideas for housing hi-fi. Write now.



Hi-Flex 10/12 loudspeaker enclosure £11/19/- sitting on Hi-Flex shelf £2/15/-.

Hi-Flex record storage £12/19/-.

Hi-Raks £8/15/- per set

Hi-Flex equipment cabinet £15/15/-.

RECORD HOUSING

Dept. 3WW Brook Rd., N.22 Tel. BOWes Pk. 7487

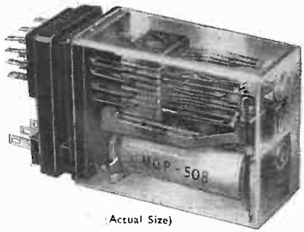
WW—023 FOR FURTHER DETAILS.

Relays—
Immediate Delivery

ECONOMICAL MINIATURE PLUG-IN RELAY—TYPE MINI-Q

More security and reliability in every shillingsworth

PRIME DESIGN CONSIDERATIONS. 1. Eliminate contact failure. 2. Electrical longevity. 3. Functional confidence. 4. Utmost sensitivity.

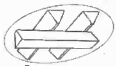


TWIN SILVER BAR CONTACTS (Springs bifurcated full length)

★Constant Contact Area ★Improved Dissipation

★Erosion and Welding Avoided

★Switching Capacity 1a @ 100v. (100w.)



Contact mode

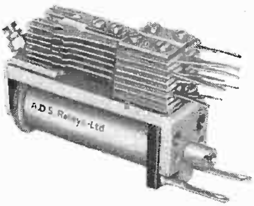
SENSITIVITY. Special bobbin requires less mA at nom. volts. Operates lower than any comparable 4 C/O relay—40Ω/190 mW—10KΩ/240mW.

(Actual Size)

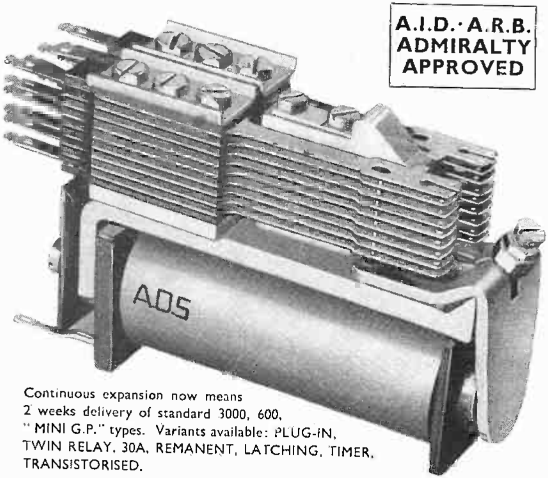
5 COILS — 3 to 125 VDC — INTERCHANGEABLE

"MINI G.P."

S1500 PO. Miniature General Purpose relay. Miniaturised version of P.O. 600 type with identical specification. $2\frac{1}{4}''$ plus tags $\times$ $1\frac{1}{4}''$ $\times$ $\frac{3}{4}''$



A.I.D.·A.R.B. ADMIRALTY APPROVED



14 Days Delivery

of 3000, 600 & "MINI G.P." types

Continuous expansion now means 2 weeks delivery of standard 3000, 600, "MINI G.P." types. Variants available: PLUG-IN, TWIN RELAY, 30A, REMANENT, LATCHING, TIMER, TRANSISTORISED.

48 HOURS PROTOTYPE SERVICE

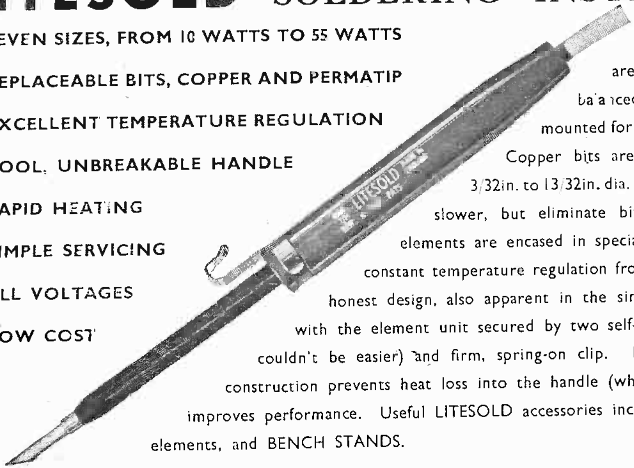
Mark ***URGENT*** enquiries 'E.M.S.' for 'EXPRESS MANUFACTURING SERVICE'

A.D.S. RELAYS LIMITED

97 ST. JOHN STREET, London, E.C.1. 'Phone: CLErkenwell 3393. Cables: ADSRELAYS, LONDON, E.C.1.

WW—024 FOR FURTHER DETAILS.

LITESOLD SOLDERING INSTRUMENTS



- SEVEN SIZES, FROM 10 WATTS TO 55 WATTS
- REPLACEABLE BITS, COPPER AND PERMATIP
- EXCELLENT TEMPERATURE REGULATION
- COOL, UNBREAKABLE HANDLE
- RAPID HEATING
- SIMPLE SERVICING
- ALL VOLTAGES
- LOW COST

LITESOLD instruments are compact and nicely balanced. Bits are spring-collet mounted for firmness and easy removal. Copper bits are standard, in sizes from 3/32in. to 13/32in. dia. PERMATIP bits are slightly slower, but eliminate bit face wear. LITESOLD elements are encased in specially pre-oxidised wire for constant temperature regulation from new—less glamour but honest design, also apparent in the simple, unbreakable handle, with the element unit secured by two self-tapping screws (servicing couldn't be easier) and firm, spring-on clip. LITESOLD hollow-spindle construction prevents heat loss into the handle (which DOES stay cool) and improves performance. Useful LITESOLD accessories include HEAT GUARDS for elements, and BENCH STANDS.

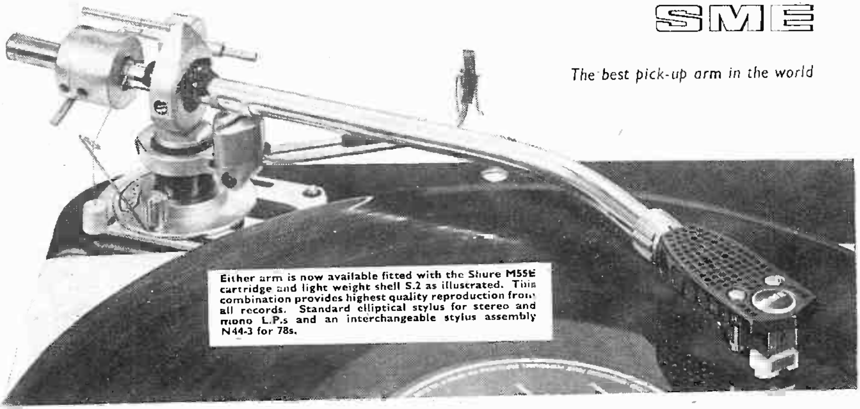
Free details of the whole wide range of LITESOLD and ADAMIN soldering equipment *in brochure SP5.*

LIGHT SOLDERING DEVELOPMENTS LTD., 28 Sydenham Road, Croydon, Surrey. *Tel.: CRO 8589.*

WW—027 FOR FURTHER DETAILS.

SME

The best pick-up arm in the world



Only S.M.E. Precision Pick-up Arms offer all these features · Choice of arm length Model 3009 (9 in.) or Model 3012 (12in.) for still lower tracking error—of special importance with elliptical styli · Low inertia · High precision ball races and knife-edge bearings for minimum pivot friction · Linear offset chosen for lowest distortion · Automatic slow-descent with hydraulic control · Bias adjuster calibrated for tracking force · Exact overhang adjustment with alignment protractor · Precise tracking force from $\frac{1}{4}$-5 grams applied without a gauge · Shielded output socket · Low capacity 4ft. connecting cable with quality plugs · Light-weight shell · Camera finish in satin-chrome, gun-black and anodised alloy · Comprehensive instructions · Rational development—all improvements can be incorporated in any existing Series II arm.

For sales and service ring Steyning 2288.

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GOVERNMENTS AGREE-

on the quality of the TEONEX range of valves. Governments all over the world have ordered TEONEX valves requiring compliance to E.V.S. or M.I.L. specifications.

Up to now, TEONEX valves have been available only for Government contracts.

In response to many enquiries, the TEONEX range, incorporating the entire working range of British-produced valves or their equivalents, has now been made available for use *outside the U.K. only*.

Price lists and technical specifications may be obtained from:-

TEONEX LTD.,
Westbourne Grove Mews,
London, W.11. England
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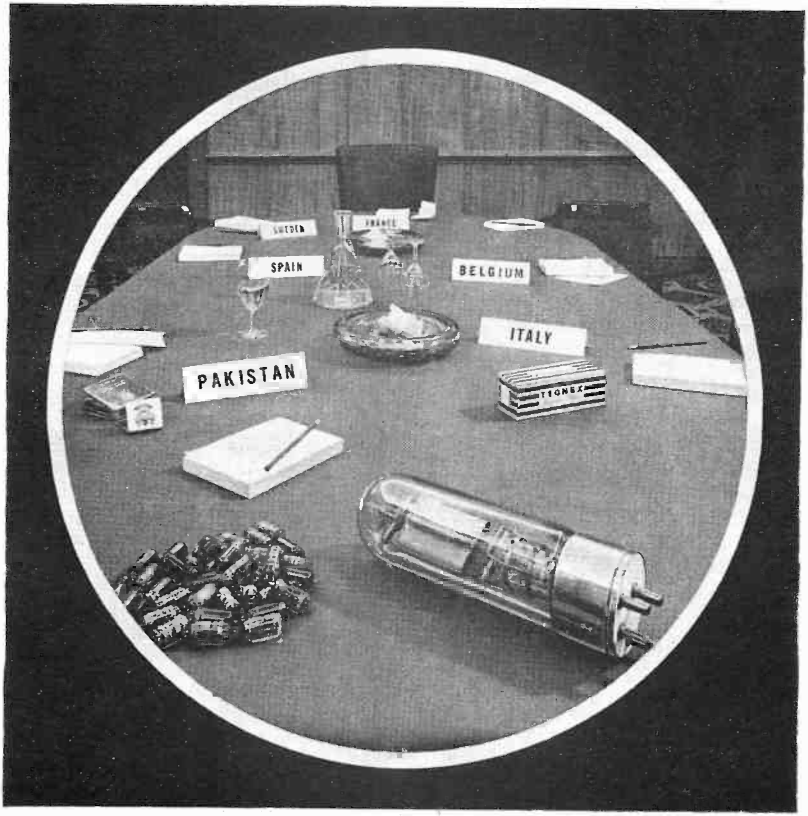

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LANCON I.S.

THE FIRST **INTRINSICALLY SAFE** VHF POCKET RADIOTELEPHONE

As the first-ever pocket-sized 2-way radiotelephone to be granted the Intrinsic Safety Certificate for use in hazardous atmospheres, the new G.E.C. LANCON I.S. brings entirely new standards of efficiency and safety to mines, oil refineries, petro-chemical plant, etc.

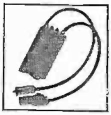
The LANCON I.S. is a fully transistorised 3-channel VHF set—robust, compact, reliable and designed for simple operation. It can be comfortably worn in an inside pocket—or in a separate lightweight harness—and the small microphone and earpiece loudspeaker units clip conveniently on the lapels. The separate flexible aerial system is combined with the microphone lead. Thus, the user has complete freedom of movement and can operate the set in very confined spaces.

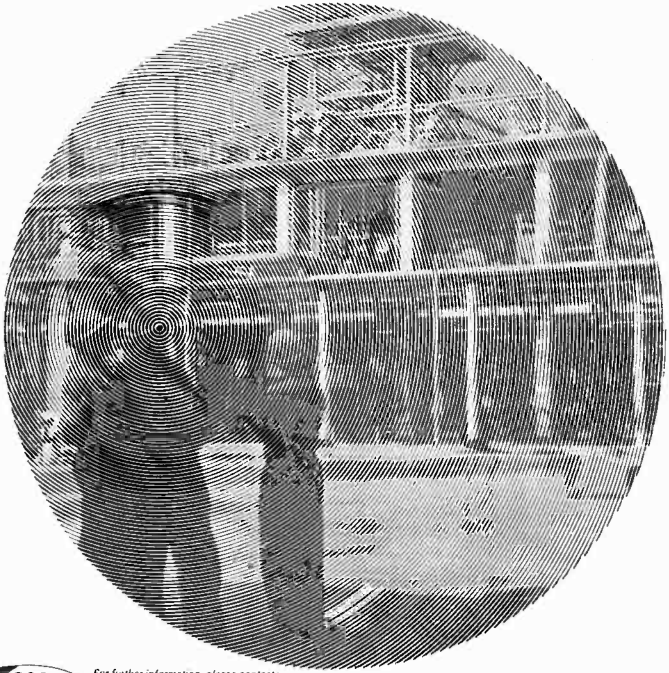
The LANCON I.S. has been developed from the extremely successful LANCON —the largest selling all-British pocket VHF radiotelephone.

LANCON I.S.

- Fully transistorised — single slim case.
- Full protection against accidental damage.
- Measures $7\frac{7}{8}'' \times 4\frac{3}{8}'' \times 1\frac{7}{16}''$—weighs only 28 ozs.
- Completely concealed, patented aerial system—avoids dangers of conventional trailing or extending aerials.
- Certificate No. 2735 covers Classes 2a, 2c, 2d
- Powered by rechargeable 12V battery—range up to 5 miles.

One of a new range of VHF equipment by G.E.C. Electronics





G.E.C. ELECTRONICS

For further information, please contact:
G.E.C. (ELECTRONICS) LTD. Radio Communications Group, Spon Street, Coventry. Tel: Coventry 22027
A subsidiary of The General Electric Company Ltd. of England

WW—041 FOR FURTHER DETAILS.

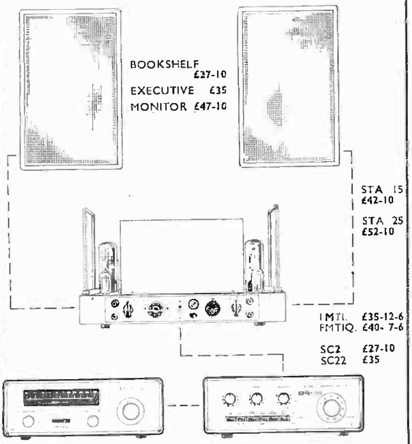
TA 3474

THE SUBTLETY OF PERFECTION

The difference between 'average' and 'highest attainable' performance in sound reproduction is not always as forceful and absolute as manufacturers of high quality equipment would like. It is very difficult even for experienced listeners to assess systems quickly in unfamiliar listening conditions, and practically impossible for beginners. It is understandable then if the subtle parameters of extra performance and the qualities which put an item in a superior class are overlooked on first evaluation.

If you already possess reproducing equipment and you intend to replace it, it is essential that you study carefully what is offered. Get yourself familiar with all relevant details including the subtleties so easily overlooked.

Finally get to know what to listen for in demonstrations and if possible listen in your home for comparison with your existing equipment and/or the alternative choice. As a guide, specification information in respect of Radford products is detailed below.



Pre-Amplifiers

High signal to noise ratio (no hum, no noise at maximum or any listening level); smooth and noiseless, tone, volume and balance controls with virtually infinite life; accurate RIAA equalisation for correct response contour; accurate tone control potentiometers for flat response at zero position; flexible input and output level handling capacity to ensure low distortion under all conditions of use.

Power Amplifiers

No background noise, virtually zero distortion at the rated power output over the whole frequency band from 20 to 20,000 c/s; very large power reserve; fast transient response without ringing or hangover (note the quality and the naturalness of transient sounds in comparison with other amplifiers); absolute stability (you cannot damage Radford amplifiers or incite them into instability by continuous overload with any type of signal into any kind of load, from short circuit to open circuit or any kind of reactance).

F.M. Tuners

High sensitivity (5μv), high capture ratio (4 db) enabling reception of very weak signals from multipath sources without distortion; wide bandwidth (for low distortion and multiplex operation); yet very selective (adjacent channel reception of a weak signal near to a powerful signal is practicable); virtually complete absence of spurious responses (you can receive weak signals without interference from signals generated in the receiver itself by cross modulation with powerful incoming signals).

Loudspeakers

Exceedingly smooth response achieved by using the best drive units obtainable and equalising them with complex networks (note the lack of listener fatigue after long listening periods, and directional stability in stereophony); wide angle response (note that you can listen anywhere in the room with the same frequency balance with perfect integration on a stereo programme); lack of coloration (note the naturalness in voice reproduction and absence of boom at low frequencies).

General

Equipment and loudspeakers built to high standards must of necessity be made from the best materials available to provide consistency and long life without failure. Only the finest polyester, polystyrene, and electrolytic capacitors; high stability carbon, metal oxide, and wire wound resistors; and moulded track; potentiometers are used. Loudspeaker enclosures are manufactured from 1in. thick solid Afrormosia, rigidly stressed and lagged with a natural material far superior to that conventionally used.

Why not see your dealer now about Radford equipment? Supplies have been scarce but more will be available, gradually.

RADFORD ELECTRONICS LTD., ASHTON VALE ROAD, BRISTOL 3

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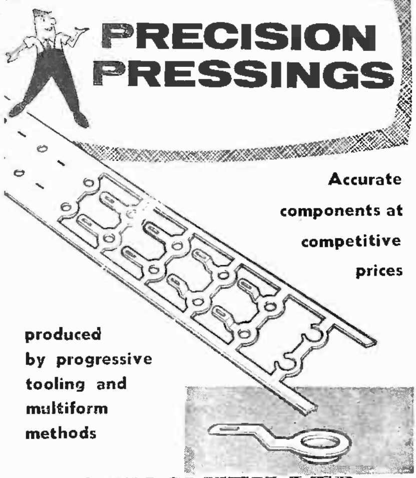
PRECISION PRESSINGS



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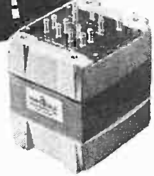

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There are no better output transformers for the High Fidelity constructor than Partridge. They are in fact specified for Mullard and most other leading published circuits.

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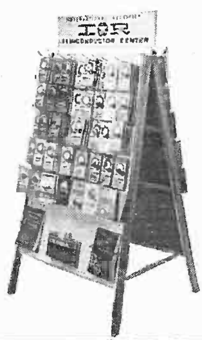

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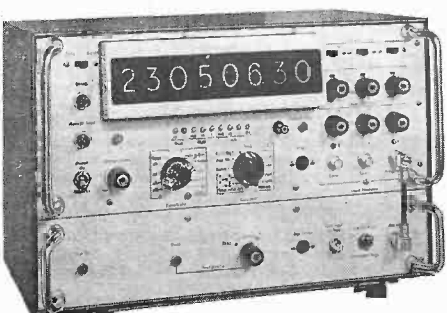
RACAL Digital counters combine versatility with economy



SA.550 N.A.T.O. Codification 6625-99-971-8519

Racal SA.550 100 Mc/s Digital Frequency Meter

Direct Frequency Measurements from signal levels as low as 100 mV are possible without tuning or interpolation. Measurement capability can be extended by the use of the active probe unit type SA.544.

- All Solid-State Design
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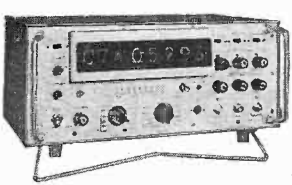
- Internal or External Standard

The SA.540 Universal Counter Timer illustrated below is for time, period and frequency measurement up to 11 Mc/s.



SA.540

RACAL

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Dukes Ride, Crowthorne, Berks.
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RI/A64

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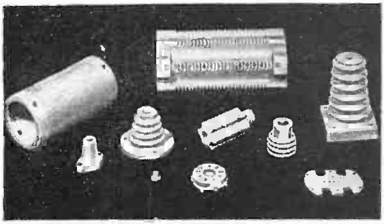
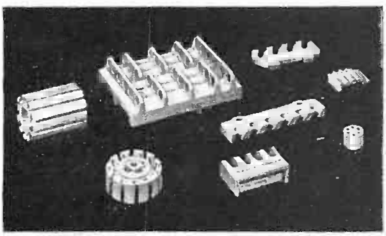
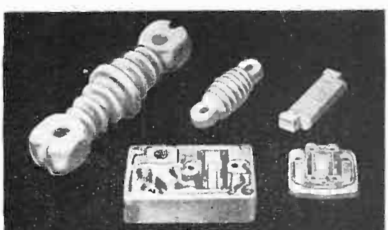


Frequelex—for high-frequency insulation.



Refractories for high-temperature insulation.



Bullers porcelain for general insulation purposes.

Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products. *Write today for detailed particulars.*

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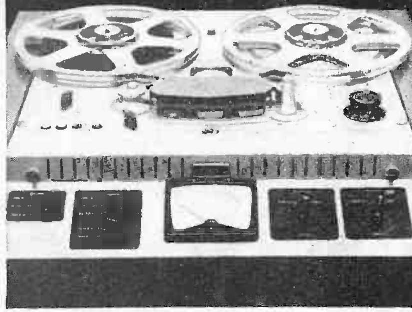
WW—049 FOR FURTHER DETAILS.

NEW Mark V *professional* STUDIO RECORDERS *by* LEEVERS-RICH



Comprehensive Specifications Very Competitive Prices!

The special feature of the new Mark V series of studio recorders is the open head block for ease of editing. Special screening ensures an excellent signal/noise ratio, whilst the amplifiers have a bandwidth well above the latest standards of magnetic tape available.
Ease of maintenance, which has always been a feature of Leevers – Rich equipment, is now better than ever.
Other features of the new Mark V include:—

- PARALLEL SYNCHRONISED PLAY-OFF
- 4-TRACK VERSIONS
  for master recordings on ½" or 1" tape
- MULTI-TRACK VERSIONS
  for monitoring applications with up to 16 tracks on 1" tape
- SYNCHRONISED SYSTEMS
  for multiple tape copying

PRICES
range from £640 for ¼" recorders ('E' series) to 4-channel recorders at £1,205 ('H' series)
Also available – Six band audio equalisers (Model 46X) and a complete range of magnetic tape bulk erasers.
WRITE TODAY for full technical information, specifications and quotations to meet **YOUR** special requirements.
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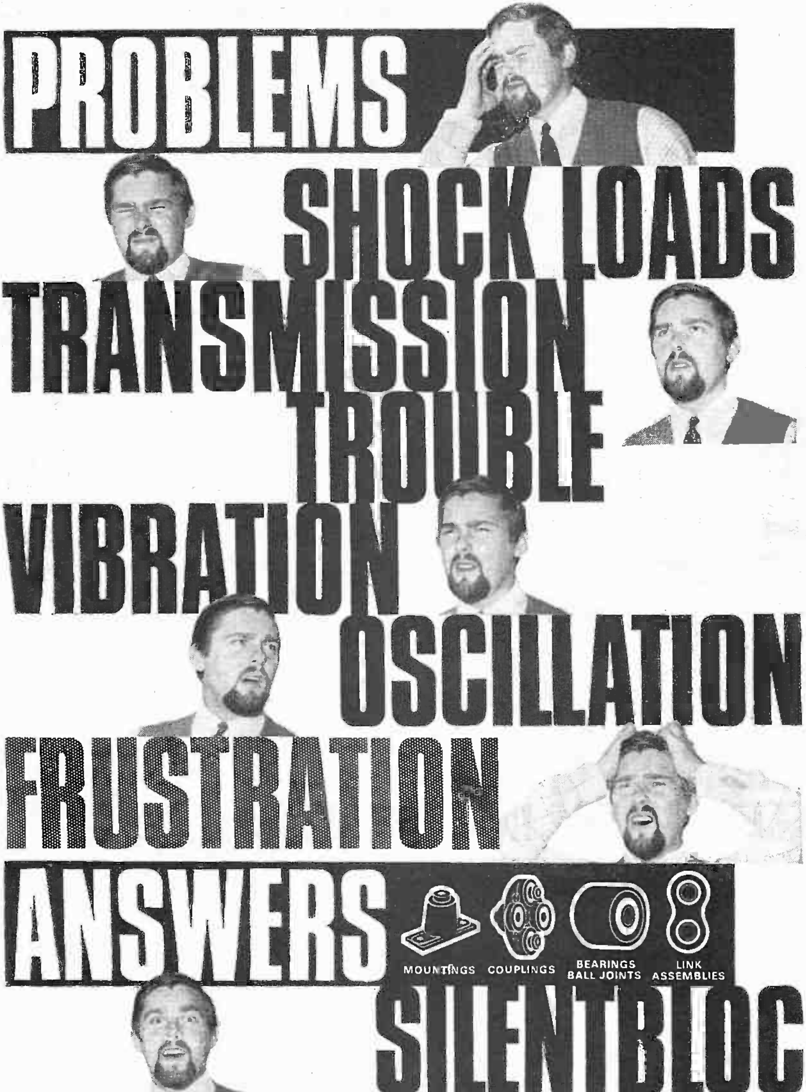
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THE NEW SLIMLINE
LC.92

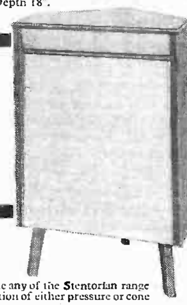
- **SLIM CABINET**
  only 6" deep. Height 29". Width 24".
- **A 9", 15 OHMS DRIVE UNIT**
  with graded cone and extended treble response.
- **ACOUSTIC LABYRINTH CABINET**
  gives balanced response throughout the audio spectrum.
- **CLEAN DESIGN**
  Walnut cabinet with satin melamine finish. Weight 25½ lbs.

THORESBY BASS REFLEX CONSOLE CABINET (C15)

This cabinet is designed for Stentorian 8" or 10" Loudspeakers and there is also provision for fitting tweeter unit if desired. *Size*: Height 31" × Width 19⅝" × Depth 18".
Mahogany (C15) Walnut (C15A)

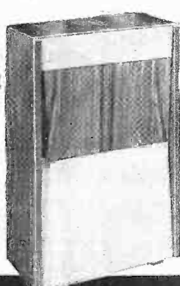
THORESBY HI-FI EQUIPMENT CONSOLE (C16)

This takes most makes of tape-deck or record player, amplifiers, pre-amplifier control unit and radio tuner. *Size*: Height 31" × Width 19⅝" × Depth 18".
Mahogany (C16) Walnut (C16A)



THORESBY BASS REFLEX CORNER CONSOLE (C14)

Specially designed to utilise the natural acoustic properties of walls, it is ideally suitable for use where space-saving is a consideration. It is sturdily constructed to take every advantage of Stentorian 8" or 10" units, with provision for tweeter unit. *Size:* Height 31" × Width 19¾" × Depth 17".
Mahogany (C14) Walnut (C14A)



THORESBY SLIM LINE CABINET (C17)

This enclosure has been designed to accommodate any of the Stentorian range of 8" or 10" units. Provision is made for the addition of either pressure or cone type tweeter and a crossover may be used.
The cabinet is substantially constructed and acoustically proportioned to give a balanced reproduction with the chosen units. *Size*: Height 31" × Width 20" × Depth 9¼"
Mahogany (C17) Walnut (C17A)

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WB180

RUSTRAK MINIATURE RECORDERS engineered for years of rugged service

All over the world you can see Rustrak recorders mounted on the cross-arms of telegraph poles, gathering dependable data day and night, winter and summer.

Because Rustrak recorders use pressure sensitive paper they maintain optimum accuracy in temperatures from sub-zero to 160°F.; from sea level to 100,000 ft. and under conditions of high humidity.

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Other important features include:

NO INK. Smooth, high resolution traces are produced without ink, heated stylus or voltage sensitive paper.

11 SPEEDS WITH ONE MOTOR. With any one drive motor 11 different chart speeds are available by means of rapidly interchangeable gearboxes.

99 CHART SPEEDS. From $\frac{1}{16}$" to 450" per hour on all analogue (galvanometer) recorders.

LARGE CHART CAPACITY. At 1" per hour a standard chart roll lasts a full month.

AC, DC OR BATTERY DRIVE. Chart drive powered by AC synchronous motors of any standard voltage, DC motors which consume only milliwatts of power, or by rechargeable batteries.

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EXPERT ADVICE. Our representatives will be glad to advise you on any application.

LOW COST. Prices from £53 — portable units or for panel mounting.

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(Established 1935)

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MINIATURE RUNNING TIME METERS (Sangamo). We have great demands for this remarkable unit and can now supply immediately from stock. 200/250 v. 50 c. synchronous. Counting up to 9,999 hours, with 1/10th indicator. Only 1½in. square, with cyclometer dial, depth 2in. Many industrial and domestic applications to indicate the running time of any electrical apparatus—easy to install, **60/-** (post paid).

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

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COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable any price 200/250 v. A.C./D.C. Fitted latest radio T.V. suppressors. Comprising motor with fixing brackets, foot control and switch, needle light with switch, belt, etc. and instructions for easy fixing to ANY machine. The complete outfit **£6/18/6** (des. 3/6).

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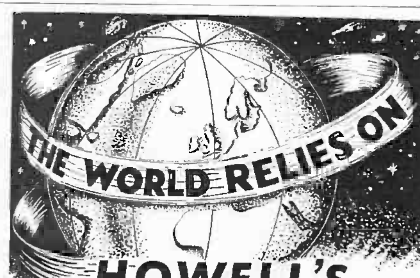

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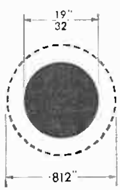

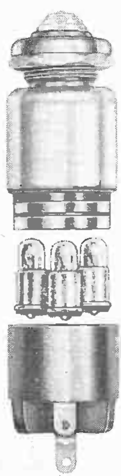

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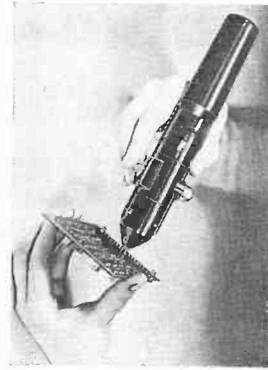

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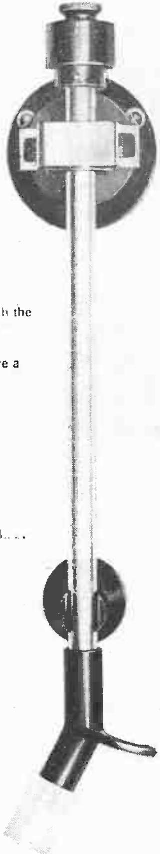

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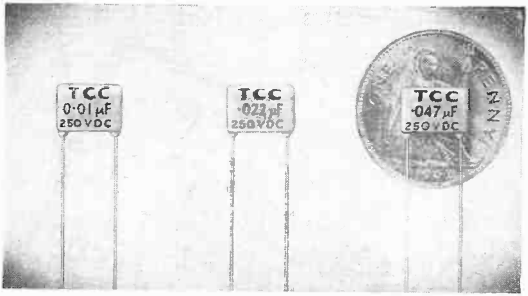

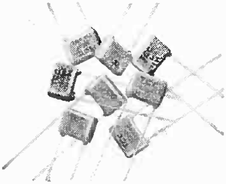

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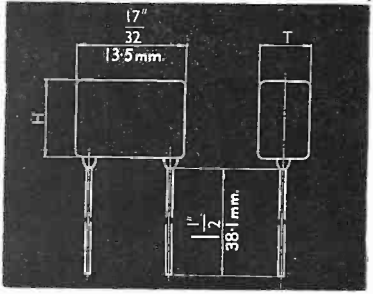
0.022	11/32in. 9mm	7/32in. 5.5mm	FMX2
0.033	11/32in. 9mm	7/32in. 5.5mm	FMX5
0.047	11/32in. 9mm	7/32in. 5.5mm	FMX3
0.068	7/16in. 11mm	9/32in. 7.2mm	FMX8
0.1	7/16in. 11mm	9/32in. 7.2mm	FMX4
400 V. D.C. at 85°C. working			
0.01	11/32in. 9mm	7/32in. 5.5mm	FMX41
0.022	11/32in. 9mm	7/32in. 5.5mm	FMX42
0.033	7/16in. 11mm	9/32in. 7.2mm	FMX45
0.047	7/16in. 11mm	9/32in. 7.2mm	FMX43



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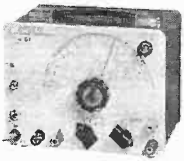

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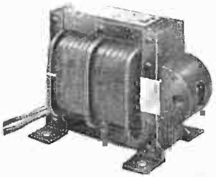

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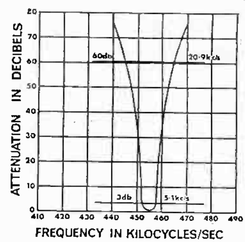

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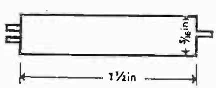
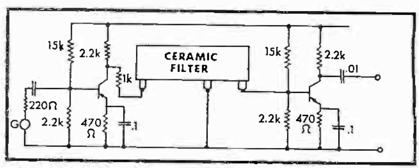
Shape Factor 60/6 db	1.3 : 1 to 2.6 : 1 Dependent on B/W

Keep your eye on Brush



SIZE

This illustrates the typical dimensions for a ladder filter. The case is a plated brass cylinder with glass end seals and pigtail leads. A 1½ inch length will provide sufficient volume to give 80 db stop band rejection.



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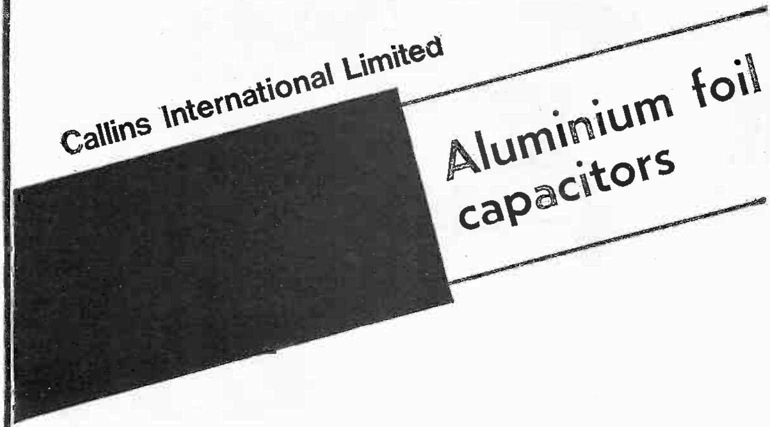

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ELECTRONICS, TELEVISION, RADIO, AUDIO

MARCH 1966

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Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

Radio Regulations: Need for Overhaul

IT is rumoured that plans are afoot to split the existing Post Office into two and create a new Department or Ministry of Telecommunications responsible for the "telecom" side of the existing department, leaving the Post Office responsible for the postal services. It was thought that the Minister of Telecommunications, as Mr. Wedgwood Benn (the P.M.G.) has called himself on several occasions, would make some reference to this proposal when speaking at the recent annual dinner of the Telecommunication Engineering and Manufacturing Association, but we were disappointed. Whether or not this severing of telecoms from the postal services is imminent the P.M.G. has several items on his agenda which call for prompt legislation.

First there is the question of the "pirate" radio and TV stations, which now number ten, around our coasts. A year ago this country was a signatory, with six other European countries, to an agreement to prevent the operation of broadcasting stations on vessels outside national territorial waters. Under the agreement signatories would treat as punishable offences, not only the setting up of these stations, but also the providing of supplies, equipment, transport or programmes to them. This meant, of course, that legislation would have to be drawn up in each country, making provisions necessary to take action against offenders. So far, nothing has been done in this country and the number of "pirate" stations goes on increasing. Some positive action must be taken—either that the operators are given the opportunity of becoming law-abiding citizens by being offered licences, or that they should be made outlaws and treated as such.

What may well be the biggest problem if the "pirates" were offered licences, is the question of operating frequencies. All the frequencies allocated to the U.K. under the 1948 Copenhagen Plan (the revision of which is long overdue) are in use. Would the "pop" stations be willing to operate on one of the two International Common Frequencies—1484 and 1594 kc/s—or would they expect a share of the frequencies used by B.B.C. stations?

On the purely programme side of their activities it may be that the "pirates" prefer to "fly the skull and crossbones" and brandish their cutlasses in the face of the authorities which limit the B.B.C. stations to but a few hours of recorded music a day!

Another item on the P.M.G's agenda is the question of Citizens' Band radio, as it is called in the U.S.A. Increasing imports of walkie-talkie transceivers, most of them from the Far East, have prompted us to ask the Post Office why these sets are permitted into the country—and we are certain they are not smuggled in—if it is illegal to use them. We were told blandly that the Post Office has no jurisdiction over imports! Is this "head in the sand" attitude good enough? These transmitter-receivers, which operate on a frequency of about 27 Mc/s and cause interference with licensed radio users in this part of the spectrum, can be purchased for a few pounds, and can be seen in use by youths in many parts of the country. If the P.M.G. has no intention of granting licences for these sets, their import should be prohibited by the Board of Trade and the Post Office should take action against their illegal use.

VOL 72 NO 3
MARCH 1966

Voltage-controlled Amplifier - 1

USING MODULATED PULSES TO GIVE VARIABLE GAIN AT A.F.

The circuit described uses a direct voltage to control a pulse-ratio modulated train which in turn operates a transistor-diode switch. The result is an amplifier whose gain can be controlled over a 26 dB range and which may be used for a variety of purposes, some of which will be outlined in Part 2.

By
M. BRONZITE,
B.Sc.

THERE are many applications, especially in analogue circuitry, where a voltage-controlled amplifier is required. In the past this has been achieved by using the physical properties of active elements such as f.e.ts and ordinary transistors, as well as by using thermistors, optical methods, and servo motor systems. References 1, 2, 3 are representative of some of these methods, which all suffer from some form of inherent non-linearity, temperature dependence, narrow band of operation, and lack of interchangeability of active elements. It is proposed in this article to illustrate a mode of operation which is purely electronic, independent of the amplifier element used, shows a large degree of linearity and stability and is readily controlled by an applied direct voltage. Further, it will be shown that the circuit can be easily modified to perform other analogue functions.

The system depends on an application of pulse modulation, the principles of which have been discussed elsewhere [4, 5, 6, 7, 8]. Since, however, the basic pulse generator and its subsequent utilization might prove unfamiliar, they will be given some consideration before the circuit itself is discussed.

M. Bronzite graduated in physics and chemistry at Reading University in 1958 and after spending four years in industry, first with B.T.H. Rugby and then Plessey's, he went to Israel in 1962. He spent a short time in the Weitzman Institute and then worked in the Hebrew University on the design of equipment for Meteorological studies. His article on a d.c. transistor amplifier in the March 1964 issue arose from work at the University. After returning to this country he was with Kelvin Hughes until last June when he emigrated to Canada and is now with R.C.A. Victor on space electronics projects.

Design philosophy

Most previous forms of pulse modulation consist of modulating either the pulse frequency or pulse duration with incoming a.f. signal. The resulting pulse train is then amplified and passed through some form of low-pass filter to recover the original signal. A system of pulse-duration modulation is outlined in Fig. 1 and

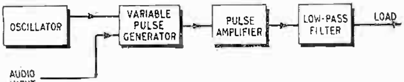


Fig. 1. Conventional pulse-width modulation system for a.f. amplification.

examination will show that there are practical difficulties associated with this system which are not, at first, readily apparent. In the first place, the required switching speeds of the pulse generator will normally preclude the use of saturated switching circuity as the following example will show. Let us assume that the upper end of the audio pass band is 25 kc/s and that the pulse repetition frequency (p.r.f.) of the oscillator is 100 kc/s. (This is about the minimum p.r.f. desirable to maintain a high signal-to-noise ratio on the audio output without recourse to an elaborate low-pass filter.) In order to maintain good efficiency of the system it would be reasonable to permit 90% modulation with the incoming signal. The original pulse width is 5 μs (half the pulse cycle time) and, with full modulation, this will vary from 1-9 μs. Now, in order to maintain good modulating linearity, the pulse shape must remain the same under all operating pulse widths, which include 1 μs, which in turn suggests a rise and fall time of not greater than 100 ns for the pulse generator, which is a far cry from audio frequencies. The system is also very poor with regard to the effect of overload. On one half-cycle the pulse width will become extremely narrow, with loss of pulse shape while on the other half cycle, "lock-on" of the pulse generator will occur, resulting in a very high increase in distortion at the output. Another practical difficulty arises over the tracking of the pulse generator timing network with that of the oscillator. That is to say, with no signal input, the pulse width generated must be exactly half the pulse cycle time of the oscillator over the given temperature range, and over the life of the equipment. If they do not, a net d.c. shift will occur at the filtered output, which, at minimum, will alter the operating conditions of the last stage (see Fig. 2). This problem can be eliminated by the use of high-stability components in the timing networks, but the use of precision capacitors is neither convenient, nor cheap.

Pulse-ratio modulation.—These difficulties are significantly alleviated by the use of pulse-ratio modulation[9], in which the frequency and pulse duration both vary non-linearly with input, but the duty ratio (pulse " on " time to pulse cycle time) is proportional to the input. Since the filtered output depends solely on the duty ratio, independent of which system of pulse modulation is used, this hardly constitutes a problem! In the absence of any input there is the usual 50% duty ratio on the output of the pulse generator. With increasing modulation (here " modulation " is loosely used with respect to only one cycle of the incoming signal and denotes a slowly varying change from the initial conditions) the pulse width becomes larger and larger over one-quarter cycle returning to its original value at one-half cycle. From there the pulse width becomes smaller, reaching an asymtotic value of half its original value. This is illustrated in Fig. 3. The frequency becomes smaller with increasing modulation and can (with signal overload) enter the audio band. The pertinent parameters of pulse ratio modulation are as follows:

$$t_1)_a = t_1)_0 \cdot \frac{1}{1-a} \quad \ldots \quad 1$$

$$f)_a = f)_0 (1 - a^2) \quad \ldots \quad 2$$

$$\mathrm{d.r.})_a = \tfrac{1}{2}(a + 1) \quad \ldots \quad 3$$

where $t_1)_a$ is the pulse width with modulation level a; $t_1)_0$ is the pulse width with no modulation; $f)_a$ is the frequency with modulation; d.r.$)_a$ is the duty ratio and a varies between -1 and $+1$. These results are derived in Appendix 2. It will be seen that variation of the timing network will have no effect on these parameters, thus completely eliminating the problem of drift of these components, which in turn permits the use of cheap, low-toleranced components. With overload (i.e. a approaches $+1$ or -1) the output signal will be distorted but the original information will be detectable. With this form of modulation "lock-on" cannot occur providing a does not equal $+1$ or -1, but the modulating frequency will fall within the passband and this will be the sole source of distortion.

It is of interest to note that equations 1, 2, and 3 are perfectly general, and equations of a similar form could be derived for a controlled conventional multivibrator, or for the circuit used in ref. 9. The particular advantage of the circuit to be considered here is that all the active elements operate in an unsaturated state, which is necessary for the high speed of operation that will be utilized.

Bowes oscillator.—The Bowes oscillator [10], shown in a simple form in Fig. 4, is an emitter-coupled multivibrator with linear charge and discharge rates, which facilitates design and gives high stability. The description that follows, along with Appendix 1, will only consider first-order effects. Two current generators supply current i_1 and i_2 to the emitters of the two transistors. Assume that transistor Tr2 has just switched off. Then current $(i_1 + i_2)$ passes through transistor Tr1, part

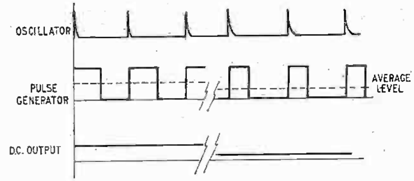


Fig. 2. Effect of one timing network altering with life or temperature, in a pulse-width modulated amplifier.

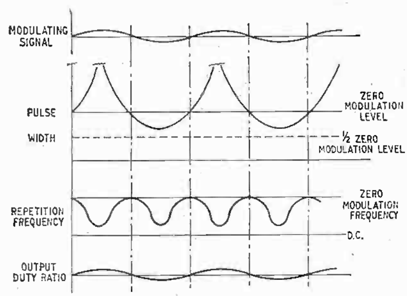


Fig. 3. Effect of modulation on a pulse-ratio modulated train.

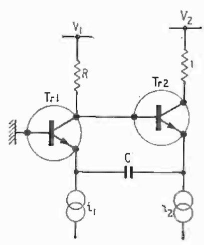


Fig. 4. The Bowes oscillator.

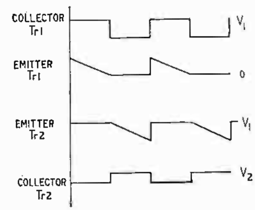


Fig. 5. Waveforms of the Bowes oscillator of Fig. 4.

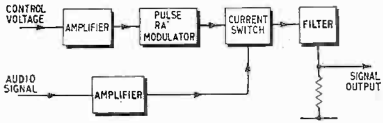


Fig. 6. Block diagram of the voltage-controlled amplifier.

direct, part through capacitor *C*. This provides a voltage step at the collector of Tr1 which biases Tr2 off. The voltage developed across *C* linearly reduces, due to the charging current, thus reducing the voltage at the emitter of Tr2 until it becomes forward biased, and regeneratively switches on again. Since the value of resistor R is sensibly low, the base, and thus the emitter, of Tr2 passes rapidly up to voltage V_1. This voltage change is transmitted through *C* to back bias Tr1 and now the total current is supplied to Tr2. The action of the capacitor again reduces the back bias on Tr1 until it switches on again, switching off Tr2 and completing the cycle. The higher voltage, V_2, is required to prevent saturation of Tr2. The waveforms for operation are shown in Fig. 5 and the analysis of the circuit is given in Appendix 1. It has been shown[10] that second-order effects will alter the performance of the oscillator by about 3%, and that variation with temperature is less

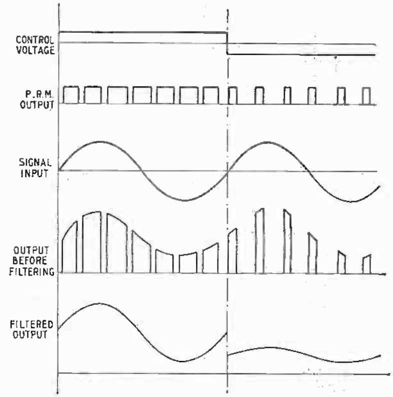
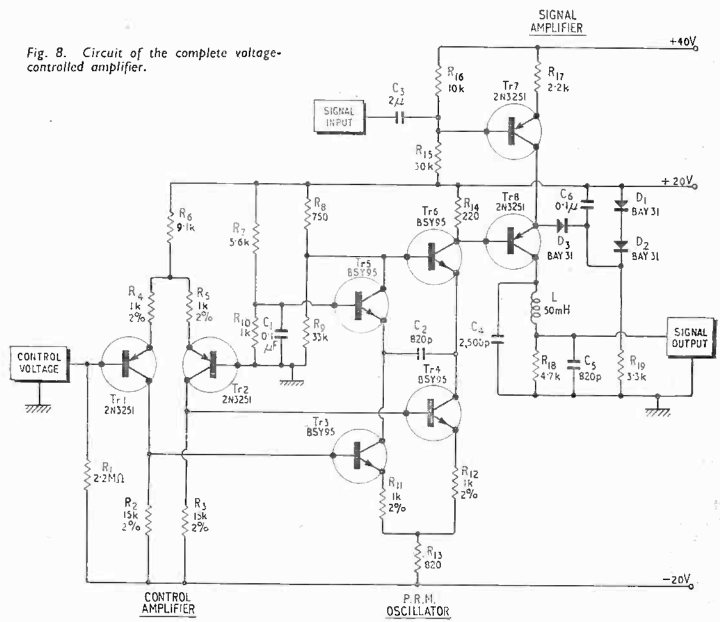


Fig. 7. Waveforms illustrating the change in output amplitude with control voltage in Figs. 6 and 8.

Fig. 8. Circuit of the complete voltage-controlled amplifier.



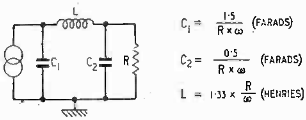


Fig. 9. Low-pass filter design.

than 0·5% over an extended range, which suggests that it will be an ideal vehicle for instrumentation circuits.

In order to use this oscillator for modulation purposes it is necessary to modulate the current generators with two equal amplitude out-of-phase signals. This is accomplished by using transistors as current sources, and voltage driving the bases of these transistors with signals from a long-tailed pair amplifier. The output is taken from the collector of Tr2, and Appendix 2 shows how the output duty ratio will follow the control signal.

Voltage-controlled amplifier

Having shown at some length a method of switching, it might be politic to try and relate it now to the title of the article! The block diagram of a complete voltage-controlled amplifier is shown in Fig. 6. The controlling signal is amplified and then fed to the pulse-ratio modulator which in turn controls the switching of current through a long-tailed-pair switch. The current itself has been derived from the output of the audio signal amplifier and after passing through a filter in one arm of the current switch, develops a voltage across the load, which constitutes the output. The manner in which the control voltage will alter the amplitude of the output voltage is shown in Fig. 7.

The actual circuit is shown in Fig. 8. Transistors Tr1 and Tr2 amplify the control voltage to provide equal out-of-phase signals at the bases of Tr3 and Tr4, which in turn constitute the current generators to the oscillator Tr5 and Tr6. The voltage across R_{11} and R_{12} is made 5 V without modulation and therefore for a 90% swing the voltage at the bases of Tr3 and Tr4 may swing ±4.5 V. Knowing the control voltage range of operation, the gain of the first stage is thus fixed. The frequency of oscillation was made 500 kc/s, since with 90% modulation ($a = 0.9$) the minimum value of frequency derived from equation 2 approximately becomes:—

$$(1-0.8)\ 500\ \text{kc/s} = 100\ \text{kc/s}$$

which, as explained earlier, is felt to be the lowest desirable modulator frequency. R and V_1 shown in Fig. 4 are simulated by R_8 and R_9, where $V_1 = V_2 R_8 / (R_8 + R_9)$, and R is R_8 and R_9 in parallel. The output at R_{14} is approximately a 2 V pulse train with rise and fall times of about 15 ns. The current switch consists of transistor Tr8 and diode D3, and, while a transistor could have been used in place of D3, there would be little advantage since no second output signal is required. Diodes D1 and D2 provide a bias to the switch such that Tr8 is either fully on or fully off, depending on the output of the modulator. The switch will pass current generated by the audio signal amplifier (Tr7) through the filter to develop the output signal across R_{18}. If one excluded the switch and filter it would be apparent that the voltage gain of the signal amplifier is approximately $2(R_{17}/R_{18})$, and in the absence of a control signal, i.e. 50% modulation, the gain reverts to unity. This circuit has two additional advantages: (1) variations of supply voltages will not alter the duty ratio and (2) the amplifier can be readily modified for use with d.c. signals.

Low-pass filter

The sensitivity of the amplifier in the final analysis depends on the noise level at the output. Since, in this case, the noise is represented by pulse train information, the action of the filter in suppressing the modulating signal becomes somewhat important. For this reason an 18 dB/octave Butterworth filter was used with a turnover frequency of 20 kc/s. The necessary design information was abstracted from Ref. 11 and the approach is indicated in Fig. 9. While this filter uses an inductor, which is more inconvenient than a simple *RC* approach, it is felt that the results warrant it, with approximately 40 dB attenuation at 100 kc/s. In order to calculate the degree of "breakthrough" of a pulse train, it is first necessary to do a Fourier analysis to determine the amplitude of the fundamental sinusoidal component. It should be self-evident that with an 18 dB/octave filter, all subsequent harmonics are at least an order of magnitude lower. For the same reason only the lowest operating p.r.f. need be considered. Ref. 12 shows the frequency spectrum of a pulse train with a pulse width of 500 ns and p.r.f. of 100 kc/s and gives the relative amplitude of the 100 kc/s component as 10% of the original pulse amplitude. Thus with such a pulse with a height of 5 V, the fundamental amplitude will be approximately 0.5 V and the resulting filtered output will be 5 mV. The measured output was 7 mV pk-pk which suggests that the approach is valid. For a signal-to-noise ratio of 20 dB it becomes apparent that the signal at the output must not be less than 70 mV (with maximum modulation), and to improve on this figure either a lower level of modulation must be used or the filter performance must be improved.

Results

Because of the rapid rise and fall times of the generated pulses it proved expedient to locally decouple all supply rails, with 0.1 μF capacitors, to the earth rail at the point where the load resistor was connected. The same was found to be necessary for the filter earth connections. Once this had been done the circuit was surprisingly well mannered and gave no further difficulty whatsoever. The maximum output voltage was 9V pk-pk and the

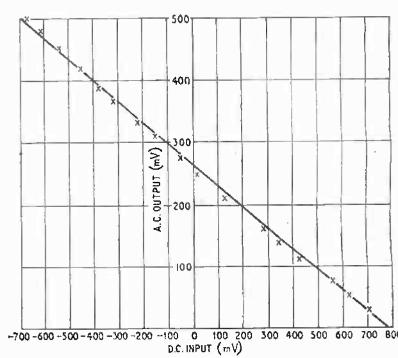


Fig. 10. Linearity of amplifier, showing signal input vs. output.

minimum was 20 mV (depending on the degree of distortion that is tolerable). Anywhere within this band the output could be varied over a 26 dB range, and the response was 3 dB down at 20 kc/s which was due solely to the filter response. It was observed that the inductor caused ringing on the output at a frequency of 30 Mc/s and with a peak amplitude of 20 mV. This occurred whenever the switch changed state and died away in about 300 ns. This should not prove a serious problem since it can be removed at a later stage if necessary. The linearity of the circuitry is shown in Fig. 10, the curvature shown being due to common mode amplification in the control voltage amplifier and can be readily improved. It should not prove difficult to extend the frequency response to 100 kc/s. The unmodulated oscillator frequency could be raised to 1 Mc/s, and at the same time the output duty ratio could be lowered to 90% (currently it is at 95%) which, at 1 Mc/s, would cause the minimum frequency to be

$$1\ \text{Mc/s} \times (1-(0.8)^2) = 360\ \text{kc/s}.$$

This would be almost two octaves above the maximum signal frequency. Finally, if necessary, the filter could be improved using more elements.

Summary

A circuit has been described that uses pulse-ratio modulation to control the effective gain of an audio amplifier over a 26 dB range, and since the circuit was only constructed to illustrate a principle there should be little difficulty in extending its performance to meet any given requirement. It should be noted that no trimmer or "setting-up" is required, the active elements are readily interchangeable with no loss of performance and variation of supply rails and temperature will give only second order effects.

Next month it is hoped to conclude this article with some possible applications.

APPENDIX 1

Operation of the Bowes Oscillator (Figs. 4 & 5)

Assume Tr1 has just switched on.
Voltage step at collector of Tr1:

$$V_s = (i_1+i_2)R \qquad \ldots \quad \ldots \quad \ldots \quad (1)$$

This step also represents the degree of back bias on transistor Tr2 since the emitter cannot change instantaneously.
Thus, after time t_2 transistor Tr2 will conduct again, where:—

$$t_2 = CV_s/i_2$$
$$= \frac{C(i_1+i_2)R}{i_2} \qquad \ldots \quad \ldots \quad \ldots \quad (2)$$

At this instant, transistor Tr1 switches off and is back biased by V_s (*via* Tr2 and C). Tr1 switches on again after time t_1 where:—

$$t_1 = \frac{C(i_1+i_2)R}{i_1} \qquad \ldots \quad \ldots \quad \ldots \quad (3)$$

Total period $(t_1+t_2) = CR(i_1+i_2)\,(1/i_1+1/i_2)$

$$= \frac{CR(i_1+i_2)^2}{i_1 i_2} \qquad \ldots \quad \ldots \quad \ldots \quad (4)$$

i.e. frequency, $$f = \frac{i_1 i_2}{(i_1+i_2)^2 CR} \qquad \ldots \quad \ldots \quad \ldots \quad (5)$$

and if $i_1 = i_2$, $$f = 1/4CR \qquad \ldots \quad \ldots \quad \ldots \quad (6)$$

APPENDIX 2

Pulse ratio modulation with the Bowes Oscillator

With no modulation $i_1 = i_2 = i$

With instantaneous level of modulation a, let

$$\left.\begin{array}{l} i_1 = i - ai \\ i_2 = i + ai \end{array}\right\} \quad -1 < a < +1$$

i.e. $i_1 = i(1-a)$ and $i_2 = i(1+a)$.

Now, from Appendix 1:—

Pulse width, $$t_1 = \frac{CR(i_1+i_2)}{i_1}$$

$$t_1)_0 = 2CR \qquad \text{without modulation}$$

$$t_1)_a = \frac{CR.\,2i}{i(1-a)} \qquad \text{with modulation.}$$

$$= \frac{2CR}{(1-a)}$$

$$= \frac{t_1)_0}{(1-a)} \qquad \ldots \quad \ldots \quad \ldots \quad (1)$$

From Appendix 1:—

$$\text{Frequency, } f = \frac{i_1 i_2}{(i_1+i_2)^2 CR}$$

$$\text{thus } f)_0 = 1/4CR$$

$$\text{and } f)_a = \frac{i^2(1-a^2)}{4i^2.CR}$$

$$= 1/4CR \cdot (1-a^2)$$

$$= f)_0(1-a^2) \qquad \ldots \quad \ldots \quad \ldots \quad (2)$$

From Appendix 1:—

$$\text{duty ratio, (d.r.)} \quad \frac{t_1}{(t_1+t_2)} = \frac{CR(i_1+i_2)}{i_1} \cdot \frac{i_1 i_2}{CR(i_1+i_2)^2}$$

$$= i_2/(i_1+i_2)$$

$$\therefore \text{d.r.})_a = \frac{i(1+a)}{2i}$$

$$= \tfrac{1}{2}(1+a) \qquad \ldots \quad \ldots \quad \ldots \quad (3)$$

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Silicon Transistor Millivoltmeter

WIDE RANGE VOLTMETER WITH GOOD FREQUENCY RESPONSE AND HIGH INPUT IMPEDANCE

By D. E. O'N. WADDINGTON, A.M.I.E.R.E.

UNTIL fairly recently, the high price of silicon planar transistors has precluded their use by the electronic experimenter, particularly as similar performance, with regard to gain and f_T, has been obtainable from the very much cheaper germanium alloy diffused transistor. However, the introduction, by several manufacturers, of plastic-encapsulated silicon planar transistors at competitive prices, has made it possible for these to be used more generally. Some of the advantages of these transistors are:—

Low leakage current—less than 0.5 μA (total)
Good performance at low collector currents
Good frequency response
Low noise figure
Both n-p-n and p-n-p types are available.

These features make the use of silicon planar transistors very attractive as the design can, to a large extent, ignore variations in the transistor parameters and control the overall performance by the application of suitable negative feedback techniques. The author has used them in several home projects, of which the millivoltmeter is an example.

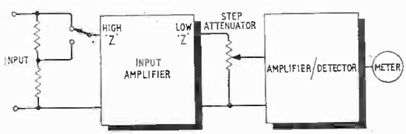

Fig. 1. Basic arrangement of the millivoltmeter.

General design

In the design of a millivoltmeter there are two main factors, namely, voltage range and frequency range, which dictate what system should be used.

In order to obtain a good frequency response from an attenuator, the simplest method is to operate at low impedance where stray capacitance has least effect and, with luck, there will be no need to apply compensation. This conflicts with the common requirement for all voltmeters i.e. that the input impedance should be high so that the voltage being measured is disturbed as little as possible by the test gear. Thus, it is expedient to use the system shown in Fig. 1. Here, the first stage will have a high input impedance and a low output impedance. This makes is possible for the low impedance attenuator to be used without affecting the input. However, as the dynamic range of the input amplifier is limited both by the maximum input signal which it can accept and by the amount of power which it can accommodate, it is necessary to include a range switch right at the input. As this will necessarily be a high impedance, capacitive frequency compensation circuits will be necessary. This will not add much to the complication as it need only be a two-position switch. The output from the low impedance attenuator is fed to the main amplifier/detector circuit and thence to the meter.

SPECIFICATION

Ranges
1 mV, 3 mV, 10 mV, 30 mV, 100 mV, 300 mV;
1 V, 3 V, 10 V, 30 V, 100 V, 300 V.

Accuracy
Better than ±5%. The attenuator accuracy can be improved if necessary.

Frequency response
±1%, 50 c/s to 100 kc/s
±10% (better than 1 dB), 16 c/s to 1.5 Mc/s.

Noise level
Around 10 μV with input open circuit.

Input resistance
Better than 1 MΩ for 1 mV-300 mV ranges.
10 MΩ for 1 V-300 V ranges.

Consumption
11 mA at 12 V.

Input stage

Many forms of high input-impedance, low output-impedance circuits could be used here with very little change in overall performance. In this case the complementary feedback pair was chosen as it is economical and, at the same time, provides adequate performance for the application.

The use of a low noise, low leakage-current transistor in the first stage made it possible to use high value resistors (3.3 MΩ) in the base bias chain without any fear of adverse thermal effects. Thus, an input impedance of greater than 1 MΩ was achieved without using bootstrap circuits which increase the complexity. No over-

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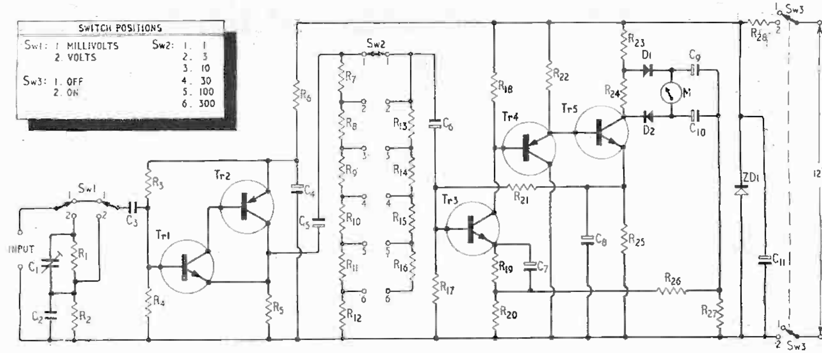


Fig. 2. Circuit of the silicon transistor millivoltmeter.

Resistors

R1	10MΩ	± 5% ½W
R2	10kΩ	± 5% ½W
R3	3.3MΩ	±10% ¼W
R4	3.3MΩ	±10% ¼W
R5	3.3kΩ	±10% ¼W
R6	1kΩ	±10% ¼W
R7	2.16kΩ	± 5% ½W
R8	683Ω	± 5% ½W
R9	216Ω	± 5% ½W
R10	68.3Ω	± 5% ½W
R11	21.6Ω	± 5% ½W
R12	10Ω	± 5% ½W
R13	470Ω	±10% ¼W
R14	180Ω	±10% ¼W
R15	68Ω	±10% ¼W
R16	22Ω	±10% ¼W
R17	47kΩ	±10% ¼W
R18	68kΩ	±10% ¼W
R19	6.8kΩ	±10% ¼W
R20†	22Ω	± 5% ½W
R21	47kΩ	±10% ¼W
R22	5.6kΩ	±10% ¼W
R23	2.7kΩ	±10% ¼W
R24	100Ω	±10% ¼W
R25	3.3kΩ	±10% ¼W
R26†	53.2Ω Use 56Ω ±5% shunted to give correct calibration	
R27†	22Ω	± 5% ½W
R28	390Ω	±10% ½W

Capacitors

C1	3-8pF	Philips trimmer
C2	0·015μF	30V
C3	0·1μF	350V
C4	100μF	12V
C5	25μF	6V
C6	5μF	6V
C7	100μF	6V
C8	500μF	6V
C9	2μF	6V
C10	2μF	6V
C11	1000μF	12V

Semiconductor Devices

D1	1S44, 1N914
D2	1S44, 1N914
ZD1	OAZ206
Tr1	TI415, 2N2925
Tr2	TIS04, HT101
Tr3	TI415, 2N2925
Tr4	TIS04, HT101
Tr5	TI415, 2N2925

Miscellaneous

M	100μA f.s.d.
S1	d.p.d.t. toggle switch
S2	two-pole, six-position wafer switch
S3	d.p.s.t. toggle switch

Notes:

†Non-inductive types (carbon).

R7 2.16kΩ = 2.2kΩ in parallel with 120kΩ (±10%)

R9 216Ω = 220Ω in parallel with 12kΩ (±10%)

R11 21.6Ω = 22Ω in parallel with 1.2kΩ (±10%)

R8, R10: The use of the nearest preferred value (i.e. 680 or 68Ω) will introduce an error of only 0.5% in addition to the normal component tolerance.

If greater accuracy is required, the attenuator resistors can be given closer tolerances.

load protection circuit was included in the original voltmeter as it increases the input-capacitance, and may also affect the overall frequency response. (The modification necessary to add this protection if it is required is very simple and is shown in Fig. 3.)

Meter-range switch S.2

This is a simple voltage-divider circuit with the values chosen such that the steps are in the ratio $\sqrt{10}:1$ thus making it possible to use the same dB scale on all ranges

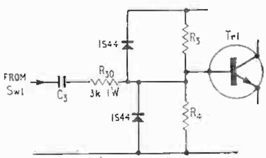
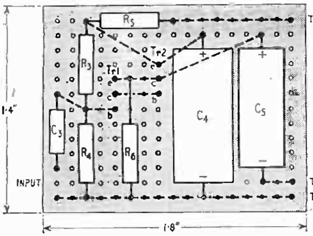


Fig. 3. Alternative input circuit with protection diodes included.

of the meter. The series resistors included in position 3 to 6 of the switch, serve to keep the output impedance of the divider more or less constant. This minimizes errors due to loading of the divider chain by the input impedance of Tr3. In order to prevent large transients during range switching, both the input and output of the attenuator are isolated by means of capacitors.

Amplifier and detector

This section consists of two common-emitter amplifier stages, coupled by an emitter follower. Overall d.c. feedback from the emitter of Tr5 to the base of Tr3 stabilizes the working points of the transistors very effectively. The rectifier circuit, which is of the voltage doubling type, is connected in the feedback loop from the collector of Tr5 to the emitter of Tr3. The effect of this is two-fold: it provides a high source-impedance feed for the rectifier circuit thus ensuring a linear scale shape and it also stabilises the gain of the amplifier. In building this circuit, care must be taken to ensure that R20, R26 and R27 are all non-inductive as these resistors control both the gain and



▲ *Fig. 4. Input amplifier layout.*

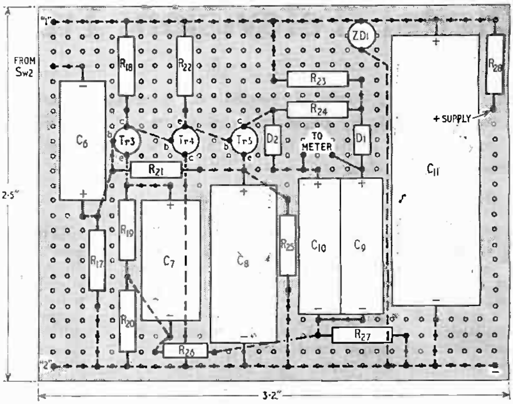


Fig. 5. Amplifier-detector layout. ▶

the frequency response. Silicon planar diodes are used as rectifiers and, in order to help the signal to overcome the pedestal voltage, a standing bias potential is applied across them by means of R24. Meter protection is accomplished by limiting the current through the output transistor and thus the drive to the rectifier circuit.

Construction

The layout of the circuit is not very critical provided that lead lengths are kept reasonably short and the input circuitry is not mixed up with the output. In the experimental model it was convenient to make the input amplifier on one piece of "Lektrokit" board and the amplifier-detector on another. (Figs. 4 and 5.)

Setting up

There are two adjustments (gain and frequency response) which need to be made in order to ensure that the voltmeter works correctly. To set up the gain, switch the voltmeter to the 1 V range, apply a signal having a frequency of approximately 400 c/s but with level set to 1 V as precisely as possible to the input. Adjust the value of R26, by shunting it with resistors having values in the range from 330 Ω to 10 kΩ, until the meter reads exactly full scale. The frequency response is not quite so easily set up as it requires the use of a signal source capable of providing an accurate volt at 100 kc/s. If this is available, the procedure is to use this as the input signal on the 1 V range and to adjust C1 for full scale deflection. The meter scale will be identical with that given on p. 270 of the June 1964 issue.

Performance

The accuracy of a voltmeter, such as has been described, is very dependent upon the accuracy with which the gain may be set and also the accuracy of the resistors used in the voltage divider chains. However, an accuracy of better than ±5% is fairly easily attainable with generally available components. If a better accuracy is required, the attenuator resistors can be given tighter tolerances. The frequency response may be set to be flat to within ±1% from 50 c/s to 100 kc/s. In the experimental model, the response was found to be ±10% from 15 c/s to 1·5 Mc/s. The noise level indicated on the meter, with an open circuit input but with the instrument installed in its metal box, was of the order of 10 μV. Battery consumption is approximately 11 mA.

CONFERENCES & EXHIBITIONS

Further details are obtainable from addresses in parentheses

Mar. 10-11 — Burlington House
Circular Dichroism—Electronic & Structural Principles
(Royal Society, Burlington House, W.1)

Mar. 15-17 — King's Head, Harrow
Public Address Exhibition
(A. J. Walker, 394, Northolt Road, South Harrow, Middx.)

Mar. 28-31 — Alexandra Palace
Physics Exhibition
(Inst. of Physics & Phys. Soc., 47 Belgrave Sq., S.W.1)

Mar. 23-30 — Earls Court
Electrical Engineers Exhibition
(A.S.E.E. Exhibition, 25 Museum Street, W.C.1)

CRANFIELD

Mar. 21-24 — College of Aeronautics
Aerospace Instrumentation Symposium
(M. A. Perry, College of Aeronautics, Cranfield, Beds.)

EASTBOURNE

Mar. 22-23 — Grand Hotel
Exploiting Instrument Development
(Scientific Instrument Research Assoc., Chislehurst, Kent)

OXFORD

Mar. 30-Apr. 1 — The University
Nuclear and Particle Physics
(Inst. of Physics & Phys. Soc., 47 Belgrave Sq., London, S.W.1)

OVERSEAS

Feb. 25-Mar. 6 — Copenhagen
International Electronics Fair
(Secretariat, Julius Thomsens Plads 1, Copenhagen V)

Mar. 2-4 — Washington
Scintillation & Semiconductor Counter Symposium
(I.E.E.E., 345 East 47th St., New York, N.Y. 10017)

Mar. 10-15 — Paris
Festival du Son
(S.I.E.R.E. 16 rue de Presles, Paris 15)

Mar. 28-31 — Paris
Electronic Switching
(Colloque de Commutation Electronique, 16 rue de Presles, Paris 15)

Digital Television Transmission

Why has there been a revival of interest in transmitting television signals by pulse code modulation? This article takes a look at some of the experimental work in progress and the incentives behind it

ALTHOUGH the transmission of television pictures by pulse code modulation has been the subject of experiments for 15 years or more,[1] it is only recently that this technique has been looked at seriously as a means for satisfying practical needs. It has been a case of a good idea waiting for applications. One of the main problem, of course, has been that a pulse coded television signal requires considerably more bandwidth than the original video signal—although in exchange for this one gains a valuable increase in signal/noise ratio.

There are several reasons for the current resurgence of interest. In the first place, p.c.m. telephony has shown itself to be a practical proposition for use in public services[2]. Secondly, the advent of solid-state circuitry has made it possible to design complex digital encoding, decoding and regenerating equipment that is reliable, compact and economical to manufacture. Thirdly, the wide-band transmission systems needed for transmitting p.c.m. signals are becoming cheaper and cheaper. Present systems use coaxial cable, but there are possibilities of even wider bandwidths with the long-haul waveguides and coherent light guides of the future.

Allowing that new electronic techniques—and the practical experience gained with them—have put the means of p.c.m. television in a more attractive light, what are the particular ends our systems engineers have in mind in 1966? There are, of course, the spectacular applications in the exploration of space. The successful transmission to Earth of pictures of the planet Mars from the Mariner IV spacecraft[3] showed what could be done in overcoming extreme signal/noise ratio problems. Military television applications arise from the possibility of using secret codes for the p.c.m. signals. But the widest use of p.c.m. television is likely to be in broadcasting—in conveying signals between studio centres, outside broadcasting sites and transmitters. Most of this, of course, would be done through the communications network operated by the Post Office, and here it is necessary to consider television signal transmissions as merely one part of the whole communications pattern. Forward thinking in this field envisages increasing use of digital techniques, not only in conveying the information but in switching as well. This means, in the first instance, p.c.m. telephony and high-speed data transmission. First, a number of "digital areas" centred on the large cities might well be developed, and then these would be linked by digital trunk routes. Efficient use of channel capacity depends on time division multiplexing of the pulse trains representing different types of information. Thus, in the future it is likely that the transmission of television signals would have to fit into some such comprehensive scheme of time division multiplexing, and pulse coding is necessary to enable this to be done.

Broadcasting organizations are investigating the possibility of using pulse coded signals within their own television studio centres. It is thought that this coding will facilitate automatic methods of switching and control

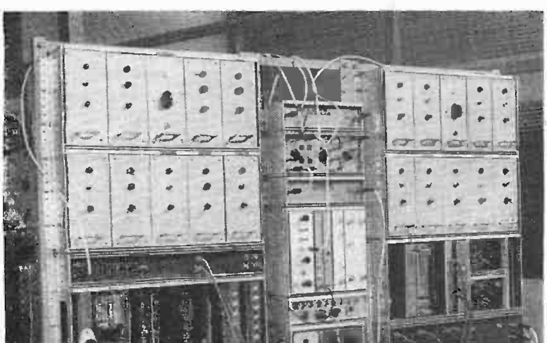


Fig. 1. Experimental encoding and decoding equipment at Standard Telecommunication Laboratories.

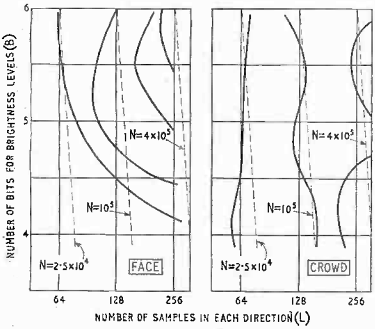


Fig. 2. Workers in the Research Laboratory of Electronics, Massachusetts Institute of Technology, U.S.A., have been studying subjective assessments of the quality of quantized still pictures, using a computer-simulated p.c.m. system with variable system parameters and a picture input/output device. On the graphical results shown here for two subjects, a face and a crowd scene, the solid lines are isopreference curves (curves of constant preference) and these indicate how picture quality varies with the number of brightness levels used ($=2^B$) and with the spatial sampling rate (number of samples in a picture $= L \times L$). The number of bits per picture is $N = L \times L \times B$, and for guidance, curves of constant N are shown by the broken lines. (Further details in "PCM picture transmission" by Thomas S. Huang in the December 1965 issue of IEEE Spectrum, *to which acknowledgement is made.)*

and so reduce the dependence of the final transmitted picture on the skill of individual operators.

Pulse code modulation was invented in 1938 by Alec H. Reeves, and it is only to be expected that the main British work on p.c.m. television is being done in the organization where he still works—Standard Telecommunication Laboratories at Harlow, Essex. Here experimental equipment has been developed by which 625-line television pictures can be transmitted over 960 yards of coaxial cable (see Fig. 1). *Wireless World's* reporter found the received picture indistinguishable from the original when both were viewed at the correct distance on adjacent 23-inch K-B television sets. Closer examination of the received picture showed that extremely small flaws were being introduced by occasional coding errors in the transmission system. These appeared as tiny black spots or slots in individual lines, but were so infrequent and so randomly distributed over the picture as to be hardly discernible. S.T.L. state that these impairments will be almost completely eradicated in future equipment.

Code for sync pulses

As is well known, the principle of p.c.m. is to take samples of the analogue signal waveform at a rate at least twice that of the highest component frequency to be distinguished (the Nyquist rate[1]) and to encode each amplitude value into a binary number represented by a sequence of pulses. Whereas the analogue waveform is a continuous function of time, the encoding process introduces quantization and consequently the p.c.m. representation of the waveform is constructed from a finite number of amplitude levels. In the S.T.L. equipment the total swing of the picture waveform from peak white to black level (excluding sync pulses) is divided into 80 amplitude levels, and the rate at which these levels are sampled is 12.5 Mc/s. The sync pulses are not treated as part of the waveform because, being cyclic and of constant amplitude, they have a high degree of redundancy, and it would be a waste of channel capacity to use 30% of the available amplitude levels (and the corresponding code characters) to represent them. Thus the sync pulses are represented by one additional amplitude level (making 81 levels altogether for the composite waveform) and the presence of this amplitude level is signalled by one corresponding code character.

Choice of the sampling rate and number of amplitude levels has been determined mainly by the spectrum of the 625-line television signal, by the transmission channel bandwidth available and by the limitations of present-day pulse circuits. Other considerations may enter into it, however, and, for example, a group at the Massachusetts Institute of Technology, U.S.A., is studying how sampling rate and number of amplitude levels affect subjective assessments of picture quality (see Fig. 2).

Block diagrams of the S.T.L. encoding and decoding equipment, which uses solid-state circuitry, are shown in Figs. 3 and 4. In the encoder it will be seen that the television sync signal is separated at an early stage and used to initiate the appropriate code character. The picture waveform passes to the sampler and here the amplitude samples are temporarily held as analogue

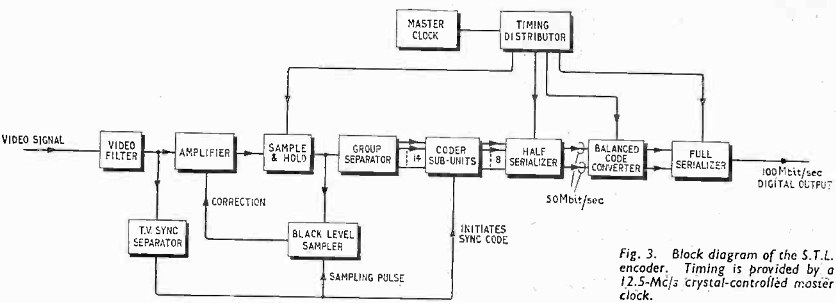


Fig. 3. Block diagram of the S.T.L. encoder. Timing is provided by a 12.5-Mc/s crystal-controlled master clock.

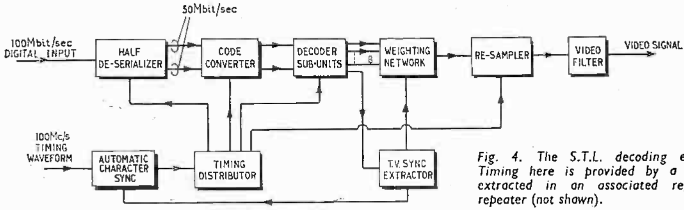


Fig. 4. The S.T.L. decoding equipment. Timing here is provided by a waveform extracted in an associated regenerative repeater (not shown).

voltages for 50 nsec to allow time for the coder to operate. At this point it is essential to ensure that the black level of the picture is represented by a constant analogue voltage value—that is, the d.c. component must be maintained—otherwise, the coder will generate incorrect characters. This is the function of the "black level sampler," which is part of a sampled-data control loop providing a feedback signal that adjusts the d.c. level of the picture signal.

The next stage is the process of analogue-to-digital conversion. In order to represent 81 amplitude levels in the type of signalling code employed, 8-digit binary characters are necessary. With a sampling frequency of 12.5 Mc/s this means a final transmitted digit rate of 100 Mbit/sec. To achieve the high speed of analogue-to-digital conversion necessary for this signalling rate, the conversion is performed on a parallel basis—that is, each amplitude sample is converted into a binary character represented by eight bits appearing *simultaneously* on eight wires. It is not, however, possible to use a single parallel coder to convert all the 81 amplitude levels as this would raise considerable problems in drive, propagation time and instability as a result of interconnecting large numbers of solid-state logic circuits. Instead the total range of amplitude levels is first separated into 14 groups of 6 levels each (except in two groups) and for each of these 6-level groups a separate parallel coder sub-unit is provided. The outputs of the 14 coder sub-units are then combined. The separation into 6-level groups is performed by a chain of voltage discriminators set by appropriately graduated reference voltages.

In the encoder each amplitude level is converted into a pattern of 8 simultaneous digits according to the scheme shown in Fig. 5 (a). This code was devised by K. W. Cattermole of S.T.L. and its features will be described later. Next the parallel code characters have to be transformed into serial characters for transmission, and for economy in transistor circuitry in the "balanced code converter" this is done in two separately operating sections of the "half-serializer"—one section producing digits 1, 3, 5, 7 as a serial pulse train at the same time as the other section produces digits 2, 4, 6, 8 as a similar pulse train (e.g. digits 1 and 2 occur simultaneously). The two resulting 50 Mbit/sec serial pulse trains then pass through a code converter and are finally interleaved in the "full serializer" to produce a 100 Mbit/sec output which is transmitted through the 960-yd coaxial cable.

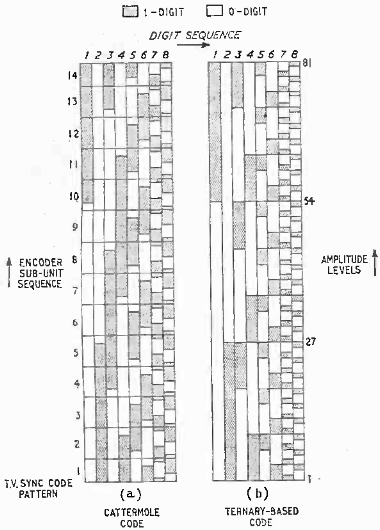


Fig. 5. Binary codes used in the S.T.L. encoding/decoding equipment; (a) Cattermole unit-distance code; (b) ternary-based code which can be translated into and from a balanced code.

Need for balanced code

The function of the code converter in Fig. 3 is to achieve a type of code which simplifies the transmission system equipment—notably the pulse-regenerating repeaters needed to make up the losses and distortions in long distance communications circuits. Pulse regeneration is basically at matter of amplification followed by amplitude slicing to restore the incoming distorted waveform to square-pulse form. If, however, the incoming pulse code waveform is unbalanced—that is, contains long sequences of similar digits (all 1s or all 0s)—d.c. restorers are necessary in the repeaters to ensure that the waveform is sliced at the correct levels. If, however, a balanced code can be used (waveform containing approximately equal numbers of 1s and 0s) d.c. restoration is unnecessary and the repeaters are consequently simplified. In addition, with a balanced code, the repeaters can work at lower supply voltages, allowing more repeaters to be supplied in series through the same cable; all amplifiers are uniformly loaded and they need not be linear; and the necessary extraction of the pulse repetition frequency in the repeater is simplified and the timing errors due to level changes

(*Continued on page* 117)

NEW *Reslo*

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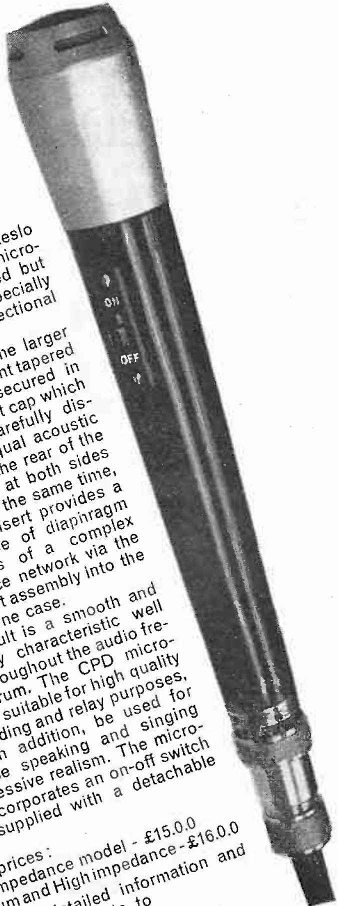

The type CPD, the latest in the Reslo range of dynamic (moving coil) microphones, incorporates a rugged but miniaturised dynamic insert specially designed to have a unidirectional sound pickup pattern.

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The overall result is a smooth and wide frequency characteristic well maintained throughout the audio frequency spectrum. The CPD microphone is very suitable for high quality music recording and relay purposes, and can, in addition, be used for loud, close speaking and singing with impressive realism. The microphone incorporates an on-off switch and is supplied with a detachable holder.

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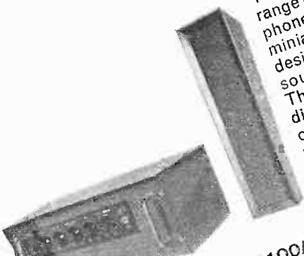

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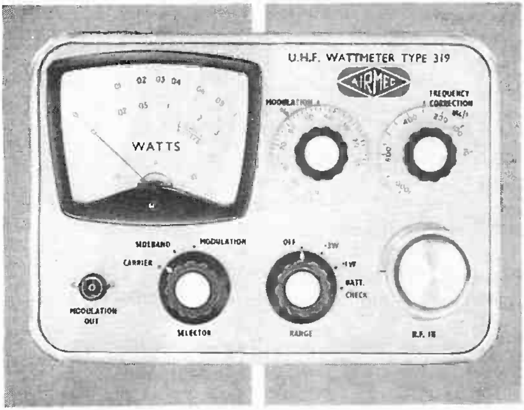

- **Frequency Range: 1—1400 Mc/s**
- **Ranges: 0·100mW, 0·300mW**
- **Input Impedance: 50 ohms.**

The U.H.F. Wattmeter Type 319 is a light and compact instrument for measuring C.W. power, sideband power, and modulation depth in the frequency range 1-1400Mc/s. Carrier and sideband powers are indicated directly on a 3½" scale meter in two ranges. Percentage modulation depth is shown on a potentiometer scale.

For carrier measurement no additional power is necessary; internal dry batteries provide power for sideband and modulation measurement. This instrument is one of the units in the Airmec range of U.H.F. equipment which includes connectors, adaptors, attenuators, reactance lines, slotted lines etc.

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are reduced. The purpose of the code converter in Fig. 3 is therefore to transform the generated Cattermole code into a balanced code providing these substantial advantages.

This transformation is performed on the basis of a ternary code, as shown in the table below. A ternary code is one in which numbers are represented in terms

Ternary code	Binary coded version	Balanced code
0	01	01
1	00	00 or 11
2	10	10

of three digits, 0, 1, 2, instead of the two digits of the binary scale or the ten of the decimal scale—the digit positions in a ternary number having the weights of powers of 3, that is, 3^0, 3^1, 3^2, 3^3 etc. The three digits of the ternary code can be represented in binary form, as shown. Here the ternary digit "1" is represented by 00, but it could equally well have been 11 because this combination is not used by either of the other two ternary digits, 0 or 2. This fact is made use of to produce a balanced code, by representing the ternary "1" alternately by 00 and 11. The waveform of the balanced code has the properties that its mean value is always equal to half its peak-to-peak amplitude and that never more than four 1s or four 0s follow each other.

The Cattermole code generated by the encoder is one of a class of what are called "unit-distance codes." A more familiar member of the class, and also used in p.c.m. television, is the reflected binary or Gray code. In analogue-to-digital conversion these codes have the property that, in handling a transition between adjacent analogue levels, only one digit changes. (This can be seen from Fig. 5(a).) This property is valuable because it avoids the encoding errors which might arise if several digits changed simultaneously, as they do in pure binary (e.g. with a five-digit binary code a transition between analogue values 15 and 16 would cause all five binary digits to change simultaneously), and it is to avoid such errors that the Cattermole code is used in the Fig. 3 equipment. It is used in preference to the more familiar Gray code because its particular cyclic pattern simplifies the circuitry for the subsequent transformation into a balanced code. In this last-mentioned process the Cattermole code is first converted into a ternary based code, of the type shown in the table above and in Fig. 5(b), which is then transformed into the balanced code. All these operations are performed by solid-state logic circuits.

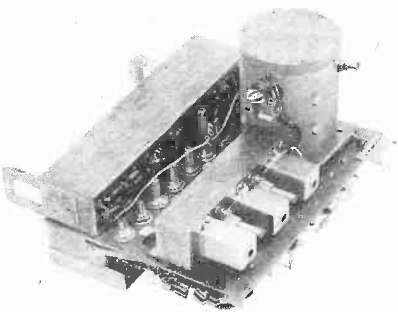


Fig. 6. Regenerative repeater used at the receiving terminal of the S.T.L. experimental equipment.

In the decoder (Fig. 4) the incoming 100Mbit/sec pulse train is first divided into two 500Mbit/sec trains, each of which is then converted back to the ternary-based code of Fig. 5(b). There are eight decoder sub-units, one for each digit position, and each sub-unit produces a sequence of analogue voltages corresponding to the arriving digits in that position. These voltages then pass into a weighting network where proportions of them are taken and combined according to the weights of the digits in the respective positions (the television sync pulse being also restored by this process). The resulting sequence of discrete voltages is then smoothed into a continuous wave-form by the video filter and passes to the picture display equipment.

Regenerative repeater

Synchronization of the decoder with the encoder is achieved by a 100-Mc/s timing waveform extracted from the 100Mbit/sec p.r.f. in a regenerative repeater at the decoder terminal. This waveform is applied to the "automatic character sync" unit which controls the timing of the various decoding operations. The regenerative repeater (Fig. 6) operates by sampling the incoming distorted waveform—after it has first been amplified by 65 dB—with accurately timed short pulses derived from the 100Mbit/sec repetition rate of the input. These short sampling pulses are obtained by amplifying, slicing and differentiating the incoming signal and then applying the differentiated pulses, after further amplification, to a filter with a high Q factor (400), the resulting 100 Mc/s sinewave being then once again sliced and differentiated. The short code pulses resulting from the sampling process have a duration of 4 nsec and have to be stretched to restore them to their full width of 10 nsec as generated by the encoder.

A certain amount of work on pulse coded television has also been done by the Automatic Telephone and Electric Co. at Liverpool. At last year's Physics Exhibition in Manchester they showed an experimental equipment for encoding signals with a bandwidth of 6.5 Mc/s. It used a 7-bit parallel code of the Gray type and the parallel characters were subsequently serialized to give an output digit rate of 91 Mbit/sec. The company claimed that this type of encoder would allow full quality colour transmission to be achieved.

In the U.S.A. the main work on pulse coded television is being done at Bell Telephone Laboratories in New York. Little need be said about it here as the experimental equipment (see Fig. 7) is very fully described in three papers in the *Bell System Technical Journal* for November 1965. Suffice to say that the equipment is not for television transmission alone but multiplexes television, telephony and high-speed data into a final pulse code stream of 224 Mbit/sec. The system will handle two television pictures; 3,456 voice channels; or 864 voice channels plus a television picture plus a composite signal comprising 600 frequency division multiplexed voice channels. The complete television waveform, including the sync pulses, is quantized into 512 amplitude levels, requiring a 9-bit unit-distance (Gray) code, and the sampling rate is 12.352 Mc/s. Encoding is performed by either a solid-state encoder or a special deflected-beam

Fig. 7. Part of the Bell Telephone Laboratories experimental p.c.m. equipment. This unit simulates the pulse jitter that would accumulate over a 4000-mile transmission system. Automatic compensation for jitter is provided.

coding tube. At present the tube still gives a slightly better performance, though it is expected that solid-state circuitry will catch up soon.

In the time-division multiplexing of the different signals, an interesting method of synchronization called "pulse stuffing" is used to avoid the necessity of locking the digit rate of the lower speed signals to that of the high speed line. Furthermore, the technique also allows information to be readily added or taken off along the route. Pulses from each coder (or from lower speed digital inputs) are written into a small digital store and then read out at a slightly faster rate which is an exact sub-multiple of the line rate of the high speed system. Each time the store is about to be exhausted, an extra pulse having no information-carrying value is generated and "stuffed" into the stream transmitted on the line. This produces a pause in the read-out from the store and allows it to refill. Thus, input sources whose rates differ by small amounts are synchronized to the digit rate of the high speed line. At the receiving terminal, the pulses are demultiplexed and each signal is written into its receiving digital store and read out at the original rate which that signal had. This is possible because the transmitting terminal sends control signals to the receiver to inhibit the writing of stuffed pulses into the receiving store.

Pulses leaving the multiplexer are converted to a balanced code, for the reasons explained above, but this is a three-level code called paired selected ternary. In this code, sequences of binary digits are grouped into pairs and transmitted as combinations of positive pulses, negative pulses and absence of pulses.

REFERENCES

1. One of the earliest accounts of work in this field was "Television by Pulse Code Modulation," by W. M. Goodall, in *Bell System Technical Journal*, Vol. 30, January 1951, pp. 33-49.
2. See, for example, "P.C.M. for G.P.O. Telephones," *Wireless World*, February 1965, p. 87.
3. "Picture transmission from Mars," *Wireless World*, August 1965, p. 385.
4. See "Information Theory and Pulse Communication," by D. N. Tilsley. *Wireless World*, June 1965, p. 265.

LITERATURE RECEIVED

A wall chart giving "**A summary of Texas Instruments silicon transistors**" has been published by their stockists Quarndon Electronics (Semiconductors) Ltd., Slack Lane, Derby.
WW 301 for further details

Airpax Electronics Inc. have produced a 6-page bulletin (F-8) on "**Electromagnetic Pickups.**" It contains details of seven of their transducers and discusses the application of magnetic pick-ups to tachometry, counting, positioning, motion study, timing, vibration measurement and synchronising. Copies are available from the Seminole Division of Airpax Electronics Incorporated, P.O. Box 8488, Fort Lauderdale, Florida 33310.
WW 302 for further details

A short-form catalogue of the "**Medical Electronic Instruments**" manufactured by San'ei Instrument Company, of Tokyo, is available from Instrumentarium Ltd., 28 Manchester Street, London, W.1.
WW 303 for further details

The complete range of **Zener and reference diodes** currently made by Motorola Semiconductor Products Inc. are included in a selection guide—which takes the form of a wall chart—obtainable direct or from the U.K. stockists, Celdis Ltd., Trafford Road, Richfield Estate, Reading, Berks.
WW 304 for further details

A 28-page catalogue on the range of **Variac variable transformers** made in this country by the Zenith Electric Company (under licence from General Radio) has been sent to us by the exclusive U.K. distributors, Claude Lyons Ltd., of 76 Old Hall Street, Liverpool 3.
WW 305 for further details

Vibro-Meter Corporation, of Switzerland, have produced a short-form catalogue on their transducers and associated electronic equipment. This is obtainable from the company's recently opened British Office at Haletop Civic Centre, Wythenshawe, Manchester 22.
WW 306 for further details

Arcolectric Switches Ltd., of Central Avenue, West Molesey, Surrey, announce that their 1966 catalogue (No. 136) covering their range of switches, neon indicators and signal lampholders is now available. A price list appears in the front of this 62-page publication.
WW 307 for further details

Lind-Air (Supplies) Ltd., of 53 Tottenham Court Road, London, W.1, announce that a new catalogue containing details of over 100,000 different types of British and American plugs, sockets and connectors is now available. A number of supplementary leaflets, on pen recorders, transducers and accelerometers, microwave components, and semiconductor devices and valves, are to be found within the catalogue.
WW 308 for further details

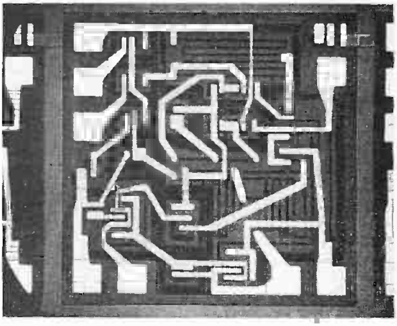
INTEGRATED CIRCUITS FLOOD INTO EUROPE

NEW LINEAR AND DIGITAL TYPES AT PARIS ELECTRONIC COMPONENTS SHOW

ALTHOUGH there is a great deal of talk about the commercial invasion of Europe by American electronics companies, it is only when one goes to a truly international exhibition like the *Salon International des Composants Electroniques* (Paris, Parc des Expositions, 3-8 February) that one appreciates its full impact. Here one is faced with the combined forces of the latest American product technology before they have become absorbed into the native industry. This year in Paris the latest invasion force was obviously integrated circuits.* Of the 22 exhibitors of these devices counted by our reporter, 16 were American, four were French and two were British. The Americans, it would seem, are desperately anxious to capture as much of the European market as possible. Integrated circuits only become competitive with conventional circuits when they are made in sufficiently large quantities. This means that there is room for only a small number of manufacturers, and it has been estimated than even the U.S.A. market may support only about five companies. Thus the question of who will survive and who will have to pull out in the U.S.A. may well depend on how much of the European market each manufacturer can secure.

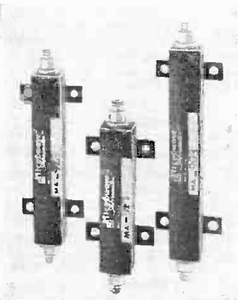
In such an atmosphere the European producers of integrated circuits, although well advanced in technology, have their backs to the wall commercially. At the *Salon*, for example, two major French companies, Cosem (controlled by C.S.F.) and Sesco (controlled by C.F.T.H.) revealed that they were exploring the possibility of a co-operative agreement to meet the American competition. In Britain, Ferranti and Marconi are jointly manufacturing a range of circuits, and in Holland, the Philips company have tied up with Westinghouse Electric International in a technology exchange agreement.

*Wireless World uses this term in the broadest sense to cover monolithic semiconductor devices, thin-film circuits and hybrid circuits.



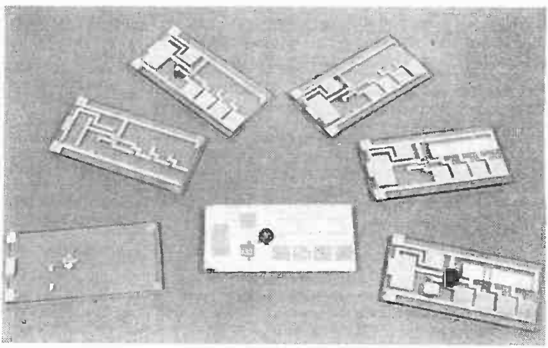
The semiconductor chip of a monolithic operational amplifier with a voltage gain of 45,000 recently introduced by SGS-Fairchild.

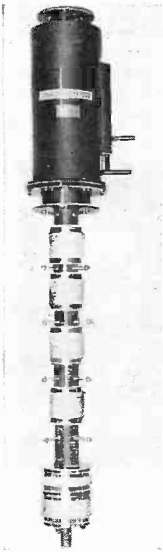
A noticeable technical trend was the increasing number of linear integrated circuit devices coming on the market. These were mostly general-purpose amplifying devices—operational amplifiers, video amplifiers, d.c. amplifiers, differential amplifiers and the like. One of the latest was a monolithic operational amplifier from SGS-Fairchild, the type μA 709, which had a high voltage gain of 45,000 and an output voltage excursion of ± 14 V. An operational ampli-



Examples of Microwave Associates' miniature i.f., pulse and logarithmic amplifiers using integrated circuits. Frequency range: 30 to 350 Mc/s. Bandwidths: 5 to 100 Mc/s. Gain factors: 60 dB to 100 dB.

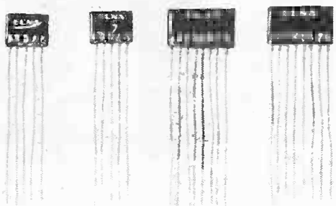
Stages in the construction of a hybrid integrated circuit as demonstrated by LCC-Steafix—one of the many passive-component manufacturers who are going into the thin-film business.





This English Electric u.h.f. klystron will operate at the high peak output power of 40 kW.

Numerical indication of signal level in decibels with respect to 0dB reference (1 mV into 600 Ω) is given by this Compagnie des Compteurs instrument designed for the range 10 c/s to 100 kc/s.



A return to the multiple resistor elements of the 1950s? Examples shown by Elna Denshi offer resistance values from 500 Ω to 220 kΩ.

fier in a TO-5 can shown by Motorola allowed a choice of input impedance—20 kΩ with conventional input circuit or 2 MΩ with a Darlington circuit.

For higher frequency working several manufacturers were offering wide-band amplifiers with −3 dB bandwidths of 100 Mc/s and voltage gains of the order of 10-15. The Philco monolithic SA-20, for example, packaged in an 8-lead TO-5 can, has an input impedance of 1.6 kΩ, an output impedance of 5 Ω and operates from a 24-V supply. Comprising three direct-coupled transistors and six resistors, it has −65 dB intermodulation distortion, a pulse response of 10 ns and provides terminals by which an external feedback capacitor or filter network can be connected into the second stage. Other amplifiers had smaller bandwidths, up to 35 Mc/s, and voltage gains in the range 10-50. Monolithic a.f. amplifiers—particularly suitable for hearing-aid amplifiers carried in the ear—included a three-transistor circuit made by La Radiotechnique, with a gain of 80 dB and package dimensions of 2.7 × 2.7 × 1.1 millimetres. Noise figures are about 4 dB.

Because of their small size and monolithic construction the majority of linear amplifiers now available are very low power devices of not much more than 50 mW dissipation, but this is not a fundamental limitation. An a.f. amplifier circuit in a TO-5 can shown by Motorola, for example, gave an output of 1 watt (with 0.5 % total harmonic distortion). For higher powers the hybrid integrated circuit technique is necessary. A good example was a servo amplifier, shown by C.S.F., with a power output of 3.5 watts. It comprised four separate transistor chips—a preamplifier, an amplifier and two power transistors—with thin-film tantalum or nickel-chrome resistors and aluminium interconnections on a silicon substrate, all mounted in a transistor-type package of about ½in diameter. The gain at 400 c/s (the amplifier being designed to work in synchro circuits at this frequency) was 60 dB. Another servo amplifier of hybrid construction, this time with an output of 5 W was shown by Solitron.

Digital integrated circuits still dominate the scene, however, in a variety of circuit techniques with different power, speed, loading and noise immunity characteristics—DCTL (direct coupled transistor logic), DTL (diode/transistor logic), RTL (resistor/transistor logic), TTL (transistor/transistor logic) and several others. Apart from the usual gates (mostly NAND/NOR logic) and flip flops, a whole host of more complex functional units was to be seen, including shift registers, code converters, memory sensing amplifiers, counters, and half adders. RCA, having entered the integrated circuit field rather late, came out with a comprehensive range of digital and linear circuits, and these included a family of exceptionally high speed OR/NOR gates with propagation delay times of only 3.6 ns. This company were also showing monolithic ferrite memory modules, using 1-inch square ferrite wafers, each providing the equivalent of 4096 ferrite cores, with associated integrated-circuit diode selection matrices. The type MF2100 module, for example, had a storage capacity of 64 words with 64 bits per word, used 128 diodes and had a switching speed of 35 ns.

Another advanced technique, shown by General Microelectronics, was the use of the m.o.s. insulated-gate field-effect transistor as the basic element in monolithic integrated logic circuits. Because of the high input impedance of the IGFET—the gate draws no input current—a very large number of the elements can be driven from the output of one element, and elements can function as memory cells by virtue of the charge storage effect. The IGFET elements work in the enhancement mode and this is stated to give good noise immunity because a threshold voltage must be exceeded before current will flow through the device. The number of elements per circuit can be 10 to 100 times greater than with epitaxial junction integrated circuits and, in fact, the economic competitiveness of the system depends on having at least 30 NAND/NOR elements per package.

Other items noted.—A whole range of off-the-shelf colour television receiver components and subsystems (OREGA) ● Artificial reverberation introduced mechanically in loudspeaker enclosures by coiled-spring resonant structures driven by rods from the cone, reverberation times being 8-15 sec over passbands between 50 c/s and 16 kc/s (Audax) ● Direct-current motors without brushes and synchro resolvers using the Hall effect (CSF) ● Small variable autotransformers as alternatives to potentiometers in low power circuits (Radiophon) ● Magnetrons for industrial heating (Varian and CSF) and rod-type heating elements heated by electron bombardment of a diode anode (Eimac) ● A water tap for hospitals, laboratories, etc., controlled without touching by a proximity detection device (Hosiden Electronics).

A Graphical Method of Harmonic Analysis

By V. O. STOKES

IT often happens that a quick harmonic analysis is required in circumstances where speed is more important than a high order of accuracy. The following method is a ready means of determining the amplitude and phase relationships in a complex waveform, provided that the levels of the 5th and higher orders are relatively low.

The accuracy obtainable depends upon the plotting accuracy and the relative levels of harmonics and fundamental, with higher harmonic levels giving a greater accuracy. It is possible to obtain values of ± 0.5 dB for harmonics at -20 dB and ± 3 dB for harmonics at -40 dB, from the plotted curves.

Before proceeding with the description, however, it must be mentioned that the method is not new. It was devised by J. Harrison many years ago and has since appeared in several text books, one of which is Castle's "Manual of Practical Mathematics" published as long ago as 1920. A more theoretical explanation of the method was given in *Experimental Wireless* in 1934[1]. Another graphical method was also described in *Wireless World* in 1962[2]. However, a recent sampling (admittedly a small one) taken among younger engineers and students seems to indicate that it has fallen into disuse—indeed, it was quite unknown to them—which is a pity, for it can often save valuable time.

V. O. Stokes, joined the Marconi Company in 1926, at the age of 20, after two years with Western Electric. He spent seven years in the Test Department and in 1935 transferred to research and development. In 1950 he took charge of the group responsible for the design and development of transmitters. In 1963 he became assistant chief transmitter engineer and since last November has been assistant to the chief engineer, telecommunications. He is also editor of the Company's journal Point-to-Point Telecommunications.

Description of the method

Perhaps the simplest way of describing the process of waveform analysis by this method is by practical illustration. Fig 1 is a plot of a complex waveform, the main constituents being fundamental, 2nd harmonic and 3rd harmonic. Points 0 to 11 are marked on the waveform at 30° intervals: 0 at 0°, 1 at 30°, 2 at 60°, etc.

On a separate strip of paper, also shown in Fig. 1, the amplitude of points 0 to 11 are marked with respect to zero level. In practice, the paper strip is moved along in 30° steps, to obtain the best accuracy.

This marked strip is used to plot curves—shown in Fig. 2 and described later—of the constituent components of the waveform, by substracting and adding the amplitudes of the various points in accordance with Table 1.

In Table 1, mathematical expressions representing component parts of a Fourier expansion are given for the three curves. As can be seen from these expressions half the amplitude of curve A gives the peak amplitude of the fundamental 3rd harmonic, ignoring the 5th,

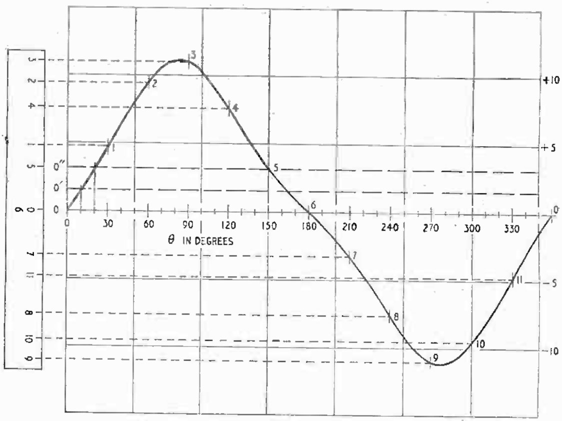


Fig. 1. A complex waveform with second and third harmonic content. The points identified numerically every 30° on the waveform are projected to determine the graduations on the card strip.

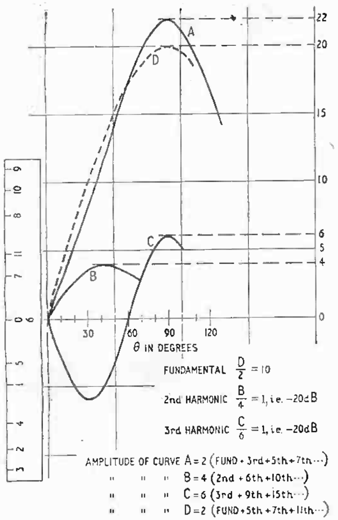


Fig. 2. The constituent components of Fig. 1 waveform plotted from the information given in Table 1. Note: For clarity sub-divisions have not been shown on the graph, but in the scale referred to in the text under the heading Accuracy, one unit would be represented by two small divisions.

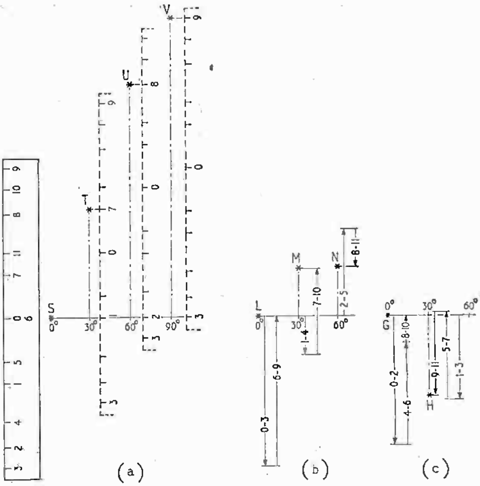


Fig. 3. The positions of the marked up paper strip which give points for curves A, B and C from the information in Table 1.

TABLE 1

θ	A 2(Fund.+3rd+5th)	B 4(2nd+6th+10th)	C 6(3rd+9th+15th)
0°	0— 6	(0—3)+(6—9)	(0—2)+(4—6)+(8—10)
30°	1— 7	(1—4)+(7—10)	(1—3)+(5—7)+(9—11)
60°	2— 8	(2—5)+(8—11)	(2—4)+(6—8)+(10—0)
90°	3— 9	(3—6)+(9—0)	(3—5)+(7—9)+(11—1)
120°	4—10	(4—7)+(10—1)	(4—6)+(8—10)+(0—2)

7th, etc. One quarter of the amplitude of curve B gives the peak amplitude of the 2nd harmonic, ignoring the 6th, 10th, etc. One sixth of the amplitude of curve C gives the peak amplitude of the 3rd harmonic, ignoring the 9th, 15th, etc.

The peak amplitude of the fundamental is obtained by subtracting one third of the amplitude of curve C from curve A, at every 10° point, giving curve D, which is twice the fundamental amplitude.

The relative phase of the three components of the original waveform is obvious from Fig. 2.

Because the peak amplitudes of curves A and C are coincident at 90° in the example, both relative phase and amplitude could be obtained without drawing curve D, but in the general case it is necessary to plot curve D for an accurate assessment.

Plotting the curves

To plot the curves, the strip is reversed and points marked at 30° intervals, as shown in Fig. 3. The method of plotting the points for curves A, B and C is shown in Fig. 3(a), (b) and (c) respectively. Points S, T, U and V are points for curve A, with points L, M and N for curve B, and points G and H for curve C, all at 30° intervals.

Fig. 3 is used to give an explanation of the method of using the inverted strip. The actual curves should be plotted as shown in Fig. 3, in order that the relative phase of harmonics and fundamentals can be determined.

From these points a rough approximation of curve A could be drawn, but they are quite inadequate to draw B and C.

Additional points can be obtained at 30° intervals, starting at 10° and 20°, by using two more paper strips. On these strips, points 0 to 11 are marked, as before, but with reference to new zero lines, 0′ and 0″ (see Fig. 1). Points on the 0′ strip are marked 0 at 10°, 1 at 40°, 2 at 70°, etc., giving points for curves A, B and C when inverted and transferred to Fig. 3, at 10°, 40°, 70°, etc.

Similarly the other strip, 0″, will give points at 20°, 50°, 80°, etc., when marked with reference to level 0″. It is seen that 0′ is the baseline drawn at the level of the complex waveform at 10°, and 0″ is the level at 20°.

Accuracy

For a second harmonic level of −20 dB and the scale used (see Fig. 2 note), the limits of measurement are about ±half of one small division in eight small divisions (curve B), giving an accuracy of approximately ±0.5dB. Also the limit of measurement of about one small division corresponds to a harmonic level of −40 dB (one tenth of curve B or C). At this harmonic level, ±half of one small division represents a tolerance of ±3 dB.

(*Continued on page* 123)

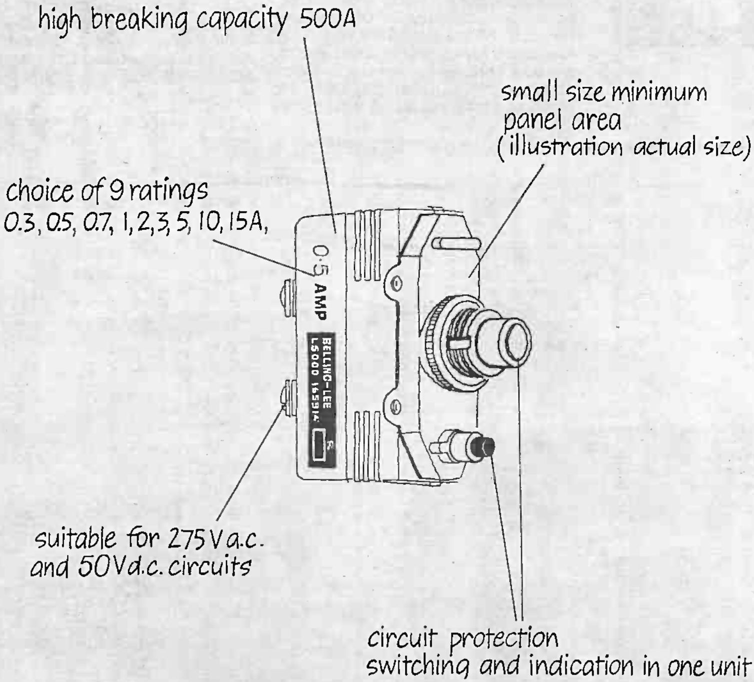

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Table 2 gives the amplitude of curve D at every 10°, showing that in the example the plot of the fundamental does not depart from a sine wave by more than 2 %.

It should be pointed out that these limits of accuracy assume that the plot of the original waveform is in itself correct within fine limits. In practical cases where the method of obtaining the original waveform does not enable the plot to be very accurate, the results will not be within such fine limits. For example, when the waveform is obtained from an oscilloscope, photographically or by tracing, the initial error is of the order of 5 %. Thus the results obtained will be less accurate by this amount, giving total tolerances of approximately ±1 dB for harmonics 20 dB down and ±5 dB for harmonics 40dB down.

Applications

It is obvious that there are many applications for this method of harmonic analysis, particularly in making early assessments, where quick answers are of more immediate importance than extreme accuracy.

One example is the determination of the harmonic content to be expected from valves and transistors under various operating conditions, based on the published characteristics.

Another example is the measurement of the harmonic content in a coaxial feeder at v.h.f., obtained from a plot of the feeder voltage along a slotted line. In an application of this nature several precautions are necessary, but with a relatively high harmonic content and low v.s.w.r., the results obtained can be substantially correct.

TABLE 2

	Level from Fig. 2	Rationalised level	Sin θ
0°	0	0	0
10°	3·5	·175	·1736
20°	6·7	·335	·342
30°	10·0	·5	·5
40°	12·6	·63	·6428
50°	15·0	·75	·766
60°	17·0	·85	·866
70°	18·5	·925	·9397
80°	19·5	·975	·9848
90°	20·0	1·0	1.0.

Acknowledgement

The author wishes to express his thanks to the Director of Engineering, The Marconi Company Ltd., for permission to publish this article.

REFERENCES

1 D. C. Espley and L. I. Farren. "Direct Reading Harmonic Scales." *Experimental Wireless*, April, 1934, p. 183.

2 H. C. Parr. "Harmonic Analysis," *Wireless World*, March, 1962, p. 106.

BOOKS RECEIVED

101 Ways to Use your Audio Test Equipment, by Robert G. Middleton. A book which the home constructor of audio equipment will find interesting. Test equipment used includes an audio oscillator, square wave generator, audio wattmeter, harmonic distortion meter, valve voltmeter and multi-purpose (current-ohm-volt) meter. Initially, nine checks are described for testing the test equipment. The remaining equipment tests are grouped under three main sections—amplifiers, components and systems. Originally published in America in 1959. Pp. 136; Figs. 150. Price 18s. W. Foulsham & Co. Ltd., Yeovil Road, Slough, Bucks.

Pick-ups: The Key to Hi-Fi, by J. Walton. In this book, the author, who has spent many years on research into the design of pickups and whose name is familiar to *W.W.* readers, presents practical advice based on the conclusions drawn from his research. In the introductory chapters definitions of fundamental terms are given, including compliance and tracking weight, stylus mass and distortion and stereo pickup separation. Succeeding detailed chapters cover recording characteristics, requirements from the pickup, pickup arms, practical use of the pickup, and fault diagnosis. Three appendices give details of calculations, record-reproduction correlators, references and further reading. Pp. 100; nearly 40 Figs. Price 10s. Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2.

Musical Instruments and Audio, by G. A. Briggs. A comprehensive, lucidly written and sometimes humorous treatment of audio characteristics, and the acoustic principles of musical instruments. The breadth of coverage is very wide and includes aspects such as directional characteristics, formants, distortion, electronic instruments, harmonic structure and tone generation. Separate chapters are devoted to the piano and to the tuning of different instruments. Where the humorous approach has been made, points in the text are supported by cartoons, some of which are reproduced from Punch. Pp. 240; Figs. 212. Price 32s 6d. Wharfedale Wireless Works Ltd., Idle, Bradford, Yorkshire.

B.B.C. Handbook 1966. Contains facts, figures and general information relating to the organization and services of the B.B.C. These cover the radio and television services including analysis of programme material and audiences. Comprehensive sections are also included on the external services and engineering arrangements; the latter contains maps showing the limits of television service areas and notes on how to get the best reception, local interference, etc. Pp. 259. Price 7s 6d. British Broadcasting Corporation, Broadcasting House, London, W.1.

ITV 1966. The annual publication of the Independent Television Authority which contains a wide variety of information ranging from audience figures, programme popularity, advertising control, staff organization and technical operation. In a separate section covering I.T.A. transmitters, details of location, channel frequencies, and e.r.p., together with maps showing primary, secondary and fringe area coverage of each station, is given. Another section gives details of each of the programme companies. Pp. 224. Price 7s 6d. Independent Television Authority, 70 Brompton Road, London, S.W.3.

OUR NEXT ISSUE

The April issue of *Wireless World*, which will be published on March 21st, will include a survey of communications receiver techniques, together with tabulated information on the receivers available in this country. It will also contain a preview of the Audio Festival and Fair which is to be held at the Hotel Russell, London, W.C.1, from April 14th to 17th.

There will also be the usual quota of technical articles including one on the applications of the variable gain amplifier discussed theoretically in this issue.

WORLD OF WIRELESS

Moon Signals via Jodrell Bank

THE soft-landing of instruments on the moon for the first time by the Russian Luna 9 on February 3rd enabled close-up pictures of the moon's surface to be transmitted to earth. The frequency of the transmitter, 183.6 Mc/s, was made known by the Russians and signals were received by the Manchester University 200 ft radio telescope at Jodrell Bank at 10 dB above noise level. The frequency modulated carrier, when demodulated gave a.f. signals which were recognized to be facsimile transmissions and efforts were then made to locate a suitable photographic receiver. A Mufax machine, similar to normal newspaper photographic receivers, was provided by the *Daily Express*. The receiver required a.m. signals of 1.3 kc/s or 1.9 kc/s (with bandwidths of 1 kc/s or 1.5 kc/s respectively), but the information available took the form of a 1.9 kc/s tone frequency modulated with a deviation of $\pm$400 c/s (the limits representing black and white) and consequently an f.m. to a.m. converter was required—also a Muirhead equipment and supplied by the *Daily Express*. Recordings made prior to the acquisition of the receiver and converter were found to be of no value. Picture transmissions continued, interposed with telemetry information, and eight pictures were received, not all complete, some of which appeared in the British Press before they were shown publicly in the U.S.S.R. The cessation of transmissions a few days later was reported to be due to failure of the supplies-batteries and/or " solar " cells.

The Muirhead photographic receiver (a modified D700) uses light from an intensity-modulated gas-discharge tube focused on to a drum covered with photosensitive paper. The drum is rotated at 60 rev/min (being controlled by a tuning fork standard of 1,020 c/s, amplifier and synchronous hysteresis motor) and the light beam scans the drum helically so that a density of 100 lines/in is obtained. The formation of an 8 in picture would thus take about 14 min. The exposed photographic paper is then required to be developed in the normal manner. The exact form of the scanning equipment aboard Luna 9 is not known, and the " index of co-operation " (drum diameter × scanning density) was not the same, resulting in distorted pictures.

The illustration shows an experimental model of a **video telephone** *developed by the Automatic Electric Company, a subsidiary of General Telephone and Electronics Corporation in the United States. A 16 mm vidicon television camera is used, and voice communication can be made either by a conventional telephone handset or by a microphone installed within the console.*

Results of Servicing Examinations

IN the annual report for the year ended February 28th 1965 of the Radio Trades Examination Board, the results of the four practical examinations conducted by the Board late in 1964 are recorded, and these are shown in the table. 1963 results are given in brackets.

Examination	Entered	Passed	Failed	Absent
Intermediate Radio and Television Servicing	1,704 (2,110)	1,081 (1,450)	565 (601)	58 (59)
Final Radio and Television Servicing	698 (547)	462 (400)	226 (139)	10 (8)
Intermediate Electronic Servicing	218 (151)	154 (89)	61 (51)	3 (11)
Final Electronic Servicing	21 (10)	14 (7)	5 (2)	1 (0)

For three of the examinations the number of candidates has been increasing but for the Intermediate Certificate in Radio and Television Servicing the number has decreased. The Council has been very concerned about this decrease and the Report contains some of the possible reasons to explain the decrease. As pointed out in the Report, entry for the practical examination is dependent on the number of candidates who pass written papers set by several institutes and there has been a drop in the number of students attending approved courses of study. Another factor is the growing popularity and interest in the wider aspects of electronic servicing rather than the limited field of radio and television servicing. In addition, however, it appears that there has been lack of support and encouragement from employers, reflected by their reluctance to release staff for attendance at courses.

Integrated Circuits

THE increasing use of integrated circuits is reflected by recent announcements from two American firms. The Radio Corporation of America is now manufacturing colour television receivers for marketing later this year with silicon chip integrated sound circuits containing up to 26 components. The second announcement was made by Motorola Semiconductor Products, Inc. The Company has started marketing integrated circuits for use by the amateur. Circuit configurations available are a binary bias driver, two types of flip-flop and a 3-input expandable gate.

Audio Fair

TICKETS for the International Audio Festival and Fair, to be held at the Hotel Russell, Russell Square, London, W.C.1, from April 14th to 17th, are now available free. Requests to the Editorial Office of *Wireless World* for tickets, which admit two, should be accompanied by a stamped addressed envelope. They are valid from 4-9 p.m. on the 14th, from 11 a.m.-9 p.m. on the 15th and 16th and from 11 a.m.-8 p.m. on the 17th. A limited number of tickets are available for the trade session from 11 a.m. to 4 p.m. on the opening day but requests for these must be made on business notepaper.

The number of exhibitors at this year's Fair is approximately the same as last year but many of the rooms being used for demonstrations are larger. Most of the 85 exhibitors will have demonstration rooms as well as booths in the main exhibition area. In our next issue we will include a preview of the Show.

Help for the Housebound.—A joint experiment by the G.P.O., the Manchester Corporation Welfare Services Department, the North Western Electricity Board and the Post Office Engineering Union is being conducted in Manchester to investigate the use of the electricity mains wiring for emergency communication between an elderly housebound person and a nearby neighbour. The system used is the Labgear Portaphone, a loudspeaking intercommunications arrangement which utilizes mains wiring for interconnection purposes. Communication is possible over a distance of approximately ¼ mile depending on the complexities of the mains distribution network. Two units, one at each end of the communication path, are connected to any mains points on the same phase and provide simple two-way voice communication controlled by a press-to-talk arrangement. In the experiment, announced by the P.M.G. last December, about 40 housebound people in selected districts on the eastern side of Manchester are to be provided with equipment by the Post Office and installation will be undertaken on a voluntary basis by members of the Post Office Engineering Union.

An international hook-up for **high-speed news transmission** was used recently by Standard Telephones and Cables Ltd. when demonstrating its GH 205 telephone-speed data communication system. The hook-up took place between the *Washington Post*, the Newspaper Society in London and Agence France Press in Paris; the equipment was installed in the Council Room of the Newspaper Society. Using normal telephone speech channels copy was passed at speeds up to 1,250 words per minute—18 times faster than conventional teleprinter speeds. In the system, messages are punched on paper tape as for standard teleprinter or automatic telex transmission. Contact is then established by telephone, the information on the tape is converted into pulses which are transmitted over the telephone line via suitable tone conversion apparatus. At the receiving end, incoming tape is fed into reproducer sets to obtain printed copy which if necessary can be transmitted to local offices over normal teleprinter channels.

Broadcast Receiving Licences.—During the last six months of 1965 the number of combined television and sound licences in the U.K. increased by 157,891 bringing the total to 13,515,894. Sound only licences fell by 88,719 to 2,678,155; this figure includes 658,200 for receivers in cars which represents an increase of 19,588.

Police Use New Facsimile Communication System.—Instead of using the conventional methods of communication between headquarters and divisional offices, Bristol police are now using a facsimile system. By this method the facsimile of any written or printed matter—for example, maps, sketches, identikit pictures—can be transmitted to different centres. Advantages are a much higher speed of transmission of typed material, freedom of errors on the received copy and the fact that the system cannot be tapped. The system has been produced by Muirhead & Company in liaison with the Bristol Constabulary and with the assistance of the General Post Office Advisory Service.

T.E.M.A. Awards.—For the eighth successive year the Telecommunication Engineering and Manufacturing Association has held a competition for the best final-year apprentice of its eight member-firms. Awards of £25 were presented to J. Daniel, B.Sc., graduate-in-training with G.E.C., P. S. Casey, student apprentice (A.T. & E.) and P. G. Howard, technician apprentice (A.T. & E.), at the Association's annual dinner on February 8th.

Computer Presented to College.—A 10-year-old Ferranti Pegasus computer has been presented to the Northampton College of Advanced Technology, London, E.C.1, by the National Research Development Corporation. During its life the computer, which has always been based at the College, has averaged a 12-hour day. The N.R.D.C. paid £45,000 for the computer but they have recovered more than this sum by charging industrial and commercial firms £30 an hour for use of the computer. A great deal of work has also been done for universities on a non-profit basis.

A new American 140-ft radio telescope *can be sighted to within 0.003° and will maintain this accuracy in winds up to 15 m.p.h. The telescope is in use at the U.S. National Radio Astronomy Observatory, Green Bank, West Virginia. Shouldering the weight of the massive yoke and dish are a 210 ton shaft and a 167 ton mirror-finished bearing of 17 ft 6 in diameter. Five months were spent in carefully grinding and polishing the bearing and the resultant accuracy is such that the telescope rotates on a film of oil only 0.005 in thick.*

N.E.R.C.—The first annual report of the National Electronics Research Council, presented by the chairman, Earl Mountbatten, records a proposal to alter the Articles of Association so as to incorporate in its constitution "every organization, large and small, which is interested in the success of the British electronics research effort." This change has been necessitated by the need for increased income.

A new £550 studentship for research purposes is announced by the Department of Electrical Engineering at the University of Newcastle-on-Tyne; normal period of tenure will be two years but with the possibility of renewal for a third year. The studentship has been endowed by Electrosil Ltd., of Pallion, Sunderland, Co. Durham.

A two-day course of lectures on **Component Reliability,** under the leadership of G. W. A. Dummer, of R.R.E., is being held at the Bristol College of Science and Technology, Ashley Down, Bristol 7, on March 8th and 9th. The fee, including meals, is £5.

PERSONALITIES

The forty-fourth award of the I.E.E. Faraday Medal has been made to **J. A. Ratcliffe,** C.B., C.B.E., F.R.S., "in recognition of his extensive researches on the physics of the ionosphere, and of his studies on the propagation of low-frequency radio waves." Mr. Ratcliffe, who graduated at Sydney Sussex College, Cambridge, remained at the University, apart from the war years, until his appointment in 1960 as director of what is now the Radio and Space Research Station at Slough. He is retiring at the end of February. At Cambridge he divided his time between teaching physics and research work on radio propagation. During the war Mr. Ratcliffe was closely concerned with the development of radar at the Telecommunications Research Establishment, where he formed

J. A. Ratcliffe.

the Post-Design Service which was instrumental in converting experimental gear into radar equipment for service in the R.A.F. Mr. Ratcliffe also founded the radar school for the Army at Petersham.

J. R. Brinkley, managing director of Pye Telecommunications Ltd., and **R. M. A. Jones,** managing director of E. K. Cole Ltd. and vice-chairman of the Telephone Manufacturing Company, have been appointed additional deputy managing directors of Pye of Cambridge Ltd., the holding company of the Pye-Ekco group. Mr. Brinkley was in the Home Office Communications Directorate from 1942 until 1948 when he joined Pye and a year later became technical director of Pye Telecommunications. He is a member of the board of the British Space Development Company. Mr. Jones, who was a Lieut. Colonel in Royal Signals during the war, joined Pye in 1936 and has for many years been managing director of Pye TV Manufacturing Co. at Lowestoft.
On the acquisition of Ekco by Pye in 1962 he also became managing director of E. K. Cole Ltd.

R. J. Lees, M.A., B.Sc., director of the Ministry of Aviation Signals Research & Development Establishment at Christchurch, Hants, for the past three years, was recently appointed deputy director (equipment) at the Royal Aircraft Establishment, Farnborough. Mr. Lees, who is 48, joined the Telecommunications Research Establishment, Malvern, in 1939 where he remained until 1959 when he was appointed head of the Instruments and Air Photography Division at R.A.E., Farnborough. While at Malvern he was successively director of scientific research (guided weapons) and head of airborne radar.

Derek D. Arnold has been appointed director of production for the Solartron Electronic Group. He was formerly works manager with Hewlett Packard Ltd., and was for three years manufacturing manager with Tektronix in Guernsey.

Sir Harold Bishop, C.B.E., B.Sc. (Eng.), F.C.G.I., M.I.E.E., director of engineering of the B.B.C. from 1952 until his retirement in 1963, has been elected an honorary member of the I.E.E. "for his contributions to the science and art of sound and television broadcasting and their application both at home and overseas." Sir Harold, who received a knighthood in 1955, started his professional career in the engineering division of the Office of Works. He joined Marconi's in 1922 and was concerned with the setting up and operation of the London 2LO broadcasting station in Marconi House, Strand. In 1923 he transferred to the newly formed British Broadcasting

Sir Harold Bishop.

Company as senior superintendent engineer. Sir Harold is now a consultant to B.I.C.C. and a director of International Research & Development Company of Newcastle-upon-Tyne.

David D. Jones, B.Sc., M.Sc., D.I.C., has been appointed head of the laboratories of Associated Semiconductor

D. D. Jones.

Manufacturers Ltd., in succession to the late Dr. E. G. James. He joined the Hirst Research Centre in 1947. During 1951 and 1952 he was a postgraduate student at Imperial College, London, where he obtained his diploma in electrical engineering. On returning to G.E.C. he helped to build up a semiconductor applications team. Mr. Jones, who is 44, studied at the University College of Wales, Aberystwyth, where he graduated with an honours degree in physics. He obtained his M.Sc. in mathematics by evening study at Chelsea Polytechnic, London. Associated Semiconductor Manufacturers Ltd., is the joint Mullard-G.E.C. company developing and manufacturing Mullard semiconductor devices.

Graham D. Clifford, C.M.G., secretary of the Institution of Electronic & Radio Engineers since 1937, left London on February 8th on a world tour. He will be visiting Israel, India, Singapore, Australia, New Zealand, Fiji, Hawaii, the U.S.A. and Canada with the object of promoting the exchange of information in electronic and radio engineering. Mr. Clifford will be in Canada when Lord Mountbatten speaks in Ottawa on April 14th on the work of the British National Electronics Research Council (of which Mr. Clifford was honorary secretary until last September) and the selective dissemination of information.

J. P. Wykes, O.B.E., A.M.I.E.E., manager of the Maritime Division of the Marconi Company since 1956, retired on January 31st. After 11 years' service as a radio operator with Marconi Marine he worked as a design engineer with the Marconi Company. In 1946 he became assistant engineer-in-chief (test), and was works manager at Chelmsford from 1949 to 1956.

Dr. G. G. Macfarlane, director of the Royal Radar Establishment, Malvern, since 1961, is to receive the honorary degree of LL.D. from the University of Glasgow on its Commemoration Day—June 22nd. Dr. Macfarlane, who graduated at Glasgow in 1937 and then did two years' postgraduate research at Dresden where he obtained his Dr. Ing. degree, was throughout the war at T.R.E. (now R.R.E.) concentrating on mathematical problems in radar and microwave physics. He became head of the mathematical group in 1945 and from 1953 to 1960 was deputy chief scientific officer at R.R.E. He then became deputy director of the National Physical Laborartory but returned to R.R.E. the following year as director.

The 40th anniversary of Baird's first demonstration of television to members of the Royal Institution at his Frith Street, Soho, laboratory, was commemorated recently at a dinner attended by members and guests of the Television Society. In the photograph, taken in the building in which the original demonstration was staged, W. C. Fox (left) The Times correspondent who attended the demonstration, is describing the occasion to members and guests. On the right is W. Taynton, the first man to be televised by Baird in 1926.

E. J. Jordan, Assoc.I.E.R.E., recently joined Audio & Design Ltd., of Maidenhead, as a director. He will be responsible for the development and design of specialized professional and domestic loudspeakers. After spending six years in the service department of the G.E.C. he was for twelve years with Goodmans Industries where from 1959 to 1964 he was senior engineer.

E. J. Jordan

Since 1964 until his new appointment Mr. Jordan has been technical director of Jordan-Watts Ltd., of Hayes, Middx., where he produced the first "modular" loudspeaker.

A. C. Robb, M.Eng., Ph.D., M.I.E.E., has joined Counting Instruments Ltd., of Boreham Wood, Herts, as chief engineer. Dr. Robb, who graduated at Liverpool University where he obtained a master's degree for postgraduate work, had been with Belling & Lee since 1961, first as technical manager and, since 1962, as technical director. Prior to joining Belling & Lee he spent some time at Glasgow University as a research fellow working on the design of high-voltage particle accelerators where he gained his doctorate for related studies. In 1963 Dr. Robb contributed an article to *Wireless World* on the problems associated with u.h.f. television reception.

W. I. Flack, Assoc. I.E.E., a member of the panel whose discussion on integrated circuits we published in our January issue, has been appointed technical director of G.E.C. (Domestic Equipment) Ltd. Mr. Flack is also a member of the management team of Radio & Allied Industries, the radio and television receiver manufacturing company in the G.E.C. Group. He joined R.A.I. in 1957 after spending 14 years with the Telegraph Condenser Company.

Roy F. Stevens, the new president of the Radio Society of Great Britain, which has a membership of some 13,500, is not in radio professionally but has been a licensed amateur transmitter (G2BVN) since 1937. Throughout the war he was in the R.A.F. His special interest in amateur transmitting is s.s.b. operation in the h.f. band. The Society's executive vice-president is **F. K. Parker** (G3FUR) who last year formed Park Air Electronics, of Stamford, Lincolnshire, who market electronic aids for aircraft.

R. F. Stevens

B. R. Coles, B.Sc., D.Phil., reader in physics at Imperial College, London, has been appointed to the chair of solid state physics at the College.

J. B. Race, A.M.I.E.E., has been appointed general manager of the Cambridge Instrument Company's factory at Chesterton Road, Cambridge. He was formerly works director of E.N.V. Engineering Ltd. During the war he served in the Fleet Air Arm, leaving with the rank of Lieutenant Commander.

OBITUARY

Edred Jeffrey, A.M.I.E.E., who will be known to many readers of *Wireless World* as contributor of the articles on a high-gain phase splitter in 1947 and a low-cost stereo amplifier in 1961, died on January 5th at the age of 49. Mr. Jeffrey had been with the Sperry Gyroscope Company since 1956 prior to which he was for a short time technical executive to Modern Telephones Ltd. At Sperry's he was successively manager engineering services and product group manager guided weapons. In this latter capacity he was responsible for all the missile activities in the company.

Gordon Scott Whale, who died on board R.M.S. *Andes* on January 9th, founded the North Wales Wireless College in Colwyn Bay, of which his son Neville is now principal. Mr. Whale, who was 72, was an operator with the Marconi Company at their stations in Clifden, Ireland and Caernarvon, N. Wales, until 1918 when he opened the Colwyn Bay college. He also opened (in 1937) the Wireless College, Southampton, which was closed in 1940 due to enemy hostilities.

James Norman Walker, technical sales engineer with Eddystone Radio since 1946, died on January 30th, aged 60. "Jerry" Walker, as he was affectionately known, was an active radio amateur with the call G5JU. He was commissioned in the technical branch of the R.A.F. in 1940 and was involved in the development and operation of "Oboe."

NEWS FROM INDUSTRY

ELECTRONIC TELEPHONE EXCHANGES

RECENTLY at the annual dinner of the Telecommunications Engineering and Manufacturing Association, the Postmaster General stated that approximately £350M is to be spent during the next four years on telephone exchange equipment. In addition, he has decided that in future all new small and medium sized telephone exchanges will be electronic.

Several British companies—Associated Electrical Industries, the Plessey group (including Automatic Telephone and Electric Company and Ericsson Telephones) and Standard Telephone and Cables—have collaborated with the G.P.O., under the auspices of the Joint Electronic Research Committee, on the development of electronic exchange systems. These systems, REX (from A.E.I.) and PENTEX (from Ericsson) use only one electromechanical component. This is a reed switch comprising two blades of magnetic material sealed in a glass envelope and actuated by an external magnetic field.

Advantages of electronic exchanges are the high speed of operation, high reliability and low servicing charges, and saving of space.

The basis of an electronic exchange as in, for example, the REX system, is the control equipment which consists of three main sections. These are:—scanners and registers which determine the source and destination of a call; markers and interrogators which decide switching and speech paths; and common control which co-ordinates the activities of the scanners, registers, markers and interrogators in accordance with stored programme instructions to ensure that a call is routed by using the available switching equipment as efficiently as possible.

SWISS DEFENCE CONTRACTS

THE Swiss Government have signed a multi-million dollar contract with the Hughes Aircraft Company, of California, for an air defence system coded Florida. The value of this order is believed to be about £15M.

The system will comprise a network of military radar stations and a number of air defence centres which will be used to control Switzerland's surface-to-air missiles and interceptor aircraft. The majority of the equipment will be made by Hughes and will include the company's new long-range, three-dimensional radars. These will provide simultaneous range, height and bearing data, even under heavy pressure from counter-measure apparatus. The computing will be on Hughes H-3324 general-purpose computers.

Ferranti Ltd. are manufacturing the data link equipment, believed to be worth about £0.5M, for this project.

The Plessey Company have also received a Swiss defence contract. This contract, which is understood to be worth over £1M, is for a comprehensive u.h.f. ground-to-air communications system for use by the Swiss Air Force. Similar equipment to that called for in the contract is being used in the armed forces of the U.K., the Commonwealth and many other countries throughout the world.

Microelectronics Firms Join Forces.—Two major microelectronics companies in Britain—Marconi Company and Ferranti—have signed a licensing agreement under which Marconi's will manufacture and sell the advanced range of silicon microcircuits designed and sold by Ferranti under the name of Micronor II. Extensive production plant for Micronor II is being commissioned by Marconi's microelectronics division at Witham, and by Ferranti at their Manchester headquarters. Micronor II is a new range of ultra fast silicon integrated circuits designed for use in computer and other logic applications. Many different circuits are available including multiple gates, power stages, J-K flip-flops, etc. The full range is already in quantity production in Manchester. The two companies now manufacture more than 70 per cent of the silicon integrated circuits made in the United Kingdom and the new agreement should further strengthen their position in the U.K. and also aid them in overseas markets. Marconi's microelectronics division will continue to develop and manufacture microelectronic components and units. Up to now, their range has been rather specialized, mainly producing units for their Myriad and (E.E.L.M.) System 4 computers.

G.E.C. Win $3.5M Contract.—G.E.C. (Telecommunications) Ltd., of Coventry, have received a contract worth over £1M for a complete semiconductor microwave telecommunication system for the northern zone of Chile. It will link Santiago—the capital—and Arica, a distance of 1,120 miles, and will provide up to 960 two-way telephone circuits. Twenty-seven repeaters are used in the system and spur links are to be provided to 21 towns en route. This order is the ninth that G.E.C. have received for its new range of semiconductor microwave radio equipment, which was introduced only a few months ago. The first of these nine orders is scheduled to be completed this year and the Chile order in 1968.

Satellite-tracking Aerial Contract.—The British Aircraft Corporation have received a contract from the SHAPE Technical Centre for a 30-ft diameter satellite-tracking aerial, with a Cassegrain sub-reflector. The parabolic dish is to be constructed out of stretch-formed light-alloy sheet. This method of construction has resulted from the company's experience in the aircraft field. Profile accuracy using this method of construction is maintained to within 0.1in. The aerial is to be delivered in May of this year to the Technical Centre in The Hague.

Rediffusion are to provide a wired television and sound network to all Corporation owned homes of the Welwyn Garden City and Hatfield Development Corporation. The network will be installed and maintained as a Rediffusion Community Service and, to quote the company, "Maintenance will, of course, be by locally based technicians up to the full standard of a public service." Four television and four sound programmes will be supplied initially with room for more at a later date. Rediffusion are to install the system at their own cost and the Corporation will pay an annual premium for this service.

£100,000 Bulgarian Order.—Standard Telephones and Cables Ltd. have received a contract worth more than £100,000 from the People's Republic of Bulgaria for ground and air navigational and communications equipment. S.T.C., who are the prime contractors for this contract, will supply v.h.f. omni-directional ranging beacons (V.O.R.), v.h.f. direction finders and v.h.f. transmitters and receivers.

Amalgamated Wireless (Australasia) Ltd., of Sydney, have appointed Livingston Laboratories Ltd., of Greycaines Estate, Bushey Mill Lane, North Watford, Herts, as sole U.K. representatives for their range of telecommunication test equipment.

Radiotelevisione Italiana, the Italian broadcasting organization, have placed an order for 150 image orthicon camera tubes with the English Electric Valve Company, of Chelmsford. This follows an earlier order for 250 E.E.V. image orthicon tubes.

Microcircuits.—Electrosil Ltd., of Pallion, Sunderland, are to start manufacturing integrated circuits later this year. They are also to market automatic integrated circuit testers.

RC ACTIVE FILTERS

—OR THE DEATH OF THE INDUCTOR?

THE interest created in the last decade or so in *RC* active filters, i.e. filters using combinations of *R*, *C* and active elements, is understandable in view of the scorn now placed upon the inductor. This has arisen partly because the inductors required for low-frequency selective filters are undesirably large. In addition, the constraints placed upon components in the field of microelectronics have left us with no alternative but to search for methods of simulating either the inductor or tuned circuits. (Inductors have been used in thin-film circuits, but there is a serious limitation in that the *Q* of inductors decreases as the square of the scaling factor.) Although it would be premature to forecast the fate of the inductor, it would seem that the decline has set in and for low frequencies, at least, *RC* filters can be made which are as good as *LC* circuits.

The recent I.E.E. colloquium on this subject was mainly concerned with low frequencies, but some of the techniques discussed can be extended to higher frequencies. The subtitle is perhaps a little unfair because whilst *RC* active filters are ousting the inductor at low frequencies, it would appear that for high-frequency work passive acoustic or mechanical resonators hold more promise than active filters.

Sensitivity and Q

It was pointed out by R. C. Foss (Plessey) that some configurations of active filter were no more complex than some present-day integrated circuits which are available quite cheaply in the U.S.A. There were problems, of course, and in a common type of active filter (using high gain amplifiers) the sensitivity (of *Q*, mainly) to component variations and tolerances was a major headache, particularly for integrated circuits. However, the situation was somewhat eased by the fact that resistor ratios can be maintained fairly accurately—to better than 1%—and gain was a commodity relatively easy to come by. Gain is important, of course, because the *Q* of an *RC* active filter is proportional to the square root of gain. For example, for a *Q* of 100 with a stability of 5%, the required gain is over 100 dB. A relation connecting these quantities has been derived by McVey[1] and is $Q_{max} = \sqrt{A\delta}$ where Q_{max} represents the maximum *Q* (quality factor) resulting from an amplifier gain of *A*, and δ is the maximum permissible departure of *Q* from its required value ($\triangle Q_{max}/Q$). (For some applications Dr. Foss felt that this relation was more appropriate than that giving the limiting value of $Q_{max} = \frac{1}{2}\sqrt{A}$ since a circuit operating with this would be unduly sensitive to variation in the unstabilized loop gain.)

Broadly speaking two general approaches to the synthesis of *RC* active filters to give desired transfer functions have been recognized since the early 1950's. One uses *R* and *C* elements, with amplifiers (of very high gain) as the active elements, and the other uses negative impedance converters (n.i.cs) as the active elements to provide simulated inductance. A third, less common, approach is referred to later.

R. J. A. Paul (University College of North Wales) outlined a new synthesis technique using amplifiers with voltage gains of 2 (and also −1 in some cases) and one-port or two-terminal *RC* networks. This is described in detail in a recent paper[2]. The method also permits the realization of transfer functions with adjustable coefficients.

A. G. J. Holt and J. I. Sewell (University of Newcastle-upon-Tyne) described a method employing multiple-loop feedback and a single operational amplifier, based upon what is known as node introduction in a 2×2 admittance matrix—a procedure which involves a substantial amount of matrix algebra. Two approaches for obtaining circuits to represent both voltage and current-inversion n.i.cs using high-gain amplifiers were outlined by A. G. J. Holt and J. Carey. Dr. Holt pointed out that while designs for active filters using high-gain operational amplifiers were made stable with a well-defined gain by feedback, n.i.cs not using such high-gain amplifiers tend to be somewhat dependent on transistor characteristics.

R.R.E. approach

The Royal Radar Establishment was represented in force—four out of the ten papers read were from Malvern—by P. J. Baxandall, F. E. J. Girling, E. F. Good and R. L. Ford. Mr. Baxandall discussed generally various active filters developed at R.R.E. including symmetrical twin-T feedback types (the normal twin-T network is not exactly symmetrical but is made so by addition of two series *RC* chains), integrator-plus-lag and two-integrator types. He stressed the advantages in avoiding mathematical complexity as much as possible and maintained that comparatively simple, and perhaps more familiar,

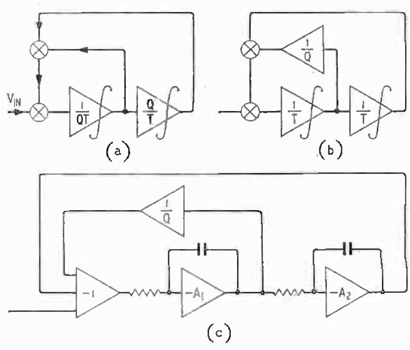

Fig. 1. A two-integrator type of active RC filter, requiring only two reactances.

techniques could be used to obtain the same results as with some of the more sophisticated methods.

A series *LCR* circuit may be simulated by providing three voltages with the same phase relationship as the voltages across the *L*, *C* and *R* elements. Girling showed how two integrators plus feedback could be arranged to give these voltages with respect to a common earth. The ratio V_R/V_L was equal to R/pL, in operator notation, hence V_R could be obtained from V_L by integration. Similarly V_C could be obtained from V_R by integration. V_L was clearly required and was derived by feedback from $V_L = V_{in} - (V_R + V_C)$. This system could be interpreted as shown in Fig. 1(a), but since it was not easy to adjust two integrators separately the arrangement of Fig. 1(b) was adopted. (To achieve the correct signs four amplifiers would be required.) Such a system might appear as Fig. 1(c), requiring only two reactances. A simple modification was described by which corrections could be made for the integrating amplifier gains. With this approach any second-order transfer function could be provided, and such units could be used to produce factors of higher-order functions. Mr. Girling stated that high *Q* values and good stability could be so obtained and also both frequency and *Q* could be independently varied.

Good described a general second-order active filter based on a single amplifier and the balanced twin-T network plus an additional *RC* branch. The circuit makes an economical building block for higher-order filters and can provide low-pass, tuned circuit, high-pass or notch response. Even though this type of active filter

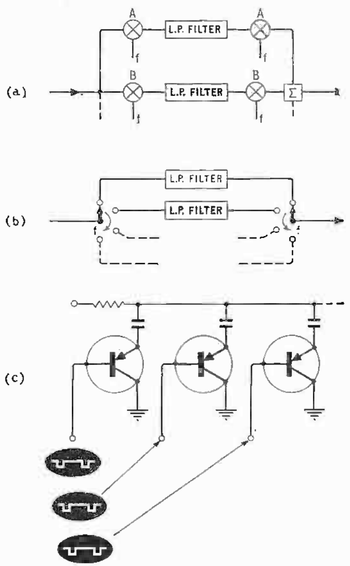

Fig. 2. The basis of the n-path, digital or sampled data type of active filter.

Fig. 3. The low-pass function is translated in n-path filters to a band-pass function centred about frequency f.

is more sensitive to component variations it is well suited to some applications.

A form of active filter was outlined by Ford in which integrators replaced the reactive elements used in passive *LC* ladder networks. One advantage of this technique is the ease with which bandwidth and centre frequency can be made continuously variable by a voltage-controlled switching technique.

N-path filters

The third type of active filter referred to earlier is the *n*-path filter, which is also known as a digital filter or sampled-data filter. The essential difference between this type and preceding types is that operation is dependent on non-linear active elements rather than the usual linear elements. The *n*-path filter falls in the general category of time-varying circuits. Basic work in this field was done in the 1940's and interest was stimulated again in 1960[3] mainly because this method allows sensitivity and high-*Q* problems to be overcome.

A. R. Owens (University College of North Wales) and R. K. P. Galpin (A.E.I.), gave separate papers describing such filters. Basically, a low-pass filter function is arranged using passive elements only. *N* identical low-pass filters are arranged in parallel, each operating between input and output modulators.

The general case is shown in Fig. 2(a), where the modulators (multipliers) A, B, . . . are supplied with suitably phased sine-waves of frequency *f*. (A particular case was referred to in which only two paths are required, the functions supplied to A and B being in phase quadrature.) The property of interest is that a band-pass transfer function is obtained which is a translated version of the low-pass characteristic and centred about the frequency *f* (Fig. 3).

A particular system of interest was described in which the modulating functions were achieved by the use of a synchronous switch, operating at the frequency *f*, as shown in Fig. 2(b). Fig. 2(c) shows partly how this may be accomplished. Tuning of such a filter was by simply varying the frequency *f*. By the use of such techniques *Q*'s in the order of thousands can be obtained and centre frequencies of hundreds of kc/s are quite feasible.

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2. "Active networks synthesis using one-port *RC* networks", R. J. A. Paul, *Proc.I.E.E.*, January 1966.
3. "An alternative approach to the realization of network transfer functions: the *n*-path filter", L. E. Franks and I. W. Sandberg, *B.S.T.J.*, September 1960.

European Station Chart

UNFOLDED copies of the chart showing the operating frequencies of Europe's long-wave and medium-wave broadcasting stations which was included in last month's issue, are obtainable from our Publishing Dept. price 2s including postage and packing.

Low-impedance Tape Pre-amplifier

By R. HIRST

THE output from a tape head is more often than not treated as a voltage output to be fed into a substantially high impedance. If the output voltage is monitored when replaying from a standard reference tape, at a speed of 3¾ in/sec with a constant current recording, we arrive at the shape of Fig. 1. This is a curve familiar to most engineers. Normally the pre-amplifier would be of high impedance, the compensation taking the form of a low-frequency boost "mirroring" the curve of Fig. 1. The use of a high impedance presents a difficulty in maintaining good signal-to-noise ratio and is also conducive to hum pick-up. As transistors are basically low-impedance, current-operated devices, they appear at first sight an incompatible match to replay head characteristics, as normally presented, i.e., as an open-circuit e.m.f.

Advantage may, however, be taken of the change in reactance with frequency characteristic below 1 kc/s. If the magnetic flux in the toroid is constant and a low enough resistance R is placed in series with L (Fig. 2a) the current through R will remain relatively constant. This in itself is not quite so, as the d.c. resistance (r) of the coil L (Fig. 2b) determines that the low-frequency current response is down by 3 dB when $R + r = X_L$.

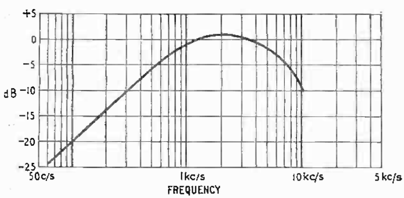


Fig. 1. Playback characteristic from 140 μs ref. tape at 3¾ in/sec.

Replacing R by a transistor in the common-base configuration is the basis of the circuit, shown in Fig. 3. (The input impedance is equal to $30/I_e + r_{bb}'$, where I_e is in mA, for a post alloy-diffused device).

Input stage

In the circuit shown in Fig. 3, post alloy-diffused transistors (NKT 677) were used for the following reasons:—

(a) high frequency cut-off
(b) low noise
(c) low leakage (typically 1μA)
(e) low r_{bb}'

An I_e of 3 mA had been chosen for low-noise operation. Under this condition, the input resistance is about 100 Ω. In order to reduce the impedance further, it would have been necessary to increase I_e, thus detracting from the low-noise operating point.

Robert Hirst, who recently joined Dictaphone Ltd. where he is working with the research and development team on closed-circuit systems, was previously a senior engineer with Newmarket Transistors Ltd. He is 31.

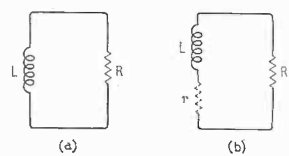
This low I_e is also advantageous in allowing a large collector load (22 kΩ) to be used, so that the voltage gain of Tr1 is substantial:—

$$\frac{R_L}{R_{in}} = \frac{22 \times 10^3}{10^2} = 220 \text{ approximately.}$$

Should this be fed into a conventional grounded-emitter stage with an input impedance of 1 kΩ then R_L would be modified to 950 Ω and the voltage gain modified to 950/100 = 9.5 times.

Second stage

In order to make use of the voltage gain of Tr1, a grounded-emitter stage was used with an un-bypassed R_e.



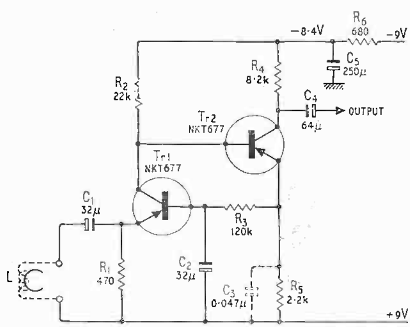


Fig. 3. Circuit of the tape pre-amplifier.

A reasonably high-beta transistor (about 100) was used so that the load presented to Tr1 is around 220 kΩ ($\beta \cdot R_e$) the shunt effect of R3 in series with C2, across R5, being negligible. This value of input resistance was sufficiently high to prevent any appreciable loading of Tr1 collector load.

The voltage gain of Tr2 would normally have been about 100, but this is modified by the unbypassed emitter resistor to approximately—:

$$\frac{R_L}{R_e} = \frac{8.2 \times 10^3}{2.2 \times 10^3} = 3.7.$$

In order to check the frequency response of the pre-amplifier (less C3) a 1 H tape head in series with the input was fed from a 10 Ω source, the generator voltage being constant at 10 mV. (The response is shown in Fig. 4.)

As the C.C.I.R. play-back curve at 3¾ in/sec indicates an RC time constant of 140 μs (Fig. 4) a further C was connected across R5 (C3, dotted in Fig. 3), so that the amplifier turnover point was approximately 1.5 kc/s, this being the point where the actual frequency response was 3 dB below the required response (see Fig. 4). The value of C3 was then calculated so that the amplifier gain was increased by 3 dB at 1.5 kc/s, this being when $X_{C3} = R_e$. Since $f_o = 1.5$ kc/s and $X_{C3} = R_e = 2.2$ kΩ, then:—

$$C(\mu F) = \frac{10^6}{2\pi f_o X_C} \approx 0.047$$

This produced the final curve of Fig. 5 curve B. (The peculiar small rise in frequency at 8 kc/s and then the resultant gradual fall as the frequency increased was due to the loading of Tr1 collector load, as the reactance of C3 in parallel with R5 modified the input impedance of Tr2. At 15 kc/s, $X_{C3} = 212\ \Omega$, and

$$R_{in} = \frac{\beta \cdot X_{C3} R_e}{\sqrt{X^2_{C3} + R_e^2}} \approx \beta \cdot X_{c3} \approx 20\ \text{k}\Omega.)$$

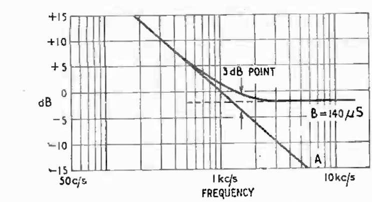


Fig. 4. Curve A shows response of pre-amplifier without C3. B shows the required output with time-constant of 140 μs.

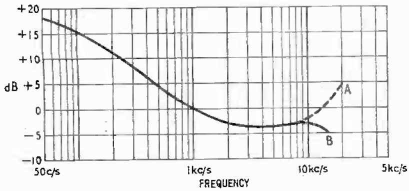


Fig. 5. Response of pre-amplifier including C3 from 10 Ω source in series with 1H tape head.

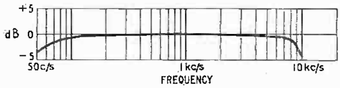


Fig. 6. Response of pre-amplifier to 3¾ in/sec 140 μs ref. tape.

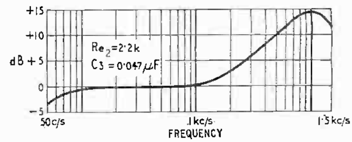


Fig. 7. Response of pre-amplifier when measured from a constant voltage source.

Without this loading of Tr1 collector, the treble response curve would have continued rising (Fig. 5, curve A). However, the decrease of R_{in} at high frequencies helps to reduce high-frequency recording bias pick-up when the pre-amplifier was used in a three-head system and also when used as a low-impedance microphone pre-amplifier on record.

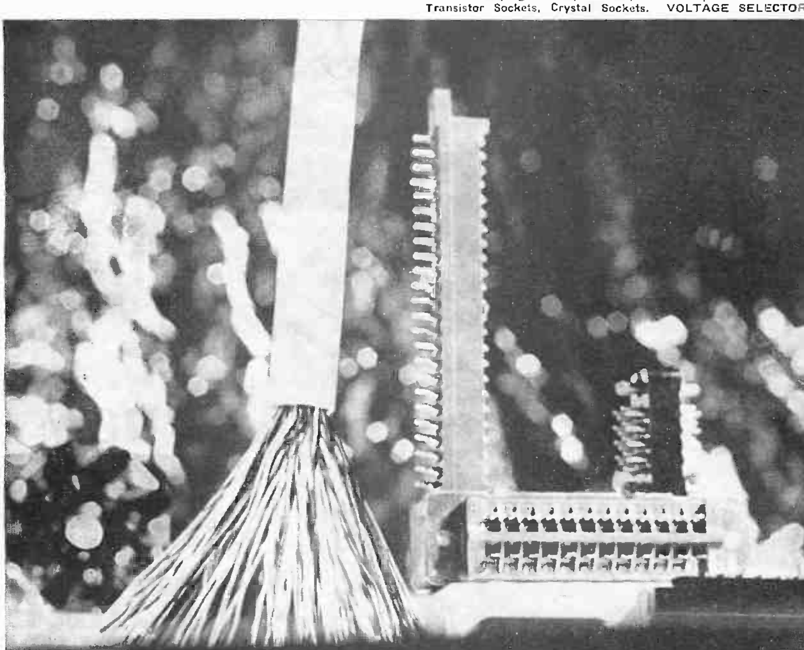
D.C. conditions

The d.c. conditions are relatively standard but careful thought had to be given to the design, so that the following conditions were met.

(a) V_{CE} of Tr1 approximately 1V, for low noise considerations.
(b) I_C of Tr1 to be small for low noise; also to accommodate a large collector load to implement high voltage gain.
(c) Collector load and emitter resistor of Tr2 to be a favourable ratio for gain considerations.
(d) R_e of Tr2 to be large enough to:—
 (i) effect high input impedance.
 (ii) provide a direct voltage for feedback purposes.
 (iii) be complementary with C to provide adequate treble lift.
(e) R3 to be large enough to obviate loading of R5 and yet sufficient to compensate for temperature variation.

As a result of this the pre-amplifier will accept transistors with a beta between 80 and 180 without any modifications. As this range was thought to be substantial no further measurements were made to accommodate lower betas, although a 220 kΩ potentiometer in place of R3 and setting Tr2 collector to 4.5V would ensure that almost any transistor may be used in Tr1 position, even down to a beta of 15.

The curves shown in Figs. 5 and 6 did not measurably alter in the temperature range 15°C–45°C. Fig. 7 shows the response of the pre-amplifier when fed from a constant voltage source (e.g. low-impedance microphone) this could quite well be compatible with the treble-lift response required in the record position of a tape recorder operating at 3¾ in/sec, thus possibly obviating a necessity for compensation switching when used as a replay or record pre-amplifier.



3—Random Events and Variability

By D. A. BELL,* M.A., B.Sc., Ph.D., M.I.E.E., F.Inst.P.

Question: *"What is the similarity between the number of Prussian soldiers kicked to death by horses in the years from* 1875 *to* 1894 *and the shot noise in a thermionic valve?"*

Answer: *"Both phenomena can be described by Poisson distributions."*

THE Poisson distribution is often described as the distribution applicable to "rare events," but the two examples given above indicate dramatically that the word "rare" is meaningless unless a time scale is attached. An event is rare in the Poisson sense if two conditions are satisfied. Firstly, it must be possible to choose elementary intervals of time such that the probability of more than one event occurring in such an interval is negligibly small. This is what is meant by "rare events," but the appropriate elementary interval of time might be a day for the Prussian soldiers and 10^{-24} second for the thermionic valve. Secondly, the (small) probability of an event must be the same for all equal intervals of time. These conditions can be expressed by saying that the events occur individually and randomly: *individually* because we have ruled out the possibility of more than one occurring simultaneously; and *randomly* because the probability of an event is the same for all intervals of time.

Deriving the Poisson formula

The formula for the Poisson distribution can be derived as follows: there are two ways in which exactly n events can have happened in total time $t+dt$: either n had already happened at time t and none has happened in dt, or $n-1$ had happened up to t and one in dt. If the probability of an event is a per unit time (and therefore the probability of no event is $1-a$) and $P(n,t)$ stands for the probability of exactly n events in time t, then

$$P(n,t+dt)=(1-a)dt\,.\,P(n,t)+\alpha dt\,.\,P(n-1,t) \quad \ldots\ldots (1)$$

This can be treated as a differential equation in time:

$$\frac{d}{dt}P(n,t)=\lim_{dt\to 0}\frac{P(n,t+dt)-P(n,t)}{dt}$$
$$=-aP(n,t)+aP(n-1,t) \quad \ldots\ldots (2)$$

The relationship (2) is satisfied if the probability of exactly n events after lapse of time t is given by

$$P(n,t)=e^{-\alpha t}\,(at)^n/n!$$

or more generally, the probability of exactly r events when the average number would be m is given by

$$P(r)=e^{-m}m^r/r! \quad \ldots\ldots (3)$$

Note that time is not necessarily the variable involved, and the Poisson distribution is also important in inspection by sampling. Suppose the average defect rate in a certain component is 8 per 1,000, then what are the chances of finding 0, 1 or 2 defective specimens in a box containing a gross? The average risk per component is 8/1,000, so the average or "expected" number of defective components per box of 144 is $144\times 8/1{,}000=1{\cdot}152$; and this is the value to be given to m in formula (3). Putting $r=0$, 1 and 2 in turn, and remembering that $r^0=1$ and $0!=1$, the values of the probabilities are found to be: $P(0)=0{\cdot}316$; $P(1)=0{\cdot}364$; $P(2)=0{\cdot}210$. Since these three probabilities add up to 0·890, subtraction from unity shows that the probability of finding more than two defective components in a gross, i.e. $\sum_{r=3}^{144}P(r)$, is 0·11. Tables are available† of the terms in the Poisson distribution (3) for various values of m and r and of the "summed Poisson distribution," $\sum_{r=x}^{\infty}P(r)$, for various values of m and x. Fig. 1 shows the Poisson distributions for $m=0{\cdot}1$, 1 and 10. The Poisson distribution for $m=10$ has been re-drawn to a larger scale in Fig. 2, and a corresponding Gaussian distribution superimposed on it. The two distributions are fairly similar, and in the limit as m becomes large the Poisson becomes identical with a Gaussian distribution. Remembering that the condition for Poisson to be applicable is not that events should be infrequent but rather that they should occur individually at random, there is no reason why m should not be large: returning to the example of thermionic emission, a current of 1·6mA corresponds to an average of 10^7 electrons per nanosecond, so m in this case is likely to be large for any practicable time interval.

In Fig. 2 we said that "a corresponding Gaussian was superimposed on the Poisson": how, then, do we pick

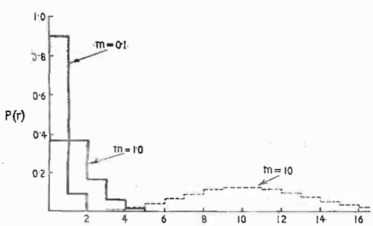


Fig. 1. Full lines. Poisson distributions for m = 0·1 and m = 1; dotted line for m = 10.

*University of Hull.

†In both Fry and Burington and May as listed in the bibliography last month. More extensive tables are given by E. C. Molina in "Poissons exponential binomial limit," Van Nostrand, 1942.

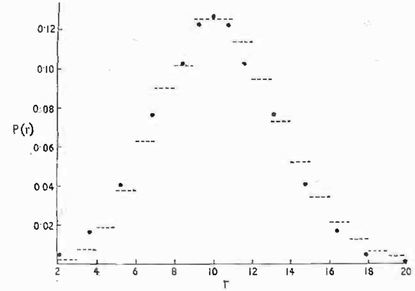


Fig. 2. Comparison of Poisson and Gaussian distributions. Dotted steps: Poisson with $m = 10$; points: Gaussian with $x = 10$ and $\sigma = \sqrt{10}$.

the parameters of the Gaussian to correspond with the Poisson? The characteristics of a probability distribution can be summed up by its position along the axis, its spread, and its shape, the first two being definable by a single number each while the shape is more complex.

At this point it is desirable to recapitulate the meaning and purpose of a "probability distribution." Suppose we measure accurately the resistances of a large number of carbon composition resistors of nominally 1kΩ resistance, and for the sake of illustration let us make the rather doubtful assumption that the values will be spread at random round the nominal according to the "normal law of errors," i.e. a Gaussian distribution. If we measure on a bridge using a decade resistance box, the values will not be spread continuously in the mathematical sense, but will be grouped in "classes" of extent corresponding to the smallest step on the decade box. But even if the decade box goes down to steps of 0·1Ω we may decide to use steps of 10Ω as our classes, both because differences of less than 1% are of little significance in this class of resistor and because one needs as many as possible in each class to get a smooth distribution ("to minimize the fluctuations due to sampling" is the formal statement); and in order to obtain a sufficient number in each class without making an excessive number of measurements in total, one must restrict the number of classes.

Probabilities of classes

The values will occur in random sequence, but hopefully when we count them up by class at the end there will be most in the classes 990 to 999 and 1,000 to 1,009, with decreasing numbers in the outer classes and only the odd one or two below 800 or above 1,199. (Note that the classes run from . . 10 to . . 09 so that they are mutually exclusive and there is no doubt about placing the . . 10 value in its proper class if measurements are taken to a higher accuracy. To make the distribution exactly symmetrical about 1,000 one would have to have a central group of 995.00 to 1,004.99 but this would not arise naturally from a Wheatstone bridge with decade adjustments). If the number in each class is divided by the total number, this gives the fraction in a particular class or the probability of that class. A histogram displaying the probabilities of the classes corresponding to successive values of the variable therefore represents a probability distribution; and if the variable is continuous it is possible by reducing the range of a class—narrowing the columns in the histogram—to approach in the limit a continuous probability distribution curve.

The obvious means of identifying the position of the distribution along the variable axis (resistance) is to take the value of the class which occurs most frequently, and this value is known as the *mode*. This is easy, since no further data-processing is required after counting the number in each class; but it is inefficient since it discards all data falling outside the one class having the highest frequency. In practice one may arrive at a situation like that shown in Fig. 3(a). With modest numbers the class frequencies do not fall exactly on a smooth curve, and one would like to interpolate the curve shown dotted, but the mode automatically selects the one largest peak. Even if the curve is smooth it may be skew (asymmetric) as shown in Fig. 3(b), and the mode is then towards one side of the distribution.

The simplest measure of position using all the data is the mean, and for symmetrical curves the mean and mode coincide. But for skew curves they signify different things: the mode is the position of the peak but the mean indicates the position of the centre of gravity. A third measure of position is the *median*. This is the value of the variable such that equal numbers of objects have values greater and less than the median. The median is particularly useful when the members of the population are considered in ranking order: e.g. in a class list the student in the middle has the median mark, but this need not be equal to the average mark.

Mean values

If we have a collection of objects having various values of x, we find the mean value of x for this collection by multiplying each value of x by the number of objects having that value, adding together all such products, and dividing by the total number of objects. But in a probability distribution function the individual numbers have already been divided by the total number, so as to give the fraction of the population having any specified value of x. Therefore the mean value of x is $\bar{x} = \Sigma xP(x)$ for discontinuous distributions like the binomial or Poisson, or $\int xP(x)dx$ for continuous distributions like the Gaussian. If $P(x)$ is likened to a set of weights or forces distributed at various distances from the origin, then the mean is also *the first moment about the origin* of the system.

Of the various possible measures of spread or dispersion, the variance (and its square root, the standard deviation) is by far the most generally used. It follows from the definition of the mean that the average distance of all members of the population from the mean is zero; but the mean-square distance is always a positive quantity, which is called the *variance* and denoted by σ^2, and the r.m.s. value σ is called the *standard deviation*. In the Gaussian or normal-law-of-errors distribution, 68.26% of the area under the curve lies between limits $\pm\sigma$ about the mean; so these limits are rather wider than the so-called "probable error" which refers to points at $\pm 0{\cdot}6745\sigma$ such that half the area under the curve is between these points.

A good deal of labour is involved in computing the variance, and for a rapid estimate of dispersion one might look at the *range* of a sample, i.e. the difference between the largest and the smallest value in the sample. For example, statistical quality control (usually called simply "Quality Control") is a technique of using samples drawn from production which is either too large in quantity for 100% inspection or such that testing involves destruction (e.g. testing the speed of a photographic emulsion). One deduces the probable characteristics of the bulk production from measurements on small samples, and it is obviously desirable to have the answer quickly so that faulty production can be stopped or corrected. Is it possible to take a handful out of a bin of nominally similar resistors, and use the difference between the highest and lowest resistances found in the handful as a measure of the variability of the whole batch? Under certain conditions it is, but this method involves a dilemma. The general rule is that large numbers or large samples are necessary to secure statistical reliability, yet the larger the sample taken from a given population the greater the range is likely to be. Considering a Gaussian distribution, the most probable values are near the mean, and these are the ones we shall usually get in a small sample; but in a very large sample we may get the odd one differing from the mean by more than 3σ, since this has a probability of about 1 in 500.

The successful method is therefore to take a small sample (less than 20 individuals in each), determine the range R in this sample, and then improve the statistical reliability by taking a number of such samples, finding the range in each, and evaluating $\bar{R}$, the mean of R over all the samples. Details will be found in text books on quality control, but one of the best presentations is to be found in B.S.600: "The Application of Statistical Methods to Industrial Standardization and Quality Control," by E. S. Pearson, published by the British Standards Institution. The standard deviation may be derived from the mean range by the formula

$$\sigma = k_n \bar{R}$$

where k_n is a multiplier depending on the number of units in a sample. For example, for $n = 2$, 5 and 10, the values of k_n are 0.8862, 0.4299 and 0.3249.

Returning to the more theoretical aspect, the variance is the second moment about the mean. Moments about the mean are always denoted by μ, while moments about another point, such as the origin, may be denoted by μ' or by an entirely different symbol such as ν, so the first and second moments may be tabulated as follows:

$\mu_1 = 0$ (i)
$\mu'_1 = \text{mean}$ (ii)
$\mu_2 = \text{variance} = \sigma^2$ (iii)
$\mu'_2 = \mu_2 + (\mu'_1)^2$ (iv)

The last relation is identical with the rule of parallel

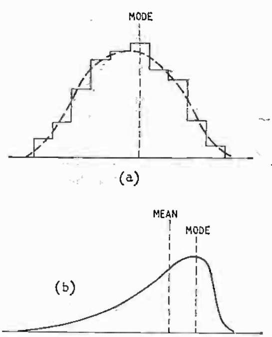


Fig. 3(a). Mode taken from a histogram. (b) The mean and mode in a skew distribution.

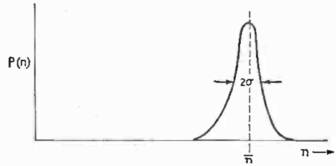


Fig. 4. Mean and standard deviation of rate of transit of electrons through a thermionic valve correspond to d.c. and r.m.s. a.c. components of current.

axes in mechanics; and the variance could be found without evaluating the distance of each point from the mean by transposing (iv) to read

$\mu_2 = \mu_2' - (\mu_1')^2$

Usually μ' is not then taken relative to the true origin, but relative to a convenient point which will simplify calculation, e.g. the whole number nearest to the mean. μ_1' is then the distance of the mean from this arbitrary reference point.

Specifying curve shape

The remaining consideration is the shape of the curve, and this can be partly defined by specifying the skewness and the *kurtosis*. Skewness is obvious—the degree of asymmetry between the two sides of the curve—and kurtosis indicates whether the distribution function is sharply peaked (like the resonance curve of a single tuned circuit) or flat-topped (like the resonance curve of a critically coupled pair); and both these characteristics can be quantitatively specified in terms of the various moments of the distribution. All the odd moments about the mean would vanish for a symmetrical distribution, so conversely the third moment should give a measure of skewness; and to normalize the measure relative to the spread the coefficient of skewness is defined as $\gamma_1 = \mu_3/\sigma^3$ (There is also Pearson's measure of skewness (mean-mode)/σ.) Similarly the kurtosis is $\beta_2 = \mu_4/\sigma^4$. Since the Gaussian distribution is for many purposes a standard, and has a kurtosis of exactly 3, the behaviour of other distributions is sometimes described by the "excess kurtosis" which is $\gamma_2 = \mu_4/\sigma^4 - 3$.

Two distributions which have equal values of mean, standard deviation, skewness and kurtosis must be pretty similar, but they need not be identical. However, specification of the mean and all the moments μ_2, μ_3, μ_4, μ_5. . . . . up to the highest which has a significant value will exactly define the distribution. An important property of variances is that if the random variations in the quantities x and y are uncorrelated, the variance of their sum is the sum of the individual variances: if $z = x + y$, then $\sigma_z^2 = \sigma_x^2 + \sigma_y^2$.

Now let us apply some of this to the noise component of a simple thermionic current‡ consisting of n electrons per second. The mean current is $\bar{n}e$ where e is the charge on each electron. Hence if we draw the Poisson distribution of the rate of electron flow as in Fig. 4, the mean value $\bar{n}$ gives a measure of the mean current which would be indicated, for example, by a moving coil meter. The spread of the curve indicates that the instantaneous current will be sometimes greater and sometimes less

‡The current is treated as temperature-limited to avoid the complications of space-charge smoothing, and electron transit-time is ignored.

than the mean; and it indicates *how often* a particular value of current will be found but not *when*.

We know from experience, and could deduce from the random nature of the phenomenon, that the various values occur in random sequence and so produce the familiar spikey noise waveform shown in Fig. 5(a). If the waveform is produced on a cathode-ray tube and a narrow slit is placed in front of it, the amount of light passing through the slit will be proportional to the frequency with which the waveform departs so far from the mean, and if the slit is moved across the trace this frequency should vary in accordance with the $P(n)$ shown in Fig. 4. This can be verified by placing a photocell behind the slit as shown in Fig. 5(b) and plotting the photocell current against slit position. But in centering the trace on the screen, i.e. placing the mean on the zero mark of our scale, we have in electrical terms suppressed the d.c. component and the noise deflection represents the a.c. component. The latter is to be measured by its r.m.s. value, which is none other than the standard deviation of the statistical distribution.

If two thermionic currents are added, the variances will be added, or in electrical terms the mean square noise currents will add. Since the constituent currents are no longer distinguishable after they have been added, any current could be divided into hypothetical components; and it follows that the mean-square noise current is linearly proportional to the mean current or d.c. component.

Rule-of-thumb for variance

The Poisson distribution has the singular property that *its variance is always equal to its mean*. This is the origin of a rule-of-thumb that in a statistical phenomenon involving a large number, the variation in the number is likely to be of the order of the square-root of the average number—a rule which is exact if the Poisson distribution applies. If $\bar{n}$ is the mean rate of arrival of electrons, the mean current is $\bar{n}e$ where e is the charge of an electron. Let $\triangle n$ be a fluctuation in n so that $e\triangle n$ is a fluctuation in current. Then the mean-square noise current is $I^2 = e^2(\triangle n)^2$. But $(\triangle n)^2$ is the variance of n

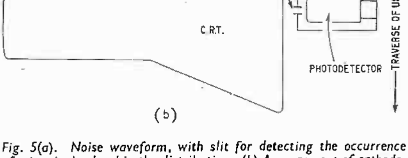


Fig. 5(a). Noise waveform, with slit for detecting the occurrence of a particular level in the distribution. (b) Arrangement of cathode-ray tube, slit and photodetector. Light passing through the slit falls on a photomultiplier, and the whole measuring unit can be traversed across the tube face as indicated by the double-ended arrow.

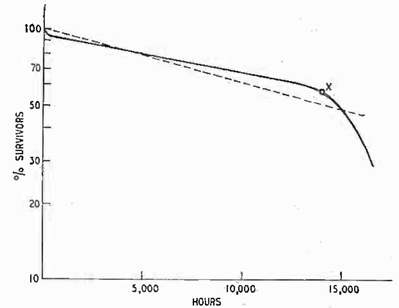


Fig. 6. Logorithm of percentage survivors of thermionic valves plotted against time. Point X can be regarded as the end of useful valve life. The broken-line curve represents a uniform random failure rate.

and from the property of the Poisson distribution must be equal to $\bar{n}$.

$\therefore I^2 = \bar{n}e^2 = \bar{i}e$

The additional mathematical manipulation needed to obtain the answer in the form of a spectrum can be found in text-books on noise and the result is

$I^2df = 2\bar{i}edf$

where I^2df is the mean-square noise current as measured in a narrow bandwidth df.

If Poisson had been alive today he would no doubt have worked on the statistics of fatal accidents on the roads rather than those of equine accidents to cavalrymen. The other modern application is to "reliability"; and in terms of reliability of passenger transport vehicles and their associated traffic control systems, reliability of electronic systems will have some relationship to accident probabilities if human error can be substantially eliminated. There is a long range of time—some thousands of hours for thermionic valves and tens of thousands of hours or more for solid-state devices—over which electronic apparatus does not seem to wear out; it just has a small risk of "death by misadventure" which is the same throughout this long range of time. But a small but uniform probability of an event in any time interval dt is the basis of the Poisson distribution, so these random failures follow a Poisson distribution. If the failure risk is constant, the number of failures is proportional to the number of items exposed to the risk. Hence the rate of occurrence of failures at any time in a large group is proportional to the number surviving up to that point, and the decay in numbers is therefore exponential:

$$N = N_0e^{-at}$$

The mean life of a single item is $1/a$ and in a system containing N items the mean time before one of them fails is $1/\mathrm{N}a$.

Mean time between failures

In a system which is repaired when a failure occurs, so that N is constant, the mean time to the next failure will be the same, so $1/Na$ is also the mean time between failures (m.t.b.f.). Unfortunately the *mean* in m.t.b.f. indicates the mean over an ensemble, either of many systems or of the same system on many occasions. Therefore, when dealing with any single system, e.g., the instrument-landing equipment on a particular aeroplane, one will probably want the m.t.b.f. to be much greater than the operating life: this is because a single sample time before failure may be either greater or less than the m.t.b.f.

The constant failure risk of the Poisson law never applies exactly and departures from it indicate some systematic fault which should be capable of elimination. For example, instead of the dotted straight line in Fig. 6 which represents a uniform random failure rate, thermionic valves often show a sharp initial fall, a long constant slope, and then an increasing slope at the end. The early failures of valves are usually the result of latent mechanical defects such as cracks due to strain glass envelopes or imperfect welds; and the increasing failure rate after a long time represents wearing out, e.g. cathode exhaustion by evaporation or barium or by poisoning. It is logical to regard the point X as the end of useful life, and in the Poisson regime preceding this point there is no advantage in replacing a valve: a new valve will be just as likely to fail as the old one, or in fact more likely unless it has been aged through the early-failure period before being put into use. Any attempt at preventive maintenance must therefore depend on detecting some symptom of wear-out, such as decline in maximum emission of a thermionic valve or increase in leakage current I_{CO} of a transistor. Components in general and solid-state devices usually do not show such a clear-cut three-part characteristic, but the plot of logarithm of percentage survivors against time will show a slight curvature indicating a failure rate which either increases or decreases with time. An analytical expression which is often applicable is the Weibull formula, which may be put in the form

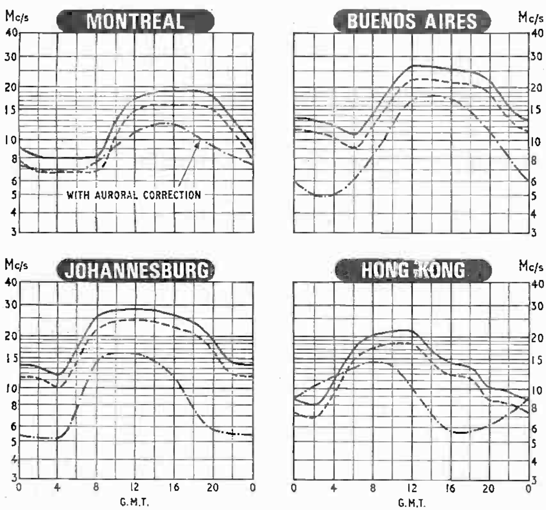
$$N = N_c \exp.(-at)^w$$

where the exponent w is greater or less than unity for failures rates increasing or decreasing with time.

However, in most electronic systems (such as computers) the failures will be repaired; and therefore the m.t.b.f. is more important than the survival rate. There is some evidence that in computer installations there may be a clustering of faults which will show up as a different kind of departure from the Poisson distribution. Two possible causes of this clustering are: (a) that an intermittent fault may not be cleared by the first remedial action, and so will reappear and be reported as another fault repeatedly until the correct remedy has been found; or (b) that the maintenance activity has disturbed other components and so provoked additional faults.

So it was perhaps a lucky coincidence that life tests on thermionic valves provided a very good illustration of a Poisson distribution of failures; the more reliable components used now have failure characteristics which are both more complex and more difficult to determine because the times involved are so long.

H. F. PREDICTIONS—MARCH



The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable frequency (LUF) for reception in this country. The MUF is, by definition, the frequency at which communication should be possible for 50% of the time. Satisfactory communication will, of course, be possible slightly above the MUF, but only for smaller percentages of time. The optimum traffic frequency is usually taken as 85% of the MUF. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, local noise level and the type of modulation. The LUF curves shown are those drawn by Cable and Wireless Ltd. for commercial telegraphy and assume the use of several kilowatts and aerials of the rhombic type.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

"British Made"

YOUR Editorial (October, 1965) and the subsequent rash of letters would have us believe that there are no hi-fi television sets on the market; this may be the case with sets of British manufacture. Your edition for December proves the absence of advanced design car radios; not a single set being capable of receiving v.h.f. How many audio appliances are there available from British sources equipped with reverberation, I wonder.

All these refinements are available through various foreign agencies, at reasonable prices. For instance, my 19 in television set (a medium-priced Japanese model) is equipped with a 10 in bass speaker and a 3 in tweeter crossover network with tone controls.

When will the British manufacturer wake up to the fact that we are being left behind and that what might have suited "Gran" just will not gell with the modern minded?

Singapore. E. H. DAVIES

Integrated Circuits Discussion

I FEAR that in publishing in the January issue such an interesting, but rather restricted and misleading discussion on integrated circuits, you may well stir up a hornet's nest. Perhaps this was your intention!

Integrated electronics as a new art is not merely the use of standard, mass-produced, "not quite right for our application," circuits put together to make systems.

It is an activity in which, at one extreme, a single technology can be used to produce similar components in connected groups, and at the other, where a variety of technologies and materials are unified to make multiple functions.

The unification has barely begun. To many working in the field, the "writing on the wall" is plain; one may list the basic requirements of electronic circuitry and realize that resistive paths, conducting paths, dielectrics, magnetics, cryogenics, and semi-conducting junctions are ultimately more likely to achieve a successful "housing development" on passive substrates rather than semiconductors.

Further, a simple truth languishes little-heeded in Mr. Lawton's statement:—"In present day practice, 90 % of all circuitry used in the electronics industry is analogue."

For this 90 %, evaporated and screen-printed metal and insulating "integrated circuit" films on glass or ceramic have already assumed great importance. The 1965 sales value of film circuits in the U.S.A. was double that of Mr. Padwick's little pellets! (*sic*).

Mr. Flack and the entertainment and professional parts of the industry will soon be able to buy a "brick" of ten stable, reliable integrated film resistors/capacitors for a fraction more than they now pay for one component.

Certainly semiconductor integrated circuits will achieve a miniscule inroad into the analogue field; perhaps more where miniaturization is important. But how does the digital field look today? During a very recent visit to the U.S.A., I was told that the largest computer manufacturer in the world was ordering more than 100 million *film circuits* in 1966/7, and that other large manufacturers in the field are following suit (I saw first hand evidence of the latter).

For an expensive base material like silicon the process currently used by most manufacturers seems very wasteful. Nearly 50% of the ingot (it costs about 8s per gram) is lost in slicing, lapping and etching operations. Of the parts actually used to make circuits, only the top 20 microns of a 100 micron thick chip are required; the rest is both thermal and electrical embarrassment. To cap this, average overall yields run at about 15 %; though many will feel this figure optimistic except for simple circuits produced in large quantity. The idea is good but "state of the art" execution is poor.

Only the most primitive natives still fashion canoes by chiselling out logs!

Engineers accept the logic that it can be more economic to put several components made by a unified technology into one package. Yet if an "active" component technique is bent to produce inferior and/or expensive "passive" components—as often appears to be the case—the logic no longer applies.

For a variety of reasons the passive components used either in the silicon, or over the passivating oxide, have tolerance and stability problems. Some of these arise from sheer small size and can be readily eliminated only by increasing area, and hence price.

Resistors and capacitors in available monolithic semiconductor integrated circuits tend to exhibit poor electrical isolation, poor linearity, comparative lack of stability, lack of space for power dissipation, lack of close tolerance ability and high temperature coefficients and be high priced.

On the reliability issue it appears that the accepted improvement for digital semiconductor integrated circuits does not necessarily apply to the analogue ones. Analogue circuits are far more sensitive to parametric drift.

It should not be inferred from this letter that I am of the opinion that semiconductor integrated circuits as we now know them are poor devices. Far from it; the message is simply that there is a strong probability that they will be priced out of large areas of the market by improved integration techniques among their humbler brethren—the passive components.

The techniques most likely to succeed in the long run are those most suitable for component and circuit definition by computer control. In this respect one may forecast that this year, Company A will be able to feed punched tape into its Telex machine and directly control a slave pattern generator in Company B, hundreds of miles away. This will make a film integrated circuit within a few seconds—with resistors and capacitors accurate to ± 0.5 % or better.

I hazard a guess that by 1970 in the 90 % application, we shall mainly have each passive and active component technology producing integrated groups of its own particular kind; and optimized for lowest price and best performance.

Finally, and with the greatest respect, *W.W.* will be guilty of neglect if it imagines it has generated, from so learned a panel, an adequate discussion on integrated circuits—merely by dramatizing* the effect of silicon planar technology on 10 to 15 % of electronics. May I suggest that early in 1966 you reassemble your panel. Perhaps it could then be stiffened with experts† from the passive component fields and move on to discuss the more important aspects of integrated electronics, i.e. the 90 % and the longer-term implications.

D. BOSWELL
(Manager, Film Circuit Unit).
Standard Telephones & Cables Ltd.,
Paignton.

* It was not our intention to "dramatize."—Ed.
† Lest our choice of "experts" should again be criticized we suggest the discussion continues in the correspondence columns.—Ed.

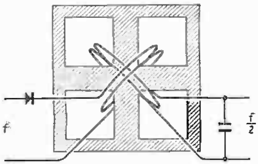
"Magnetic Frequency Divider"

I READ with interest Mr. F. Butler's article "Magnetic Frequency Divider" in the January issue, and note that he ascribes this device to Rakov and Shumkov, who published a paper in 1965. In fact, to my own knowledge, the divider described was studied at length in this country some twelve years ago by B. W. Glover,[1] with whom I had many discussions regarding this and other forms of magnetic divider used for the production of both even and odd order sub-harmonics.

The circuit shown in Fig. 1 of Mr. Butler's article is exactly that which we classified as the "transductor" type of divider since almost any transductor could be used as a divider by connecting in the manner shown. Two identical transformers with primaries in series aiding and secondaries in series opposition were often used to avoid the overwinding of two separate coils with one output winding which was regarded as the preferred method of construction for transductors.

Prior to Glover's work other forms of magnetic divider for the production of even-order sub-harmonics had been developed, first by MacCreary[2] and later by myself. All of these devices had the same basic requirements of diode input and capacitor output. MacCreary's original device used a lattice window type of magnetic core wound as shown in Fig. 1.

Fig. 1



Two other forms of construction which were successfully developed by myself are shown in Fig. 2.

Fig. 2 (a) shows a magnetic toroid with a hollowed-out channel in the centre, this channel containing a winding orthogonally disposed with reference to the second winding which was applied to the toroid in the normal way. Fig. 2 (b) shows a tape wound toroid in which the magnetic tape itself was used as one of the divider windings.

For those who may wish to experiment with any of these devices I would add that MacCreary Cross Valves can be most readily made by using double yoke laminations such as the Inter Service Pattern No. 524. If

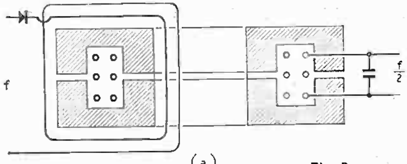
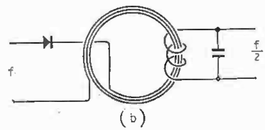


Fig. 2



these laminations are inserted in the directions North, East, South, West cyclically the lattice window pattern will appear.

Experience with these devices has shown that, as Mr. Butler comments, the theory is very abstruse. As far as I can recollect no really satisfactory design mathematics were evolved and design was based on data obtained empirically. I have not yet had the opportunity of reading the Russian paper and it may be that the theory of operation is now fully understood.

F. R. Davey[3] developed a divide-by-three system for the generation of $16\frac{2}{3}$ cycles ringing tone for G.P.O. telephone systems as long ago as 1943 using saturated magnetic cores. Transductor types of divider can also be used for production of odd sub-harmonics, particularly the third sub-harmonic, but are much more critical than the simple divide-by-two circuits. For the production of odd sub-harmonics the diode input circuit is not used.

The principal objection to the application of any of the forms of divider mentioned is that the drive power required is considerable, a point which Mr. Butler has emphasized.

J. W. McPHERSON
(Technical Manager)
Garnders Transformers Ltd.
Somerford, Hants.

1. "Transductor Frequency Dividers," B. W. Glover, G.E.C. unpublished report No. SL104, 1954.
2. "The Magnetic Cross Valve and its application to Subfrequency Power Generation," H. J. MacCreary, *Proc. Nat. Electronics Conf.*, Vol. 5, 1949.
3. "A Mains Frequency Convertor for Ringing Supplies," F. R. Davey. *Post Office Electrical Engineers Journal*, Vol. 36, 1943.

The author replies:—

Mr. McPherson's letter is one of a number which have been received, all making the point that magnetic frequency dividers of one sort or another have been in use for many years. The correspondence shows that I was less than fair to the pioneer workers in this field and I welcome an opportunity to set the record straight.

Considering only the generic type of circuit shown in my Fig. 1, it is clear that there is nothing new in the binary divider described by Rakov and Shumkov, but their divide-by-four and divide-by-six circuits are new. At the same time, it must be pointed out that these modes are quite difficult to excite, although the simpler divider presents no such problems.

The MacCreary Cross Valve and the two circuits developed by Mr. McPherson are of particular interest and I would have welcomed a little more information about the performance, frequency range, drive power and suitability for transistor operation.

Another correspondent, Mr. N. G. Dobson, of York, also points out that the circuit of my Fig. 1 is exactly that of a low-frequency divider which has been used by the Post Office since 1959. Presumably this equipment is the same as, or is related to, that described by B. W. Glover in 1954.

Finally, I have received from Mr. J. C. Barton a reprint of his paper "Simple Core Scaling Circuits," published in *Nuclear Instruments and Methods*, Vol. 5, 1959, pp. 332-334. This describes a scale-of-two counter which also employs two saturable cores associated with diodes and capacitors. The two main windings are placed in the collector circuit of a transistor. A third (common) winding is connected between base and emitter, through a capacitor, the combination forming a species of blocking oscillator. Thus the cores themselves determine the duration of the current pulse which switches them. Mr. Barton's paper continues with a description of a scale-of-ten circuit and concludes by discussing a high-speed scale-of-two circuit suitable for driving other identical stages.

All correspondents stress the complexity of the underlying theory and a study of the Soviet paper which I quoted will show how right they were to do so. This need not prevent the interested reader from developing a satisfactory divider by empirical means. An intelligent use of trial and error methods, backed by a qualitative understanding of the basic mode of operation, is enough to ensure success. The aim of my elementary descriptive treatment of the topic was to supply this need.

Cheltenham, Glos. F. BUTLER

Topsional Stability and the Unipivot

THERE were two points in Mr. J. Walton's letter in the February issue which interested me greatly, but first I must say that although I accept without question the importance of rumble reduction, I cannot accept that the method advocated is necessarily the best. As far as I can see the only means of reducing rumble without risk of compromising some aspect of pickup performance is to tackle it near its source. One such method is to fix lumps of metal at strategic points to the underside of the motorboard. This has not the elegance of the anti-rumble pickup but it is effective and is a means which the amateur at least can quite easily use.

Unfortunately, I did not see the article on the Hi-light arm and consequently it was most interesting to read that this pickup uses induced torsional motion to reduce vertical inertia.

It was also interesting to learn the effects of (presumably) small torsional movements on the stereo image as I had no exact idea as to what this might be. On hunch, I tried to limit tilt due to the arm "sticking" on its pivot to within $\pm 1^\circ$ from vertical so as to minimize any possible trouble this might cause. However, since any image displacement in this case would be more or less static, it may well be that greater tilts would be acceptable and the maximum pivot friction limit safely raised.

The reason for my attempting to prevent all torsional motion is that with an arm such as mine suspended close to its centroid on a low-friction pivot and relying on "dry" friction to limit "wobbles," there is hardly any alternative. One could juggle with the arm's reaction movement and/or pivot friction in order to permit torsional motion with warp accelerations greater than a predetermined value, but since the resultant wobbles would tend to occur at the arm's torsional resonance rather than the warp frequency, there would be no guarantee they would occur in-phase. Apart from this then offering no certain improvement in the ability of the arm to track warps, there is a great risk that the wobbles get out of control and result in the "elbow" of the arm *hitting the record*.

Incidentally, it has been suggested on occasions that a straight arm be used with the stylus situated on its longitudinal axis. Whilst this would result in a slight overall reduction in arm inertia, a more massive cartridge attachment would likely be needed, so little, if anything, could be gained. (A bent shape offered a more simple means of attaching the cartridge and was chosen mainly for this reason.) However, one could probably get away with this scheme *without stabilizing* provided (a) somewhat higher pivot frictions were used and (b) the centroid of the arm was dropped to suit.

On the question of low inertia, I go along wholeheartedly with Mr. Walton, but from the point of view of stability to shock rather than rumble reduction and it will be noticed that the inertia of my woggle arm (should it be *anti*-woggle?) has been reduced to a practical minimum (the stabilizers add only about 1·4 gm). The total inertia with the Deram anti-rumble cartridge fitted would be about 11 gm which, with the vertical stylus compliance of $2{\cdot}5 \times 10^{-6}$ cm/dyne for this cartridge, should give a resonance around 30 c/s. So although the arm was not specificially designed for this cartridge, a degree of rumble reduction might be possible when used with it.

Finally, if I may, I would like to apologize for a number of errors which were almost certainly due to my atrocious hand-writing. I think the only error likely to cause puzzlement is the counterweight's "rubber back," as printed in Pt. 1, which should read, of course, rubber bush. The lengths of the connecting wires between arm and pivot assembly were unfortunately omitted from Pt. 2 and these should be 1¾ in for each live lead and 2 in for the common E. Lastly, the point S on the alignment scale, referred to in Pt. 2, is at the intersection of the middle guide line with the line from the spindle hole.

Appleby, Westmorland. J. BICKERSTAFFE

Colour Television

A CONSIDERABLE amount of talking goes on about the introduction of colour television, but we do not seem to get very much progress. There are those who think we cannot afford it anyway, and they may be right. Certainly the cost of a network of u.h.f. stations for three 625-line programmes capable of providing a colour service is formidable. It has been suggested that upwards of 4,000 transmitters would be needed, many of course would be co-sited.

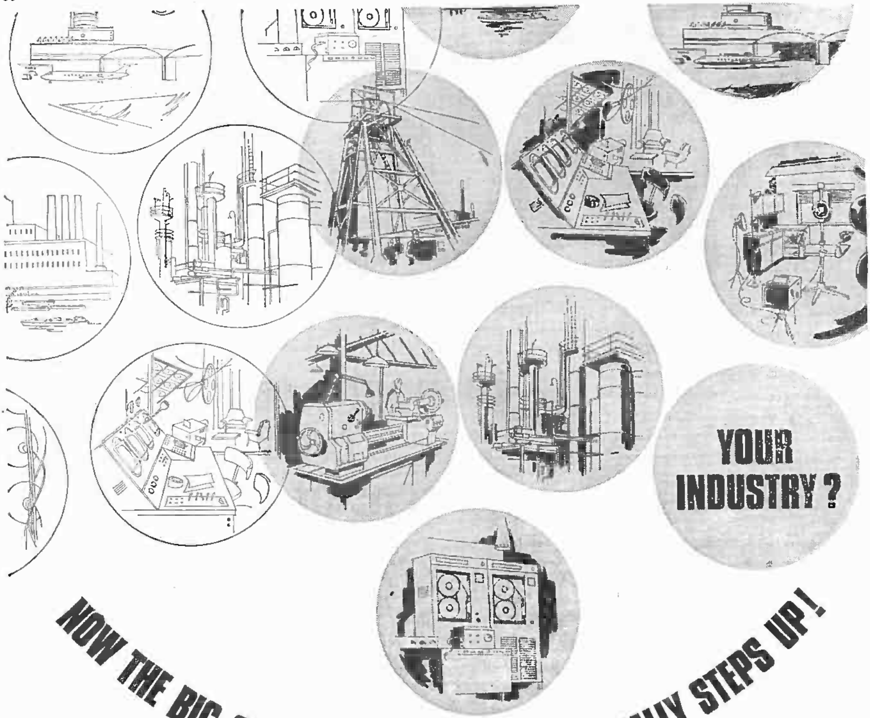
The problem for I.T.A. is particularly difficult, as they would seem to need to spend a very large sum of money for little or no immediate return.

There is thus no burning desire on the part of the I.T.A. to start on the establishment of a 625 u.h.f. network, nor any reasonably quick profit if they did. In any case it would be a very lengthy process.

During talks with a number of people who earn their living in the television industry, it has seemed to the writer that the objections to a dual-standard colour system are not very valid.

If colour programmes were made available on both

(*Continued on page 141*)



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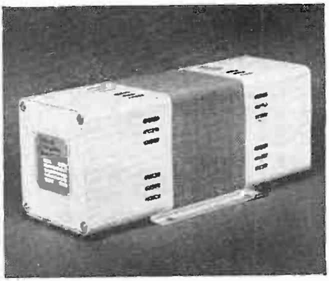

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405/v.h.f. *and* 625/u.h.f. we could at least get both the B.B.C. and I.T.A. started without too much cost or passing of time, possibly sharing some colour programmes.

Many, probably the most difficult, of the technical problems of a dual-standard v.h.f./u.h.f. receiver for black and white or colour must be solved even if 405/v.h.f. colour is left out. Would the *added* complexity created by including it be very great?

The really difficult colour receiver problem is to produce one capable of providing black and white pictures comparable to those on a good monochrome receiver.

If a dual-standard colour system was accepted, then we could see a possibility of a National coverage of colour television fairly quickly, and although receivers would be more complicated, at least some of the extra cost would be cancelled by the fact that since colour reception would be available to many more people in a fairly short period, production of sets would be much higher than if 625/u.h.f. only were used.

As 625/u.h.f. coverage takes over, 405/v.h.f. could gradually go. Even without colour it looks as if it is with us for a long time anyway.

Of course, extending the life of 405/v.h.f. may be considered undesirable, but we must find *some* way of starting colour—I suggest this is a practical way.

Northwood, Middlesex. C. H. BANTHORPE

I HAVE never been able to locate in one document an objective comparison between the N.T.S.C., PAL and SECAM colour television systems. By this I mean a direct point-by-point analysis of the advantages and disadvantages of each.

It is my belief that such a document covering both the transmitting and receiving facilities and operating characteristics would be very much appreciated by the industry.

Triangle Stations, HENRY E. RHEA
Philadelphia, Penn. Director of Engineering

"1812" Bass Booster

HAVING built the Dinsdale Transistor Audio Amplifier (with "split earths" as suggested by C. Artus—Feb., 65) I found it very satisfactory, but for one thing—the bass control gave a very "boomy" effect* on speech at maximum setting. I therefore developed my own booster, which has caused so much interest to my acquaintences (one of whom dubbed it the "1812"), that I am submitting it for your correspondence columns.

It has virtually no effect on speech frequencies, and boosts only below about 120 c/s, giving a beautiful "clean" bass effect.

It should be noted that great care must be taken to avoid acoustic feedback when using this circuit. Also a large speaker must be used.

Peacehaven, Sussex. R. G. YOUNG

* This may be due to the loudspeaker enclosure.—ED.

Loudspeaker Enclosures

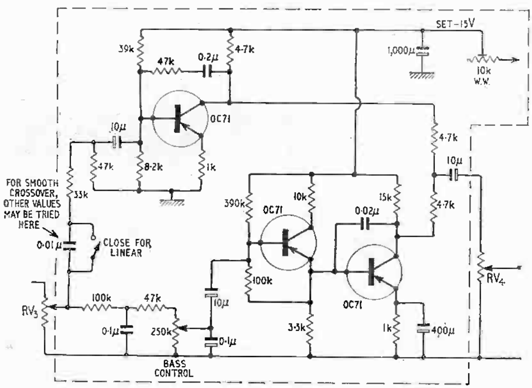
MR. P. J. WALKER in his letter in the February issue makes some very interesting points. I would, however, like to disagree with one or two of his comments, although I suspect that our differences are not wide.

First, there is no necessity for the finite acoustic line to be resonant to obtain effective bass lift in the enclosure that I described. Theoretically, a maximum lift in the bass response of 6 dB can be obtained when the port output is in phase with that of the cone itself. This has no relationship with resonance and is a time-delay effect. In addition, it is possible to obtain better efficiency still by a reduction in the wool density down the line and by increasing the line cross-sectional area. This gives rise to a type of bass horn loading.

I will agree that the line itself may tend to show half-wave resonance effects, depending on its construction; but this will add still more to the bass efficiency over and above the amount previously mentioned. Incidentally, the resonances that I was particularly aiming at reducing were the middle and lower middle frequency ones. These are by far the most objectionable, and are very difficult to damp adequately in a normal bass-reflex cabinet. It was for this reason that a longer absorbing path was felt to offer better results. The resonance of the line is, however, easily controlled by the wool density towards the end of the line. Non-resonant is perhaps a misnomer, although the resonances are far lower than a normal reflex cabinet.

By comparison, the standard bass-reflex cabinet has a port emission that is approximately in quadrature with the cone output when at resonance. This gives about 3 dB less bass reinforcement than that of the acoustic line (both assumed to be critically damped) for the same cabinet efficiency. If due allowance (somewhat less than 1.5 times) is made for the relative stored energy in the two systems, and identical sized cabinets used, the bass efficiency of the bass reflex is still not as good as that of the acoustic line. As the design basis is radically different (time delay rather than resonance) I cannot see how BS2498 applies except with suitable modifications. Incidentally the maximum efficiency given by Mr. Walker can be exceeded quite easily by the simple expedient of putting a large aneroid capsule in the cabinet, although this is cheating perhaps.

With regard to response curves in general, I feel that although free-field response is best for theoretical comparisons, they can be very misleading to the



listener. First, "free-field" means that the speaker must be several wavelengths away from any appreciable reflecting surface. At 30 c/s, three wavelengths is nearly 100 feet and this gives rise to obvious difficulties in measurement. In any case loudspeakers are normally used in close proximity to the ground, this giving improved bass loading and about 6 dB more bass output.

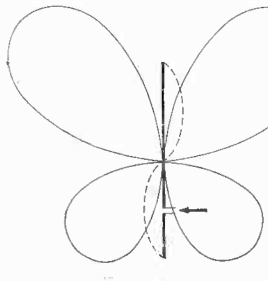
Again a rear wall is normally present along with a ceiling, and the effect of these is to increase bass efficiency to an even greater degree. If side walls are added as well, then the bass efficiency can be lifted even more, as the higher frequencies are not reflected to the same extent as the bass. Hence a "flat" free-field response will sound intolerably bass-heavy at the correct volume level under domestic conditions. It was for this reason that I used a room so as to approximate to domestic conditions.

In a lecture at the Northern Polytechnic, London, I had an independent check on the speaker performance, and it produced about 84 dB level at 24 c/s with 20 watts input. This was in a fair sized lecture room and was definitely and rather painfully audible. Reduction of the frequency to 22 c/s removed all audible sound, showing that it was fundamental radiation that was being produced.

Bradford. ARTHUR R. BAILEY

"Unconventional Television Aerial"

IN your January 1966 issue Mr. V. Wilson presents an "unconventional" television aerial. One is tempted to say that it is so unconventional it won't work although



experience has shown me that this would be a dangerous statement: all aerials work but some work better than others.

While Mr. Wilson's explanation of the input impedance is broadly correct he makes no mention of the polar diagram of a radiator one wavelength long. I need only refer to Fig. 10.25 (a) of the Services Textbook of Radio, Volume 5 which shows (above) that such an aerial has a null in its pattern at right angles to the aerial axis.

Were it not for the fact that Mr. Wilson is presumably obtaining a reasonable signal I would suggest that he tried inclining the wire at 45° towards the transmitter.

Granger Associates Ltd., P. A. C. MORRIS
Walton-on-Thames.

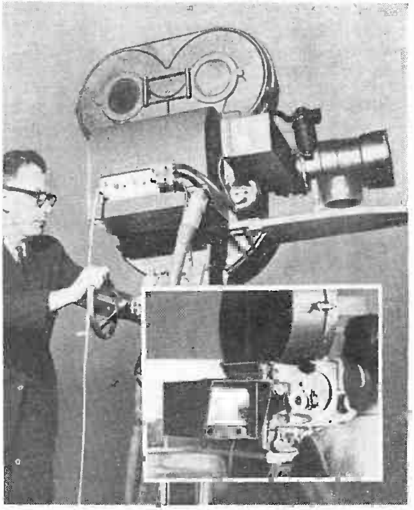
ELECTRONIC FILMING AID

A COMPACT electronic "conversion pack" that fits on the side of a standard 35 mm film camera and provides the instant monitoring and play-back facilities afforded by television studio cameras has been produced by the Communications Division of the Livingston Group at Watford. Known as "Add-a-Vision" it has been designed around a Plumbicon pick-up tube and provides the cameraman with a 7in televison picture instead of that on the normal optical viewfinder.

A zoom lens with a prismatic light-splitting system has been fitted to a standard Mitchell B.N.C. camera. One of the optical outputs forms the image on the film and the other goes to the Plumbicon. The advantage of the Plumbicon is that it requires only a very small amount of light being bled from the optical system and therefore does not degrade the film image. The pick-up tube housing can be seen in the larger photograph at right angles to the lens assembly. To the rear of this housing is the unit containing the associated equipment. The viewfinder is mounted on the opposite side of the film camera, as can be seen in the inset. This electronic viewfinder, which is said to facilitate accurate focusing, is hinged to give unimpeded access to the film loading doors.

The video processing unit, which with its associated power supply is rack mounted, provides a video outlet which may be used to feed a number of television display monitors thus enabling production executives to watch action during rehearsals to decide when a scene is ready for shooting. No film need be exposed until the sequence is ready to be taken, and then the monitors relay exactly what the cameraman is shooting.

The picture signals are to full broadcast television standards.



Mobile Communications

SOME POINTS FROM THE RECENT I.E.E./I.E.R.E CONFERENCE ON SYSTEMS AND EQUIPMENT

BACK in 1945, J. R. Brinkley (Pye) wrote the first paper to be read before the Institution of Electrical Engineers on the subject of mobile radio telephony. At the I.E.E. and I.E.R.E. conference "V.H.F. and U.H.F. Mobile Communication Systems and Equipment," held at the I.E.E. on 12th and 13th January, it was fitting that the same author opened the proceedings by presenting a paper which dealt with the past, present and future development of mobile communication equipment.

In tracing the evolution of the equipment over the last twenty years it is obvious that channel spacing has become a major problem. Twenty years ago the author estimated that less than 1,000 civil equipments (used mainly for police, fire and civil defence purposes) with 100 kc/s channel spacing were in use. Today, the author estimates the figure to be 70,000 which are used for every conceivable purpose, and channel spacing has now been decreased to 25 kc/s and in some cases to 12.5 kc/s.

The ever-increasing demand for more channels has dictated the development of equipment for operation in the u.h.f. bands, and within the auditorium the author demonstrated a 450 Mc/s pocket radiotelephone by contacting Millbank Tower just over one mile away and holding a brief conversation.

The user

An extensive v.h.f. mobile radio network covering most parts of the country has been established by the Electricity, Gas and Coal Boards and an interesting paper was presented by C. E. Dadson (Joint Radio Committee, nationalised power industries). Electricity is the most extensive user having 377 base stations and 7,369 mobiles. Channel requirement demands have been a problem. In 1958, 22 v.h.f. channels with 25 kc/s spacing were allocated for the exclusive use of these industries. However, the increasing use of mobile equipment has necessitated the recent allocation of four u.h.f. channels in the frequency range 450-470 Mc/s and six additional v.h.f. channels, but the latter are to be used with 12.5 kc/s spacing.

As regards the question of a.m. or f.m., an interesting point was made by the author. When the industries were first considering the establishment of their mobile communication networks, the advantages of a.m. were greater because of the complexities of the f.m. equipment then available. Once a.m. systems were established it was obviously necessary to maintain compatibility as the networks expanded. This could account for the apparent increasing popularity of a.m., but the author stated that there is a tendency for new networks to be developed with f.m. systems.

In considering the use of selective calling with its associated advantage of the increased number of operators in one channel, Mr. Dadson mentioned that the facility had not been widely used because of the apparent reluctance of manufacturers to incorporate the facility as a standard feature. He thought that the need for a cheap form of digital pattern-recognition decoder existed.

In the January 1963 issue of *Wireless World* a detailed description of the pilot scheme of the Netherlands Simofoon selective calling system was given. A paper presented by the same author, G. M. Uitermark (Netherlands PTT), described the system which was put into service in September, 1964. After being in operation for a year it had about 2,000 subscribers.

Quartz crystals

One of the problems arising from reduction of channel spacing is the improved frequency stability required of the local oscillator which in turn depends upon the characteristics of the crystal. In a paper entitled "Recent Developments in Quartz Crystals" by N. C. Rolfe and E. W. Kentley (Cathodeon Crystals) the authors considered that six main factors affect frequency stability—variation of load reactance—level of crystal drive—stability of other components—general environmental conditions—temperature—long-term ageing. Only the last two were considered in detail; the first four, the authors considered, could be eliminated by careful design.

The problems associated with **ageing,** the authors stated, were successfully mastered quite a few years ago for specially processed high stability crystals. However, the techniques were complicated, selective and costly, and today the demand for bulk production of high stability crystals with rigid specifications is a further problem. However, the problem of ageing has been overcome by the perfection of a glass seal which ensures both a high degree of cleanliness and the exclusion of flux vapours and other volatile matter during the sealing process—two factors which if ignored can accelerate ageing.

The **temperature** problem has been countered by arrangements which compensate for the change occurring in equivalent circuit parameters during temperature changes. One method described by the authors was that by which temperature dependent d.c. voltage is applied to a voltage dependent reactance, such as a silicon capacitance diode forming part of the oscillator load reactance. By using a thermistor network to obtain a preselectable, temperature dependent voltage, different voltages can be obtained for compensation of individual crystals, and factory set temperature compensated oscillator modules have been developed which have a stability of about -1 p.p.m. from -40°C to $+70^\circ$C.

Microwave equipment

An unusual mobile communication system was the subject of a paper by E. Goldbohm of the Netherlands Radar Research Establishment. The paper described a microwave tracking system for communication between mobile vehicles. The author explained the arrangement as a line-of-sight relay system (with many of the features of a fixed microwave link) in which the aerials of two identical equipments track with each other. Both aerials radiate narrow beams about 1·9° wide and have a forward gain of about 29 dB. The directivity decreases effects of ghosting, multiple path propagation and other signal distortions and also ensures a high degree of privacy. However, if the system is to be used with a base station controlling several vehicles, then the base station would be equipped with an omnidirectional aerial and the vehicles would operate as individual tracking stations—but with separately modulated carriers which can be filtered out after demodulation of the r.f. signal.

Each equipment uses a reflex klystron for both transmitter and local oscillator functions. Because of the wide bandwidth of the klystron, the system is suitable for television signals and the author stated that good quality television pictures had been received at distances of up to eight miles over land and 10 miles over water.

INEXPENSIVE TAPE RECORDING AMPLIFIER

By GEORGE WAREHAM

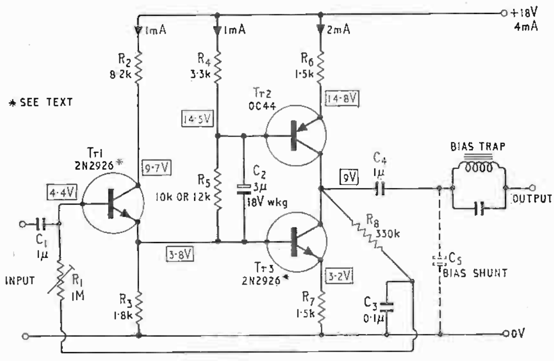
MODIFICATION OF THE GRUNDY/COLLINS/WATSON DESIGNS TO ALLOW USE OF CHEAP N-P-N SILICON PLANAR TRANSISTORS

IN the August, 1965, issue (p.403) J. B. Watson presented a design for a recording amplifier which avoids the need for high-voltage transistors as used in the Ferranti design (*W.W.* July-Aug. 1965). Mr. Watson's circuit specified germanium transistors and a negative collector supply. However, it can be readily adapted for use with n-p-n silicon transistors and a positive collector supply. The cheap epoxy-encapsulated planar transistors now coming on the British market can then be used instead of expensive high-voltage types.

Readers may wish to use Mr. Watson's high-impedance transformerless output stage in conjunction with either his own or some other input circuitry, such as the first two stages of the Ferranti design (July, 1965, issue p.328, Fig. 5). For this reason the last stages of the Watson circuit have been redesigned as a complete single unit, as shown in the accompanying diagram. Some simplification has been achieved in the interstage coupling network. Overall a.c. negative feedback has been increased by increasing the size of the unbypassed emitter resistors of the output transistors from 560Ω to 1500Ω. Linearity is good.

Typical performance data are as follows:—

Input impedance ..	100 kΩ
Output impedance (driven from 1 kΩ source)	180 kΩ
Output impedance (driven from 10 kΩ source)	120 kΩ
Maximum undistorted output current ($Z_L = 0$)	1 mA r.m.s.
Maximum undistorted output voltage ($Z_L = \infty$)	4 V r.m.s.
Input voltage for 125 μA in 18 kΩ load ..	100 mV
Input voltage for 4 V r.m.s. ($Z_L = \infty$)	20 mV
Cut off frequencies (−3dB)	6c/s and >30 kc/s



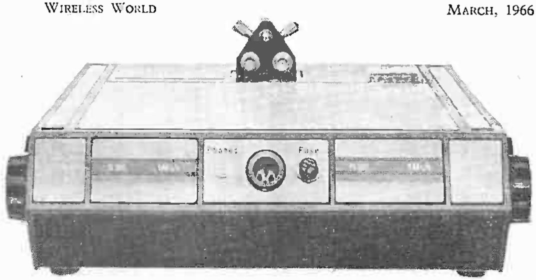
The redesigned circuit. All resistors are ±5% tolerance. Voltages boxed are d.c. voltages measured with a high resistance voltmeter. R_1 is adjusted to obtain 9V at the collectors of Tr2 and Tr3.

Silicon transistors type 2N2926 have a wide range of current gain (35 to 470), but are divided into five narrow gain groupings, identified by a colour code. To obtain the stated performance, Tr1 should preferably be a "yellow" type (h_{fe} = 150 to 300) but an "orange" type (h_{fe} = 90 to 180) may also be used, the main effect being a reduction in output impedance to about 100 kΩ. Tr3 may be either a "yellow", "orange" or "red" (h_{fe} = 55 to 110) type. (Readers should note that at least one manufacturer omits the colour-code dot on the commonest type, "orange".) This transistor type may also be used in both the Ferranti and Watson low-level circuits. Again, "orange" or "yellow" types are preferable.

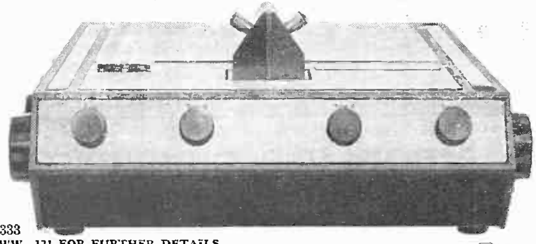
The resistor R_2 is inserted to protect Tr1 against excessively high collector voltages. It has virtually no effect on performance, but provides a possible pick-off point for the signal supply to a recording level indicator (500 mV when the amplifier output current is 125 μA). C_2 may be omitted if the signal-source impedance is 1 kΩ or less, since most of the resulting negative feedback voltage is then lost across R_8 and R_1.

The bias trap must have a very high impedance to be effective, since it forms an inverted-L attenuator with the output impedance of the amplifier, which is itself high.

Transistors type 2N2926 are obtainable from Amatronix Ltd., 396 Selsdon Road, Croydon, price 5s each.




WAYNE KERR B 201



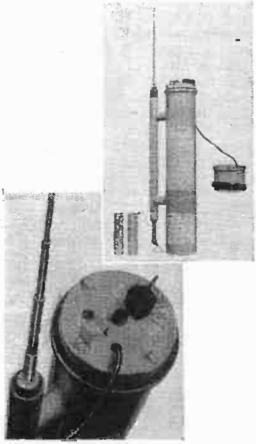
NEW PRODUCTS

equipment systems components

SURVIVAL TRANSCEIVER

A SOLID-STATE transceiver called Safcom is being produced by K. W. Electronics Ltd., for fitting to fishing vessels' liferafts. Last year the Merchant Shipping Rules (17-8) were amended making it compulsory for fishing vessels of more than 60 ft in length to carry emergency rescue beacon equipment. This transciever conforms to the regulations and has received British P.O. type-approval.

The transceiver contains a crystal-controlled transmitter and receiver operating on the international marine distress frequency of 2182 kc/s. The output of the



transmitter is in excess of 1 W and the receiver sensitivity is 1 μV for standard output. Audio output is quoted as 4 V pk-pk across the transducer.

Thirteen silicon planar n-p-n transistors are used in the transmitter section. Eight of these are employed in a tone generator, which provides an alternating output of 1.3 and 2.2 kc/s. Eight silicon planar transistors are used in the receiver section which employs a superhet circuit with a tuned r.f. stage and Class B output for battery economy. All the receiver circuits—and the tone generator and tone switching circuits—are voltage stabilized.

The transceiver is powered by two mercury batteries that give a nominal voltage of 16 V. Battery life, with a 1 to 9 transmit-receive ratio, is in excess of 100 hr.

The Safcom is contained in a cylindrical watertight container measuring 24 in long by 4 in in diameter. An auxiliary tube containing a telescopic aerial (74 in extended) and "earthing" lead is bonded to the side of the main tube. The end cap of the main tube houses the microphone, loudspeaker and transmit switch. (Even with the end cap removed from the body of the main tube, the transceiver is watertight.) A separate switch is provided for radiating the two-tone alarm signal.

The Safcom will float, even when dropped into the water from a height of 20 ft. It weighs 9½ lb.

Although exclusively manufactured by K.W. Electronics Ltd., of Vanguard Works, 1 Heath Street, Dartford, Kent, this transceiver is being distributed by several companies including Marconi International Marine, who are marketing it under the name "Lifesaver," and Kelvin Hughes.

WW 309 for further details

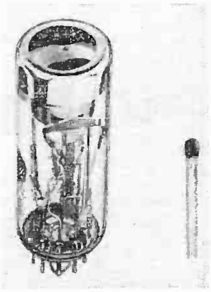
ANTI-MAGNETIC TWEEZERS

STAINLESS heat-resistant alloy is used for the tips of a pair of tweezers recently introduced by Henri Picard & Frere Ltd., of 34 Furnival Street, London, E.C.4. These tweezers are anti-magnetic and will withstand temperatures in excess of 500° C (normal hardened steel becomes noticeably soft above 300° C).

WW 310 for further details

PHOTOMULTIPLIERS

TWO new devices have been added to the Mullard range of photomultiplier tubes, a four-stage device designated XP1114 and the six-stage XP1113 tube. Both devices measure 68 mm by 19 mm in diameter and have cathode sensitivities of 40 μA/lumen. The photocathodes are deposited directly onto the



inside of the end face of the tube and focused by a dynode electrode system giving an overall sensitivity of 4 mA/lumen for the four-stage tube (illustrated) and 400 mA/lumen for the other.

The cathode material in both tubes is antimony-caesium and has a response peaking in the blue region. At a later date it is hoped to offer tubes that will operate in the infra-red and ultra-violet regions.

Both tubes are available in development quantities. The address of Mullard Ltd. is Mullard House, Torrington Place, London, W.C.1.

WW 311 for further details

TRANSISTORS

QUANTITY price reductions of up to 50% in a broad range of silicon planar and planar epitaxial transistors are announced by Transitron Electronics Ltd., of Gardner Road, Maidenhead, Berks. As an example the 2N2784, which is a hermetically sealed device with an f_T of 1 Gc/s, is now under 10s at 1,000 up. For small orders the price has not been changed; the 2N2784 costing 18s 11d.

Units with relaxed specifications such as the ISP6120, a general fast switching device with an f_T of 1 Gc/s, are also cheaper in quantity. At the 1,000 level, the ISP6120 costs 8s 6d; one-off they are 15s 4d.

WW 312 for further details

Loudspeaker Units

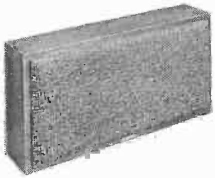
TWO 12 watt loudspeaker units have been introduced by Jordan-Watts Ltd., of Benlow Works, Silverdale Road, Hayes, Middx. Both enclosures are fitted with their standard drive unit and are suitable for use with amplifiers having output impedances from 7.5 to 16Ω.

The Juno, as one is called, is an 0.6 cu ft bass reflex unit and has a frequency response of about 40 to 20,000 c/s (±6 dB). Although based on their current enclosures, the Juno has been stiffened and the port and tunnel modified to improve the bass frequency response. Distortion with a low input is approximately 5% at 50 c/s and $1\frac{1}{2}$% at 100 c/s. The external dimensions of the unit are $24\frac{1}{2}\times12\times5\frac{1}{2}$ in, and the price is £24 10s.

The other unit, which measures $8\times16\frac{1}{2}\times3\frac{1}{2}$ in, is called the Jumbo. It is a totally enclosed unit and has a frequency response of about 70 to 20,000 c/s (±6dB). The price is £17 12s 6d.

Both units are finished in light teak. A Vynair covering forms the fascia panel.

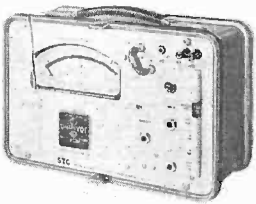
WW 313 for further details



Milliwatt Test Set

REDESIGNED versions of Standard Telephones and Cables 74166-A milliwatt test set—an instrument for measuring signal levels on unbalanced 75Ω circuits at frequencies up to 30 Mc/s—have recently been introduced. The new instruments, the 74166-H and 74166-J, are about half the size of the earlier instrument, and incorporate push-button switches.

The two models (H and J) are identical apart from their input connectors, the H being fitted with Post Office No. 1 co-axial plugs, and the J having B.N.C. connectors (Amphenol 31-221). They will make accurate terminated level measurements of +1 dB to −1 dB referred to 1 mV on 75 Ω unbalanced circuits at frequencies up to 30 Mc/s, and they will also measure heater voltages of 5.6 to 7.0 V.



The instruments cannot be used for measuring "through levels" as a wired-in thermocouple is incorporated with the heater impedance shunted down to 75 Ω. A miniature Weston standard cell is included to maintain a high measuring accuracy; the measuring circuits being standardized by a series of simple switching and adjusting operations. A further feature is that the standardizing circuit can also be used to send a d.c. power level of 1 mW into external 75 Ω circuits for calibrating other apparatus. Both instruments are powered by three internal 1.5 V dry cells. The overall dimensions are $12\frac{3}{4}\times8\times7\frac{1}{8}$ in, weight is 12 lb.

The address of S.T.C.'s Testing and Apparatus Division is Corporation Road, Newport, Monmouthshire.

WW 314 for further details

Transistor for Driving Number-tubes

A BREAKDOWN voltage of 120 V and a d.c. gain of 35 (at an operating current of 3 mA) are features of a new transistor from SGS-Fairchild. Known as the C 407, it is a silicon planar device designed for use as a high-voltage driver for neon indicator tubes, such as the Nixie.

Being a silicon planar device, the leakage current is less than 200 nA and thus will eliminate the soft glow effect caused by a numeral other than the one desired drawing current. The C 407 is encapsulated in epoxy resin and has a lead pin circle identical to that of the popular TO-5 can.

The one-off cost of the C 407 is 6s 9d and at 100 up the cost is 4s. The company's address is 23 Stonefield Way, Ruislip, Middx.

WW 315 for further details

WIDE RANGE VOLTMETER

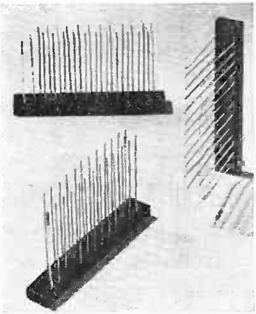
FIFTEEN a.c. ranges and three d.c. ranges are provided on the new Type M1 voltmeter now available from Linstead Electronics Ltd., 35c Newington Green, London, N.16. The input impedance is 10 MΩ on all but the lowest a.c. ranges where it is between 6 and 10 MΩ. The mV ranges provided are as follows: 1-10, 2-20, 5-50, 10-100, 20-200 and 50-500 mV; and the voltage ranges 0.1-1, 0.2-2, 0.5-5, 1-10, 2-20, 5-50, 10-100, 20-200 and 50-500 V. The frequency range of the M1 is 10 c/s to 100 kc/s.

The three d.c. ranges provided are 0 to 4, to 40 and to 400 V. The sensitivity is 20 kΩ/V.

The transistor instrument contains a four-inch meter and is powered by an internal 9 V battery. An amplifier output—at low impedance—is provided with a voltage gain of approximately 80 on the most sensitive range.

The overall dimensions of the M1 are $6\frac{1}{2}\times8\frac{1}{4}\times5$ in, the weight is 5 lb and the price is £24.

WW 316 for further details



Multiple Capacitor Units

FOUR types of multiple capacitor unit for use in the manufacture of delay lines are now being made by Johnson, Matthey & Co. Ltd., of 73-83 Hatton Garden, London, E.C.1. The units contain a number of silver-mica capacitors—with or without interconnection—and are encapsulated in an epoxy resin to give a high humidity resistance and a wide operating temperature range.

Units with various combinations of capacitance value will be made to customers' specifications from the four standard types of unit. The available capacitance ranges are as follows: 50 V, 440 to 1,500 pF; 200 V, 300 to 439 pF; and 350 V, 1 to 299 pF. The temperature range of the units is from $-55\,^{\circ}$ to $+100\,^{\circ}$C. Temperature coefficient is $15\times10^{-6}/^{\circ}$C at 1 kc/s and $5\times10^{-6}/^{\circ}$C at 1 Mc/s.

WW 317 for further details

Standard Integrated Circuit Boards

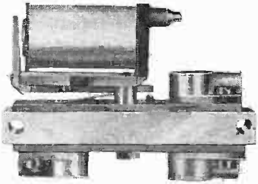
TWO standard printed circuit boards are being manufactured by the Triad Division of Litton Industries to enable manufacturers to quickly assemble integrated circuits. Both boards are double-sided with flat-pack mounting tabs on one side and TO-5 pads on the other. Up to six TO-5 cased components or six flat packs—or a combination of both—may be mounted on each board. The boards are designed for use with either 25-contact or 18-contact double-sided connectors.

Litton products are handled in the United Kingdom by Litton Precision Products, 503 Uxbridge Road, Hayes, Middx.

WW 318 for further details

Aerial Changeover Relay

A NEW co-axial aerial changeover relay, having no plugs or sockets on the body of the relay, is now available from Magnetic Devices Ltd., of Newmarket, Suffolk. Designated Series 951, it is a d.c. operated device and is suitable for switching signals at frequencies of the order of 450 Mc/s. It can be used in applications where low inter-contact capacitance is important.



The relay contains a single changeover contact enclosed in a brass housing and is designed for use with U.R. 43 cables—which are soldered directly to the relay and secured by brass clamps. The soldering operation does not affect the relay contact setting and the brass clamps provide continuity of screening and cable outlets in any three directions. Operate time is 20 ms and release time is 8 ms.

The maximum d.c. working voltage of the relay is 100 V; maximum coil wattage is 1.5 W and maximum coil resistance is 9,350 Ω. The contact rating is 1 A or 30 W maximum with a nominal impedance of 50 Ω. Other specification details include a voltage standing wave ratio of approximately 1.1 : 1 at 450 Mc/s, and a cross talk figure of 39 dB.

WW 319 for further details

DIGITAL VOLTMETER

THE range of instruments made by G. & E. Bradley has been extended and now includes a digital voltmeter. Designated Type 160, it covers 0 to 1,000 V d.c. in four ranges and has an accuracy of 0.1%.

A four-digit in-line display is employed in this solid state instrument, which contains a standard cell for calibration. A filter is also provided that can be switched into the input circuits to suppress superimposed noise or a.c.

The basic version of the 160 does not have an output for driving printers and costs £240. A version with a printer output is available and costs approximately £20 more. The dimensions of the 160 are $4\times11\frac{3}{4}\times8$ in, and its weight is $8\frac{1}{2}$ lb.

The address of G. & E. Bradley Ltd. is Electral House Neasden Lane, London, N.W.10.

WW 320 for further details

CO-AXIAL CONNECTORS

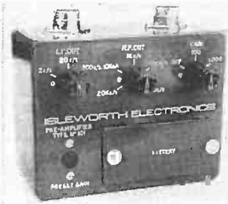
A SERIES of small B.N.C. two-pin co-axial connectors made by the French company Radiall are now available through Lectropon Ltd., of Kinbex House, Wellington Street, Slough, Bucks. Designated B.R. 2, this series of connectors is suitable for use with twin screened cables having diameters of 4, 5 or 6 mm.

The maximum current capacity is 3.5 A and the working voltage (at ground level) is 500 V r.m.s. Other electrical characteristics include an insulation resistance at 500 V d.c. of 100 GΩ, a contact resistance of 1 mΩ at 1 A, and a between pin capacity of 1.7 pF at 1 kc/s and 1.3 pF at 1 Mc/s. Between pins and case, the capacity is 4 pF at 1 kc/s and 3.2 pF at 1 Mc/s.

WW 321 for further details

PARAMETRIC A.F. PRE-AMPLIFIER

A HIGH input impedance, low noise transistor pre-amplifier is announced by Isleworth Electronics, of Frederick St., Waddesdon, Bucks. Noise voltages referred to the input are 10 and 20 μV pk-pk with input short and open circuted respectively. With a 100 kΩ



metal film resistor across the input the noise voltage is 25 μV pk-pk. The high input impedance of 10 MΩ and the low noise performance are achieved with a 10-stage differential amplifier, the first stage of which is a parametric amplifier using a varactor diode and operating with a pump frequency of 10 Mc/s. An output of 1 V pk-pk with a 10 kΩ load is provided. Output impedance is less than 500 Ω. A switched gain of either 100 or 1,000 times is provided and common mode rejection is 120 dB.

The amplitude-frequency response is variable, switched high- and low-pass filters being provided—giving 3 dB-down frequencies of 20 kc/s, 10 kc/s, 1 kc/s, 200 c/s and 50 c/s for the low-pass filter, and 2 c/s, 20 c/s and 200 c/s for the high-pass filter.

Power supply units (type P101) are available for the amplifier (designated A101), giving a stabilized supply of 150 mA at 9 V, which is sufficient to operate 10 amplifiers. Operation from an internal 8.4 V mercury battery would provide 40 hours of use. It is arranged that the amplifier will automatically switch to battery operation in the event of mains supply failure. A 19-in rack mounting kit is available including a drilled rack panel.

The ex-works price is £45.

WW 322 for further details

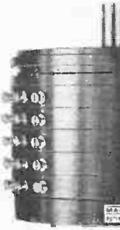
Conductive-plastic Potentiometers

A NEW series of conductive-plastic potentiometers have been added to the extensive range of precision potentiometers made by the Markite Corporation, of New York. Non-linear laws —which prior to the advent of this track material were considered impossible— are included in the new series known as the Slimline. Also included are units with sine-cosine and rectilinear track laws.

Stainless-steel bearings are used in these multi-gang potentiometers, which under test have performed without failure for up to 200 million operations. Accuracies of up to 0.01% are quoted for the larger units in the series.

These potentiometers are available in the United Kingdom through Davies Integrated Sales, 252 Kempshott Lane, Basingstoke, Hants.

WW 323 for further details



VIBRATION & DISPLACEMENT MEASURING INSTRUMENT

MEASURING complex vibration effects in delicate structures where the measuring device must not load the body being measured, is one of many jobs within the scope of the Model DF/2 detector/filter unit now available from Associated Engineering Ltd., Cawston, Warwicks. The instrument has been designed for use with matched pairs or double versions of A.E. displacement transducers and will measure displacement or vibration at frequencies from zero to 10 kc/s at a distance of 0.015 in. Resolution is up to 10 μin, depending on the material.

The overall temperature stability, including the transducers, is better than $\pm 2\,\mu$in/°C when the transducers are temperature cycled. Long-term stability for static displacement measurement over an 8 hr period is better than 100 μin for ferrous materials.

WW 324 for further details

Miniature Connectors

CIRCULAR connectors manufactured by Souriau et Cie. of France, are available in the United Kingdom through Lectropon Ltd., of Kinbex House, Wellington Street, Slough, Bucks. The range offered, called Miniphi, has six shell sizes ranging from 0.43 to 0.93 in in overall diameter. The number of pins range from 7 to 61.

A nominal current rating of 3 A is quoted for the connectors, which will operate in the temperature range −55° to +125°C. Reinforced diallyl phthalate is used as the insulation material and a light metal alloy for the shell. The insulation resistance is 10^6 MΩ.

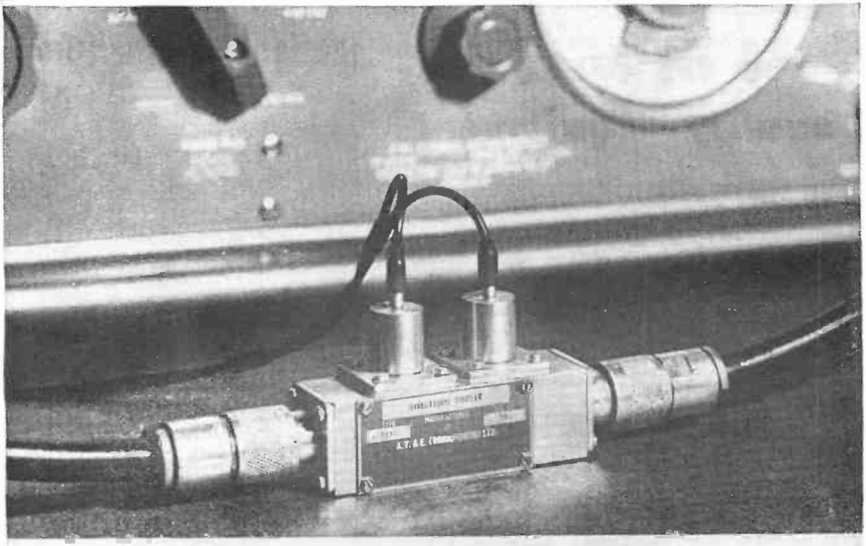
WW 325 for further details

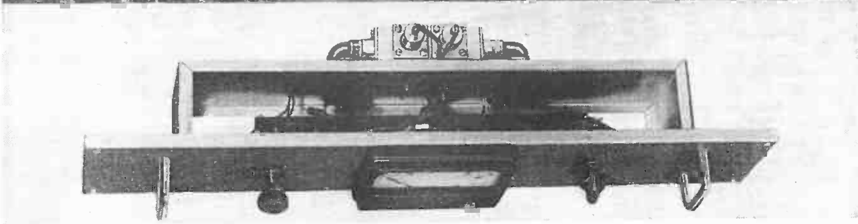
INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

We invite professional readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by WW, and it is then necessary only to enter the number(s) on the card.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.





now you can monitor VHF-UHF power and VSWR without affecting transmitter output

With a primary line SWR less than 1.05 and negligible insertion loss, this range of coaxial directional couplers Type PRI gives you continuous monitoring of power levels up to 300 watts, without interfering with your transmitter, transmission line or aerial. Available for frequency bands between 50 Mc/s and 500 Mc/s, these couplers weigh only 8 ounces and measure only 5″ x 2½″ x 1″. They have sensitivities of 50 microamps (DC) per watt (RF), nominal impedances of 50 or 75 ohms, and Type N connectors.

Type PRI directional couplers are also supplied incorporated into complete coaxial reflectometers Type M2X, suitable for mounting in 19-inch racks or in portable units. Both forward and reflected power can be measured directly, and accuracy is independent of line VSWR. Full-scale power readings of 10 watts and 100 watts are standard, as are direct readings of VSWR from 1.0 to above 10.0.

For easy-to-install, non-interfering, high-accuracy VHF and UHF power measurements, the directional couplers and coaxial reflectometers from AT&E provide an ideal inexpensive solution. AT&E will be happy to supply additional details; just write to AT&E (Bridgnorth) Ltd., Bridgnorth, Shropshire, England.

PLESSEY Electronics

PE(T)4

WW—123 FOR FURTHER DETAILS.

Subminiature Pressure Transducers

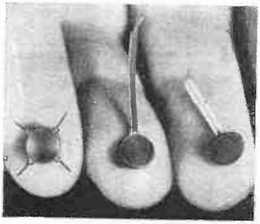
THE range of subminiature pressure transducers made by Scientific Advances Incorporated, of Ohio, are now available in the United Kingdom through Wessex Electronics Ltd., Royal London Buildings, Baldwin Street, Bristol, 1. There are a number of basic models in the range, each covering a variety of pressure ranges. The models differ mainly in the geometry of lead attachment—see illustration. (Model M-5 on the left, M-6 centre and M-7F on the right.)

A four arm, bonded-foil strain gauge is employed, to take maximum advantage of the strains on a flat diaphragm, and is cemented to the inside surface of the diaphragm. The transducer itself will, through its small dimensions, cause little interference in gas or liquid flow systems.

Typical of the physical and operating characteristics of the range are those of the Model M-5. This particular model is available in four pressure ranges—from 0 to 15, to 30, to 100 and to 150 p.s.i.—and its thickness ranges according to pressure range from 0.02 to 0.035 in. The weight of the M-5 is 0.1 gm.

The recommended input voltage for all models is 3 V d.c. or a.c. and the working temperature range is -40° to $+150^\circ$F.

WW 326 for further details



High-voltage Transistors

A RANGE of high-voltage silicon n-p-n transistors, manufactured in the U.S.A. by Industro Transistor Corpn., are available from Lectropon Ltd. of Kinbex House, Wellington St., Slough.

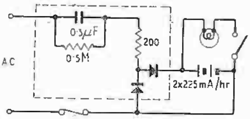
The range includes types with V_{CE} and V_{CB} of 100-800 V (at 200 μA) with an L_{FE} of 20-30 at 25mA. Peak collector current is 400mA and dissipation varies between 3 W and 15 W at 25°C case temperature. Prices vary between 9s and £19 depending on ratings required.

WW 327 for further details

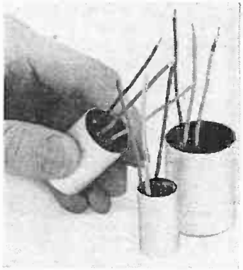
Miniature Charger Modules

A RANGE of miniature constant-current charger modules for use with nickel-cadmium batteries is now available from Kynmore Engineering Co. Ltd., 19 Buckingham Street, London, W.C.2. The range is based on an earlier module developed for incorporation in rechargeable torches and pocket lamps.

Three- and four-lead modules are available and, having low reverse current figures, may be permanently connected to the batteries they are to recharge. The three-lead modules use a circuit similar to the original module for the torches and pocket lamps (illustrated), while the four-lead modules employ a bridge circuit. As can be seen from the illustrated circuit, a capacitor is



used to drop the voltage before rectification by a pair of gold-bonded semiconductor diodes. Six different sizes are available in the standard range, with



capacities ranging from 2 to 45 mA—assuming a 230 V a.c. supply. On 115 V supplies the current ratings are halved. The maximum load is ten cells.

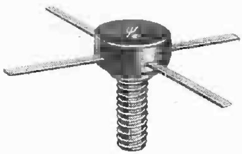
The smallest in the range measures 0.8 in long by 0.6 in diameter and the largest 1.7 in long by 1.25 in diameter. The price of the modules varies according to current rating. Hundred up prices are from 10s, for a 2 mA unit suitable for driving up to five cells, to 19s 6d for a 45 mA unit, suitable for driving up to ten cells.

WW 328 for further details

V.H.F. HIGH-POWER TRANSISTORS

A NEW series of high-power v.h.f. silicon n-p-n transistors, from TRW Semiconductors Inc., includes a device which will deliver up to 40 W, with a 6 dB power gain, at 175 Mc/s. Designated PT5690, it is a silicone encapsulated device with the dice completely isolated. It is mounted on a beryllium oxide stud and has radially-mounted leads making the device suitable for printed circuit board mounting. The transistor geometry makes use of a unique symmetrical method of paralleling devices on a single chip. The complete transistor comprises 24 transistor elements arranged in four clusters of six and each element contains a thin film emitter resistor to balance the input r.f. voltage characteristics of the base-emitter diode. Other specification details include a V_{CBO} 60, V_{CEO} 40 and a V_{EBO} 3. One-off price is £44.

The other two in the series, available in the United Kingdom through M.C.P. Electronics Ltd., of Station Wharf Works, Alperton, Wembley, Middx., are both 150 Mc/s devices. The PT5692 has a 6 dB gain and will provide a 20 W output, and the PT5694 a



power gain of 8 dB and a 12 W output. The respective prices are £22 and £12.

WW 329 for further details

U.H.F. TV Tuner

A TRANSISTOR quarter-wave television tuner for the band 470-860 Mc/s was announced by Plessey at the Paris Components Show—a report of which appears on p. 119. The tuner has four push-buttons which operate directly a 60° tuning capacitor, thus eliminating the more usual switches. Two versions are available, to cater for both 75Ω unbalanced and 300Ω balanced inputs. The tuner is obtainable from the Electro-mechanical Division, New Lane, Havant, Hampshire.

WW 330 for further details

MARCH MEETINGS

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

LONDON

1st. I.E.E. & I.E.R.E.—Discussion on "Infra-red camera techniques" at 2.0 at Savoy Pl., W.C.2.

2nd. I.E.E.—Colloquium on "Microphones" at 9.30 at Savoy Pl., W.C.2.

7th. I.E.E.T.E.—"Control by computer" by A. St. Johnston at 6.0 at Savoy Pl., W.C.2.

7th. I.E.E. Grads.—"An introduction to silicon controlled rectifiers" by P. J. N. Norris at 6.30 at Savoy Pl., W.C.2.

8th. I.E.E. & Soc. of Instrument Tech.—"A new approach to measurement and data transmission for process-control systems" by I. R. Young, A. T. Keefe and G. Moss at 5.30 at Savoy Pl., W.C.2.

8th. Radar & Electronics Assoc.—"Where are we with radar?—some highlights in radar development and achievement" by K. F. Slater at 7.0 at R.S.A., John Adam St., W.C.2.

9th. I.E.E.—"Applications of electrostatics" by A. W. Bright and P. L. Secker at 5.30 at Savoy Pl., W.C.2.

9th. I.E.E.—"The scanning electron microscope and other electron probe instruments" by Prof. C. W. Oatley at 6.0 at Savoy Pl., W.C.2.

9th. S.E.R.T.—"Electronic organs" by K. G. Burge at 7.0 at the London School of Hygiene, Keppel St., W.C.1.

9th. R.S.G.B.—"Aerial farming in a monastery" by Rev. P. Sollom (G3BGL) at 7.0 at R.S.A., John Adam St., W.C.2.

9th. B.K.S.T.S.—"Auditorium acoustics" by C. C. Buckle at 7.30 at Central Office of Information, Hercules Rd., S.E.1.

10th. I.E.E.—Discussion on "The Multicarrier performance of communication-satellite repeaters" at 5.30 at Savoy Pl., W.C.2.

11th. I.E.E.—"Some recollections of the early days of radio research" by Dr. R. L. Smith-Rose at 5.30 at Savoy Pl., W.C.2.

14th. I.E.E.—"The explanation of some fundamental phenomena of modern physics using a ballistic theory of light" by R. A. Waldron at 5.30 at Savoy Pl., W.C.2.

14th. I.E.E.—"The ten-element bandpass filter section and its applications" by G. C. S. Brown at 5.30 at Savoy Pl., W.C.2.

16th. B.K.S.T.S.—"The B.B.C. television film department" at 7.30 at Central Office of Information, Hercules Rd., S.E.1.

21st. I.E.E.—"Electron-beam welding and machining" by H. N. G. King at 6.0 at Savoy Pl., W.C.2.

22nd. I.E.E.—Discussion on "Solid-state switching—for better or for worse?" at 6.0 at Savoy Pl., W.C.2.

23rd. I.E.E.—Discussion on "Technical information—a new teaching subject" at 5.30 at Savoy Pl., W.C.2.

23rd. I.E.R.E.—"The propagation of sound through liquids" by Dr. R. W. B. Stephens at 6.0 at 9 Bedford Sq., W.C.1.

24th. I.E.E.—12th Graham Clark Lecture "The place of the engineer in society" by Lord Snow at 5.30 at Savoy Pl., W.C.2.

28th. I.E.E., I.E.R.E. & Television Soc.—"Semiconductors in television receivers" by P. L. Mothersole, R. Bridgen and K. E. Martin at 5.30 at Savoy Pl., W.C.2.

29th. I.E.R.E. & I.E.E.—Symposium on "Computer control in industry: equipment design and application engineering" at 2.30 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

30th. B.K.S.T.S.—"The use of magnetic tape" by P. T. Hobson at 7.30 at Central Office of Information, Hercules Rd., S.E.1.

31st. I.E.R.E.—A symposium on "Monitoring of ground and airborne I.L.S. equipment for automatic landing" at 2.30 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

ARBORFIELD

10th. I.E.R.E.—"Random signal testing" by P. Atkinson and A. Ley at 7.30 at R.E.M.E. School of Electronic Engineering.

BIRMINGHAM

7th. I.E.E.—"Radar—present position and future trends" by Dr. E. V. Glazier at 6.30 at the Midlands Electricity Board, Summer Lane.

23rd. S.E.R.T.—"Colour television" by B. J. Rogers at 7.30 at College of Advanced Technology, Gosta Green.

28th. I.E.E.—"A review of laser devices and applications" by N. Forbes at 6.30 at the Midlands Electricity Bd., Summer Lane.

BRIGHTON

30th. I.E.E.—"The radiophonic workshop of the B.B.C." by F. C. Brooker at 6.30 at College of Technology, Moulsecoomb.

BRISTOL

23rd. I.E.R.E. & Brit. Computer Soc.—"High-speed magnetic thin film memories" by A. T. Gibson at 7.0 at University Engineering Laboratories, University Walk, Clifton.

CAMBRIDGE

10th. I.E.E.—"A traffic simulator" by Dr. F. G. Heath at 8.0 at the University Engineering Dept., Trumpington St.

CARDIFF

7th. I.E.R.E. & I.E.E.—"Telemetry—the present position and future trends" by R. E. Young at 6.0 at South Wales Institute of Engineers.

CARSHALTON

30th. S.E.R.T.—"The installation and maintenance of domestic colour receivers" by D. J. Seal at 7.0 at the College of Further Education, Nightingale Rd.

CATTERICK

8th. I.E.E.—"Speech compression" by Dr. J. Swaffield at 6.30 at the School of Signals, Catterick Camp.

CHELMSFORD

22nd. I.E.R.E.—"Various aspects of microwave ferrites" by J. A. Penney at 6.30 at the Technical High School, Patching Hall Lane, Broomfield.

CHESTER

28th. I.E.E.—"Telemetry—the present position and future trends" by R. E. Young at 6.30 at the College of Further Education.

CHRISTCHURCH

23rd. I.E.E.—"Radio interference problems in the Royal Navy" by B. N. Amos at 6.0 at the King's Arms Hotel.

COVENTRY

14th. I.E.R.E.—"Radio astronomy" by H. Gent at 7.0 at the Lanchester College of Technology, Priory St.

CRAWLEY

23rd. I.E.E.—"Systems engineering" by R. L. Smith at 6.30 at the College of Further Education.

DORKING

16th. I.E.E.—"Applications of masers—what they are and what they do" by Dr. K. Hozelitz at 7.0 at Star and Garter Hotel.

DERBY

31st. I.E.E.—"The problems of block release courses" by T. S. Hopkinson at 6.0 at College of Technology, Kedleston Rd.

EDINBURGH

9th. I.E.R.E. & I.E.E.—"Laser range finders—systems analysis and electronic circuits" by G. Hamilton and A. Fowler at 7.0 at the Dept. of Natural Philosophy, The University, Drummond Street.

29th. I.E.R.E. & I.E.E.—Symposium on "Tape recording of biological signals" at 9.30 at the Royal Infirmary, Lauriston Pl.

EVESHAM

29th. I.E.R.E.—"U.H.F. tuners" by R. Bridgen at 7.0 at the B.B.C. Club, High Street.

FARNBOROUGH

1st. I.E.E.—"Colour television transmission systems" by W. Wharton at 6.30 at the Technical College, Boundary Rd.

31st. I.E.R.E.—"Random access communication system" by L. C. Walters at 7.15 at the Technical College.

GLASGOW

10th. I.E.R.E. & I.E.E.—"Laser range finders—systems analysis and electronic circuits" by G. Hamilton and A. Fowler at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Cres.

14th. I.E.E.—Faraday Lecture "Computers, control and automation" by P. D. Hall at 7.0 at the Concert Hall.

HARLOW

8th. I.E.R.E.—"Automatic tracking from surveillance radars" by Dr. T. Buckley at the Technical College, The High.

HUDDERSFIELD

3rd. I.E.R.E.—"Automatic tracking from surveillance radars" by Dr. T. Buckley at the College of Technology.

LEICESTER

8th. I.E.E.—"Development of satellite communications" by F. J. D. Taylor, W. J. Bray and R. W. White at 6.30 at the College of Technology.

15th. I.E.R.E.—"Lasers and direct energy weapons" by Dr. R. C. Smith at 6.30 at the University.

15th. Television Soc.—"Pulse-width modulated amplifiers" by C. M. Sinclair at 7.15 at Vaughan College, St. Nicholas St.

LIVERPOOL

16th. I.E.R.E.—"Radiophony—the synthesis of sound effects for radio and television" by F. C. Brooker at 6.30 at Walker Art Gallery, William Brown St.

21st. I.E.E.—"Electronic design" by H. V. Beck at 6.30 at the Electrical Engineering Department, The University.

25th & 26th. I.E.E.—Faraday Lecture, "Computers, control and automation" by P. D. Hall at 6.30 at Philharmonic Hall.

LLANDAFF

18th. Television Soc.—"TV colour systems" by S. Sansom at 7.30 at the Technical College.

MANCHESTER

1st. I.E.E.—Faraday Lecture, "Computers, control and automation" by P. D.

Hall at 2.15 (students) and 7.30 at the Free Trade Hall.

MIDDLESBROUGH
23rd. I.E.E.—"Communications satellite systems" by Dr. H. C. Husband and H. Stanesby at 6.30 at Cleveland Scientific Institute.

NEWCASTLE-UPON-TYNE
2nd. S.E.R.T.—"Industrial electronics" by E. Surtees at 7.15 at Charles Trevelyan Technical College, Maple Terrace.
8th. I.E.E.—Faraday Lecture "Computers, control and automation" by P. D. Hall at 7.15 at City Hall.
9th. I.E.R.E.—"The application of analogue computers" by C. Cox at 6.0 at Institute of Mining and Mechanical Engineers, Westgate Rd.

NOTTINGHAM
29th. S.E.R.T.—"Currenr trends in transistor radio design and servicing" by D. E. A. Harvey at 7.30 at East Midlands Gas Board, Lower Parliament St.

PLYMOUTH
22nd. I.E.R.E.—"Electronic circuits" by G. King at 7.0 at City of Plymouth College of Technology.

PORTSMOUTH
2nd. I.E.R.E.—"Proximity sensing by magnetic induction applications and techniques" by D. Barnard at 6.30 at Highbury Technical College, Cosham.
16th. I.E.E.—"The future of autonomics" by Dr. A. M. Uttley at 6.30 at the College of Technology, Anglesea Rd.

READING
28th. "Planning of communication satellite systems" by J. K. S. Jowett at 7.30 at the Great Western Hotel.

SALISBURY
9th. I.E.E.—"Electronic circuits—past, present and future" by G. King at 6.30 at College of Further Education.

SCUNTHORPE
15th. I.E.E.—"Computers in control of processes" by Dr. D. N. Truscott at 7.0 at the Technical College.

SOUTHAMPTON
8th. I.E.R.E. & I.E.E.—"Electron microscopy and micro-electronics" by W. C. Nixon at 6.30 at University.
29th. S.E.R.T.—"Insulation and earth resistance measurements" by E. A. King at 7.30 at the College of Technology.

STOKE-ON-TRENT
29th. I.E.R.E.—"Masers and lasers" by Professor D. J. E. Ingram at 7.0 at North Staffs College of Technology, College Rd.

SWANSEA
17th. I.E.E.—"The application of secondary surveillance radar to air traffic control" at 6.0 at University College.

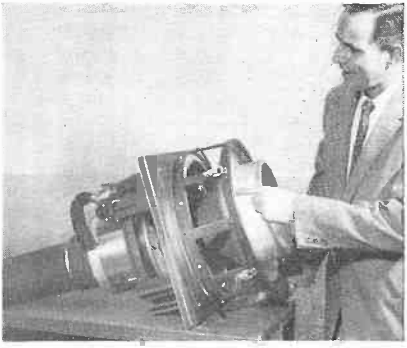
THURSO
17th. I.E.E.—"Telemetry—present position and future trends" by R. E. Young at 7.0 at the Technical College.

WHITLEY
24th. I.E.E.—"Radar, present position and future trends" by Dr. E. V. D. Glazier at 6.45 at Botham's Cafe, Skinner St.

E

1000W LOUDSPEAKER

2-IN CONE DISPLACEMENT AND AIR-COOLED VOICE COIL



1 kW loudspeaker developed for investigating high-intensity acoustics. The unit weighs 150lb and is mounted in a frame 18in square. Cone displacement can be 2in and the voice coil is air cooled.

WHAT is claimed to be the most powerful single acoustic reproducer ever built has been developed by Stromberg-Carlson, a division of General Dynamics, in the U.S.A., on behalf of Convair. The loudspeaker, rated at 1 kW and weighing about 150 lb, will be installed in Convair's acoustical laboratory, where it will be used in research into the effects of high-intensity noise on components and structures of missiles and jet aircraft.

A number of unique design features are incorporated in the speaker to make its remarkable acoustic capabilities possible. The most unusual portion of it is the low-frequency unit extending up to 300 c/s. This is driven by a powerful 24½-lb ring magnet of Alnico V, having a total flux in the air gap of 696,000 Maxwells. The heavy-duty cone is specially mounted to allow excursions of up to two inches. Because of the large amounts of power that must be dissipated, the voice coil is made of materials to withstand high temperatures, so that it is capable of continuous operation at temperatures up to 500°F. A small fan blows air through the voice coil while the loudspeaker is in use.

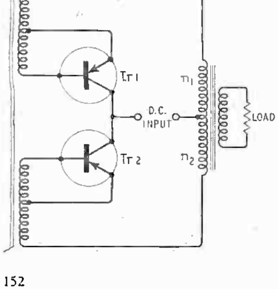
In addition to the big "woofer," the loudspeaker also includes a high-powered acoustic compression driver and coaxial horn for reproducing mid-range frequencies (300 to 2400 c/s). Thus the speaker reproduces the first six standard octave bands, as defined by the American Standards Association.

Although, in the initial application of this loudspeaker, there was no need for producing the extreme upper end of the audible frequency spectrum, Stromberg-Carlson has designed, and is now producing, high-frequency "tweeters" which will extend the range of the speaker to 15 kc/s. For any future application of the loudspeaker where this high-frequency response is required, 13 of these tweeters will be mounted in a ring around the mid-range horn.

The entire loudspeaker structure is mounted in a heavy cast aluminium frame only 18 in square, and has been designed so that each of the various moving components, where trouble is most likely to develop, can be easily removed and replaced without dismantling the entire speaker or removing it from its mounting.

LOW-VOLTAGE TRANSISTOR CONVERTER

WITH the current interest in "unconventional" sources of electrical power (thermionic and thermoelectric generators, fuel cells, and solar cells) which produce high-current low-voltage outputs, it has become necessary to develop low-voltage d.c. to a.c. converters which offer a high efficiency.

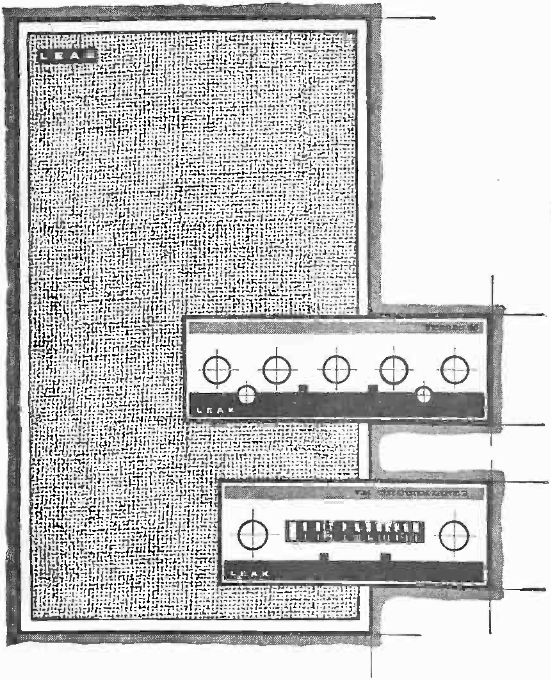


Switching converter giving an efficiency of 80% at an input of 1 V.

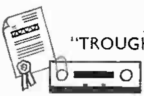
Normally, transistor converters give only a low efficiency when operated at low input voltages, and to avoid this the RIPPLE isotope-powered thermoelectric converters developed at Harwell use tunnel-diode converters. The problem is particularly relevant to space vehicles, and a transistor design has been developed under a N.A.S.A. contract, which provides an efficiency claimed to be about 80% for a d.c. input of 20 A at 1 V. At an input of 3 V the efficiency is said to be increased to 94%.

This high efficiency is, of course, obtained by operating the transistors as switches. When an input voltage is applied to the circuit shown one of the transistors will start to conduct (Tr1 say). When the saturable-core transformer becomes saturated, the base current in Tr1 will be turned off. The energy stored in the transformer then causes Tr2 to turn on. The alternate saturation and desaturation of the transformer causes the input voltage to appear alternately across n_1 and n_2, thus providing a rectangular output in the load.

The transistors should be reasonably well matched and mounted on a common heat sink. However, a high degree of mismatch can be tolerated between the base-emitter voltages of the transistors by adjusting the relative number of turns on the base-emitter windings of the saturable-core transformer.



A TRIPLE FIRST FOR LEAK



A SUCCESSOR TO THE FAMOUS "TROUGHLINE II" : FM "TROUGHLINE 3"
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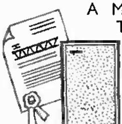
HI-FI NEWS—" *To sum up the Leak Troughline II belongs to the very limited class of aristocrats in the tuner world.*"



A MAJOR LOUDSPEAKER INVENTION THE "SANDWICH" Price £39 : 18 : 0d.

AUDIO AND RECORD REVIEW— " . . . *This design must be regarded as a breakthrough of fundamental and far-reaching importance.*"

ANOTHER MILESTONE IN AUDIO ENGINEERING "STEREO 30" TRANSISTORISED AMPLIFIER
Price: £49 : 10 : 0d.

WIRELESS WORLD Editorial, May 1963—" *Last autumn during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers . . .*"

" *People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life.*"

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SINCLAIR MICRO F M

POCKET SIZE COMBINED F.M. TUNER RECEIVER

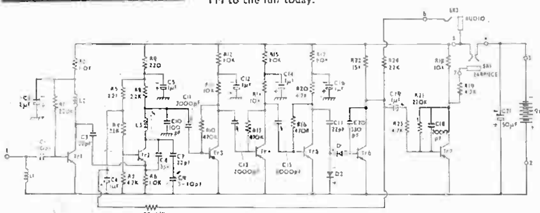
1ST. WITH PULSE COUNTING DETECTOR
WITH LOW I.F. TO CUT OUT ALIGNING
WITH TWO OUTPUTS FOR DOUBLE PURPOSE OPERATION
TO INCORPORATE THESE AND MANY MORE EXCLUSIVE FEATURES IN A POCKET SIZE DESIGN OF OUTSTANDING EFFICIENCY

7 TRANSISTORS
2 DIODES
SUPERHET FM
2 OUTPUTS
ELEGANT PROFESSIONALLY STYLED CASE

- Size—2 13/16" × 1 11/16" × 3/4" plus aerial.
- Tunes from 88 to 108 Mc/s.
- One output for amplifier, recorder, etc., and one for personal listening.
- In neat black case with polished and brushed aluminium escutcheon and matching tuning control.
- No alignment problems.

£5.19.6

Once again Sinclair Radionics prove to constructors that very high standards of efficiency can be successfully combined with micro-techniques. The Sinclair Micro FM is an outstanding example. It incorporates a number of advances over conventional practice to achieve amazing standards of performance. Despite its small size, this fully fledged 7-transistor 2 diode FM superhet has two outlets to enable it to be used both as a tuner for hi-fi or tape recorder and as an independent pocket receiver for personal listening. Pulse counting detection assures improved linearity and therefore better audio quality; low I.F. does away with alignment problems. Such is the sensitivity of this tuner that the telescopic aerial is sufficient for good reception almost everywhere. In styling, the Sinclair Micro FM is the most elegant, professional looking design ever offered to constructors, yet with all these plus features, this set costs pounds less, so that anyone can enjoy the advantages of FM to the full today.



ABRIDGED TECHNICAL DESCRIPTION OF THE SINCLAIR MICRO F.M.

The Sinclair Micro F.M. is a complete Seven transistor, two diode F.M. superhet. An R.F. amplifier is followed by a self-oscillating mixer with low I.F. This dispenses with the need for alignment and bulky components. A three stage I.F. amplifier produces a square wave of constant voltage which is eventually converted into uniform pulses, arranged so that the original modulation is reproduced exactly. After equalisation, the signal is fed to the audio output socket for use with an amplifier or recorder and also to the receiver's own audio amplifying stage for the Micro FM to be used as an independent self-contained receiver.

A.F.C. "locks" each station tuned in.

THE SINCLAIR MICRO FM is completely self-contained within a neat black plastic case faced by an elegantly designed front panel of brushed and polished solid aluminium with spun aluminium tuning dial to match. The tuning scale is marked in Mc/s.

- SUPPLY VOLTAGE—9V from self-contained standard battery.
- CONSUMPTION—5mA.
- SENSITIVITY—Typically 3 microvolts.
- SIGNAL TO NOISE RATIO—30 dB at 30 microvolts.
- AUDIO FREQUENCY RESPONSE—10 to 20,000 c/s ± 1 dB.
- A GUARANTEED SINCLAIR DESIGN

GUARANTEE: *If you are not fully satisfied with your purchase when you receive it, return it to us when your money will be refunded at once in full.*

Complete Kit of parts including Telescopic Aerial, 7 Transistors, Case, Earpiece, Instructions, etc.

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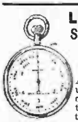

LABORATORY STOPWATCH "Waltham" (U.S.A.)

An unusual but most useful instrument, the dial taking only 6 secs. to make one revolution, thus providing a most accurate measurement to be made within this range. Suitable for use in laboratories, and workshops in recording phenomena in conjunction with pen recorders, oscilloscopes, tape transports and scientific experiments.
Jewelled movement **29/6**, plus 3/- P. & P.

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LA2100	12/6	LA2509	12/6
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LA2505	12/6	WP1238 ..	10/-

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High stability professional capacitors for use where quality is of prime importance.
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P. & P. on above 1/-.
Send S.A.E. for full specifications and comprehensive lists.

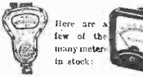
TRANSISTORS, DIODES, RECTIFIERS & VALVES

A selection from our latest lists.

OA5	@ 2/6	OC45	@ 1/9
SX68	@ 2/6	XA102	@ 1/6
OAZ246	@ 2/6	OC72	@ 3/6
GEX54	@ 1/-	OC73	@ 3/-
ZS32R	@ 2/6	OC203	@ 4/6
SX11	@ 6d.	OC170	@ 5/-
OA95	@ 9d.	OC36	@ 8/-
OC171	@ 10/-	2SL03	@ 9/9

180 Mc/s.
Rectifier 25 v. RMS @ 100 mA. @ 1/-
Send S.A.E. for complete illustrated list.

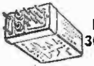
METER BARGAINS



Here are a few of the many meters in stock:

0-300 mA., 2¼in. M.C. F.R. @ 9/6
3-0-3 v. } D.C. Bell shaped testmeter
30-0-30 v. } @ 15/-
0-200 mA. 2¼in. M.C. @ 9/6
0-250 v. D.C. pocket voltmeter No. 2 @ 17/6
0-5 mA. 0-3500 v. D.C. 3½in. with shunt 22/6
Without shunt 15/6
Postage and packing on the above 2/6.
Send S.A.E. for latest meter list.

RELAYS



PO 3000

Sealed, Time Delay, Micro

Selection from our vast range:
Magnetic Sealed SM5/3-N73 24 v. 440 ohms, 4 c/o @ 15/-
Magnetic Sealed SM5-N33 24 v. 670 ohms, 4 c/o @ 15/-
Carpenter double coil 1700 ohms, 4 c/o many contact arrangements in stock from **10/6**.
Haydon semiconductor relay time delay from 1 sec.-300 sec.
@ .01% 4 c/o @ **£4/10/-**
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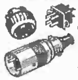

PLUGS, SOCKETS AND CONNECTORS

Very substantial stocks held of British and American connectors by Amphenol, Belling Lee, Bendix, Bulgin, Cannon, Films and Equipment, Electro Methods, Greenpar, Jones, McMurdo, Nipham, Painton, Pyle, Plessey, Thorn Pigmy Transradio. Range of connector accessories by SUPERFLEXIT.
FULLY ILLUSTRATED 24 PAGE CATALOGUE NOW AVAILABLE.

TIMER AND REMOTE CONTACTOR

TIMER
Circular panel mounting impulse operated contactor. 120 impulses drive ratchet operated cam through one revolution. Single pair of light duty contacts make every 1/4 revolution. Dial and pointer show position by means of knob on front dial. Resistance of solenoid 150 ohms, operating voltage 24.
REMOTE CONTACTOR
Spring motor driving heavy escapement which operates pair of heavy duty contacts at 120/min. Heater and bi-metal type thermostat provides temperature regulation. Fully suppressed.
Uses: forms the basis of an impulse clock, lap counter for model cars, etc.
Price 22/6 per Set. Plus 5/- P. & P.

GALVANOMETER DETECTOR

Highly sensitive twin coil galvanometer movement (with lock) enclosed in mahogany case. Many uses, ideal for converting to insulation tester, telephone circuit checking, etc.
PRICE 25/-. P. & P. 2/-.

ENGINEER'S FAULT FINDING AID

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19/6 plus 2/6 P. & P.

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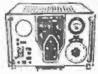
A precision instrument of American manufacture for accurately determining the flux density between poles in a magnetic circuit. Extremely efficient for testing magnets on magnetrons etc. Only one standard U2 cell required.
Our Price **£4/10/-**. P.P. & 5/6.

ROTARY TRANSFORMER Type 72

Input, 27 v. at 3.6 amps. Output HT250 V. at .07 amps. LT12.6 v. at 2.6 amps. Complete with self-cooling blower fully screened. Suitable for fluorescent lightings in caravans, radios, shavers, tape recorders, etc.
7½in. long × 3in. dia. approx. 35/-.
P. & P. 4/6.

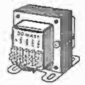


"S" BAND SPECTRUM ANALYSER

MARCONI Type TF-984/1

The Spectrum Analyser employs a Klystron Oscillator; Spare also included; (CV 2161), frequency modulated up to 10 mc/s. The input Signal is mixed with the Oscillator output, amplified, detected and fed to the "Y" plates of the C.R. Tube. The "X" plates are supplied from a Time Base circuit, which is also used to frequency-modulate the Klystron
Frequency Range—2900-3150 mc/s (10.34 to 9.52 cm.)
Input Sensitivity for 5 cm. Deflection. 200 microwatts 20 mW.
Spectrum Width . . 1 to 10 mc/s.
Sweep Frequency . . 4 to 10 mc/s.
Interim Frequency . . 22.5 mc/s.
L.F. Bandwidth—100 DC/S for 3 dB down.
Power Requirements—180V 420-650 c/s.
Dimensions 12in. × 17¼in. × 17¼in.
Weight 82 lb.
PRICE **£75.**
Fully Overhauled and Guaranteed.
If required, the instrument can be supplied complete with A.C. mains Power Pack for 230 volts at additional cost.

AUTO TRANSFORMERS—FULLY SHROUDED

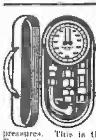


100% safe, brand new.
Range step up/down, tapped at 100-200-220-240 volt 50/60 cycles.

50 watt	@	19 6
150 watt	@	£1 17 6
300 watt	@	£3 9 6
1,000 watt	@	£7 17 6
2,000 watt	@	£17 10 0
3,000 watt	@	£24 10 0

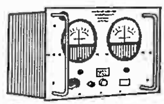
Post free.

"DUPLEX" PRESSURE GAUGE



A master gauge for calibrating existing pressure gauges and for the accurate measurement of pressures. This is the Hyson improved Bourdon type, dial with two scales 42 pointers calibrated, 0.200 lb. per square inch. Polished and lacquered brass case hexagon shank for direct mounting. Supplied with various threaded fittings. Complete in solid leather case with two carrying handles. Normal price £18.
PRICE **£7/10/-**. P.P. 3/6.

SOLARTRON COMPONENT RESOLVER



VP.748
Truly an instrument with fantastic capabilities, here, in one unit, is the means to monitor characteristics of loudspeakers, transformers, synchros and associated components; gas analysis. Frequency range 0.5 to 1,000 c/s and voltage ranges from 50mV. to 150V. Large thermocouple meters (6in.) provide Reference and Quadrature outputs and 1.0 pk/pk output for oscilloscopes are provided on the front panel. Power requirement 115V. or 200-250V. 50 cycles.
PRICE **£150.** Write in for further details.

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Large selection.
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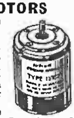
Now a simple Low Cost Servo System within everyone's reach

50-VOLT SERVO SYSTEM

A unique offer of a pair of 50-volt, 50-cycle servos that enable remote indication of angular position to be made. These are ideal for monitoring Wind Directions in the comfort of the home, or the position of an aerial system for amateur broadcasting enthusiasts. The exact position of a roulette wheel could be "guessed" by a magician using our system.
It should be noted that 50 v. is readily obtainable, by using the 200-250-volt tap on any mains transformer.
Size of magslipmotor 3½in. × 7in.
Cost of pair, **50/-**, plus 5/- P. & P.

SYNCHRO AND SERVO MOTORS



2 phase servo motors D.C. motors, braked motors, gear boxes, hysteresis motors, tachogenerators, control transmitters and transformers, torque transmitters, resolvers, motor driven variable resistors chopper relays, gears.
Vactric 11 NS 235, Size 11 24 v. 400 cycle @ **£6 10 0**
Transcoil 3500, Size 115 v. 400 cycles 11,000 r.p.m. @ **£8 0 0**
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Send for illustrated catalogue.

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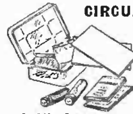
EXPERIMENTAL PRINTED CIRCUIT KIT



This Kit for "etch your own" printed circuits brings this idea within everyone's budget at only **7/6**. It not only includes etching chemicals, copper laminated boards, etc. BUT ALSO 24, yes 24 different circuit diagrams for constructing everything from Radio control receivers to metal locators, and even a man/woman discriminator!!
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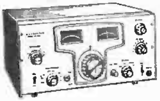
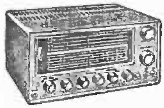
SUPERB LAFAYETTE AMATEUR EQUIPMENT



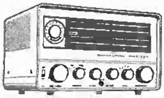
H.A. 350 10-80 METRE AMATEUR RECEIVER

A superb receiver. Dual conversion with mechanical filter. 12 valves, crystal controlled osc., product detector 100 kc/s. crystal calibrator, crystal B.F.O., A.N.L., 'S' meter. Rock like stability. Brand new and guaranteed. **75 GNS.** S.A.E. for full details.



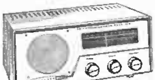
HA.230 DE-LUXE GENERAL COVERAGE RECEIVER

Wonderful value. 8 valves + rectifier. Coverage 550 kc/s.-30 Mc/s. 1.R.F. and 2 I.F. stages, 'Q' multiplier, B.F.O., A.N.L., 'S' meter, electrical bandspread, aerial-trimmer etc. Brand new and guaranteed. **£33.** S.A.E. for full details. Also available in easy to assemble Semi-kit form at **25 GNS.**



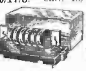
HA-63 GENERAL COVERAGE RECEIVER

7 valves + Rectifier. 4 Bands 550 kc/s.-31 Mc/s. "S" Meter-BFO-ANL-Bandspread Tuning 200/250 v. A.C. Brand new **24 GNS.** Carr. paid.



HA-55 AIRCRAFT RECEIVER

108-136 Mc/s. High selectivity and sensitivity. Incorporates 2 RF stages including 6CW4 Nuvistor. 8 tubes for 11 tube performance, solid state power supply, adjustable squelch control, slide rule dial, built-in 4in. speaker and front panel phone jack. 220/240 v. A.C. Supplied brand new and guaranteed. **£19/17/6.** Carr. 10/-.

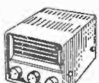


PRECISION MECHANICAL FILTER

As used in H.A. 350 Receiver For superb selectivity For 455 kc/s. I.F. provides 60db attenuator at 2.5 kc either side. Complete adjacent channel rejection **£9/19/6,** post paid.

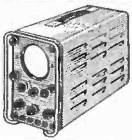
NUVISTOR GRID DIP METER

Compact true one hand operation. Frequency range 1.7-180 Mc/s. 230 v. A.C. operation. Supplied complete with all coils and instructions. **£12 10/-.** Carr. 5/-.



DE-LUXE V.F.O.

5 bands covering 80-100 metres. Employs high 'Q' series tuned Clapp Osc. High output 10-20 volts to drive any TX. Large slide rule dial. Dual impedance O/P. 230 v. A.C. operation. Size 6½in. × 5½in. × 7½in. Supplied complete with all instructions. **16 GNS.** Carr. 7/6.



TEST EQUIPMENT

PORTABLE OSCILLOSCOPE CT. 52

A compact (9×8×16½in.) general purpose 'scope. T/B 10 c/s.- 40 kc/s. Bandwidth 1 Mc/s. Sensitivity 40 mV./cm. Mullard DG7/5 2½ CRT. For operation on 200/250 v. A.C. Supplied complete with metal transit case, strap, test leads, and visor hood. Brand new and guaranteed. **£22/10/-.** Carr. 10/-. Supplied complete with instructions.

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CT53 SIGNAL GENERATOR

8.9-16.5 Mc/s. and 20-300 Mc/s. Variable precision attenuator. A.C. mains. Supplied in perfect order less calibration chart. **£12/10/-.** Carr. 10/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0-20 Kc/s. on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250 v. A.C Supplied in perfect order **£12/10/-.** Carr. 10/-.

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High quality modern American instrument. Frequency coverage on 4 bands. 0-200 Kc/s. Output impedance 1,000Ω. Output monitoring meter. 7 range output attenuator from 12 micro-volts to 12 volts. Operation 115 v. 50-1,000 cps. Supplied as new. **£40.** Carr. 20/-.

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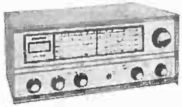
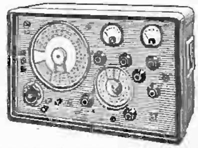
MAIN LONDON AGENTS FOR CODAR EQUIPMENT



CR70A. Communication Receiver	£19	10	0
CR.45 Receiver Kit	£9	10	0
PR.30 Preselector	£5	10	0
PR30X Self powered	£7	4	0
RQ.10 "Q" Multiplier	£6	15	0
RQ.10X Self powered	£8	8	0
A.T.5 Amateur TX	£16	10	0
AT.5 Mains P.S.U.	£8	0	0
A.T.5 12 v. Transistor P.S.U.	£11	5	0
A.T.5 Remote control and Aerial Switching Unit	£2	7	6
T.28 2-band Receiver	£15	10	0
CC-40 Station Control Unit	£6	10	0

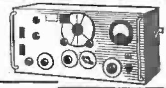
Postage extra.

AM SIGNAL GENERATOR CT394 MARCONI TF801B/3/S



Frequency range: 12-485 Mc/s. in 5 bands. Variable attenuation from .1μV to 1 volt into 50 ohms. Crystal calibrator every 5 Mc/s. Variable modulation depth. Carrier level and modulation meters fitted. Automatic output level control. 70in. main tuning dial and auxiliary incremental dial. Operating voltage A.C. 100 to 150 and 180 to 250 volts. 40 to 100 c/s. Size 14½in. × 23½in. × 10½in. Weight 67 lbs. Offered in excellent condition, fully tested and guaranteed. **£85.**

MARCONI TF144G STANDARD SIGNAL GENERATOR

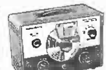


85 kc/s.-25 Mc/s. ± 1%. Output variable from 1μV to 1 volt. Internal sine wave modulation 400 c/s. up to 75% depth. Operation 200/250 volts A.C. Offered in really excellent condition, fully tested and guaranteed. **£25.** carr. 30/-.

LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

2 PF-2,000 MFD, 2 ohms-200 megohms. Also, checks impedance, turns ratio, insulation 200-250 v. A.C. Brand New **£15.** carr. 7/6.

TE-20RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120 kc/s.-260 Mc/s. on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Brand new with instructions. **£12 10/-.** P. & P. 7/6. S.A.E. for details.

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5in. 1,800ft. T.P. mylar	35/-
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,800ft. D.P. mylar	22/6
5¾in. 2,400ft. T.P. mylar	45/-
7in. 1,200ft. std. mylar	12/6
7in. 1,800ft. L.P. acetate	15/-
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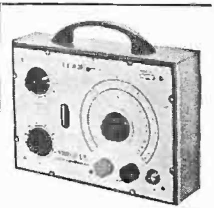
Z12 amplifier 89/6. Power pack £2/14/-.
X10 amplifier built £6/19/6. Kit £5/19/6.
X10 Power pack £2/14/-.
X20 amplifier built £9/19/6. Kit £7/19/6.
X20 power pack £2/14/-.
Micro FM radio kit £5/19/6.
Micro 6 59/6; TR750 amp. kit 39/6; Micro Amp. 28/6; Micro Injector 27/6; all post paid.



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Transistorised Audio Generator 10-100,000 c/s. Sine or square wave. **£16/15/-.**
Transistorised Signal Generator 150 kc/s.-350 Mc/s. **£9/10/-.**
Transistorised resistance capacity bridge 1Ω.-100 Meg.Ω. 1 pf-100μF. **£8/5/-.**
Transistorised Induction bridge 1μH-100H., **£18.** Mains operated Transistor power supply unit, output 1-15 v. up to 100 mA. **£6 10/-.**
All above post paid with battery.

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SRP-12 Player	£4	10	0
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1000 Changer	£5	19	6
2000 Changer	£8	19	6
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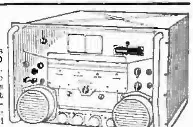
SP25 Player—Stereo	£11	10	0
AT60 Changer Stereo	£11	19	6
A70 (less cart.)	£21	10	0
LAB80	£25	0	0
401 Transcription	£30	0	0

All plus P. & P. 5/-.

R-278/GR RADIO RECEIVER



U.H.F. receiver designed by Collins Radio. Provides reception of A.M. and C.W. signals on any one of 1750 channels in the frequency range of 225 to 399.9 Mc/s. and simultaneously on one fixed tuner channel in the frequency range of 238-248 Mc/s. Power requirements 115/230 v. 50/60 cps. Size 13in. × 19in. × 20in. Output 3 watts into 600 ohms. High quality modern equipment originally costing hundreds of pounds. Available in as new condition, fully tested, complete with all crystals. **£60.** Carr. 50/-.

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FI-CHORD	LORENZ	S.M.E.	WHARFEDALE
GARRARD			

If you cannot call please send us details of your choice of equipment and we shall be pleased to quote. See Complete Systems. "Purchase tax-free Plan" for overseas visitors. H.P. Terms available.

Give a Lasky's Gift Voucher

The ideal gift for Birthdays and all these other special occasions. Any value in multiples of 10/6 (min.) upwards. *You give pleasure with a Lasky's Gift Voucher.* Available from all our branches.

RECORD PLAYERS

4-SPEED AUTOCHANGERS

B.S.R. AUTOCHANGERS AT LOWEST EVER PRICES!

All brand new and fully guaranteed complete with cartridge and stylus.

UA14 4-speed mains model	£4 9 6
UA16 4-speed mains model	£4 19 6
UA16 9v battery model	£5 19 6
UA20 4-speed mains model	£5 19 6

Add 5/- Post on each.

GARRARD

Auto-Slim Mono	£4 19 6	A70 less cartridge	£19 19 0
AT6 Mono	£8 19 6	A50 less cartridge	£9 14 6
AT6 Stereo	£9 9 0	A1000 with GCS cartridge	£6 6 0
3000LM with stereo cartridge	£8 8 0	A2000 with GCS cartridge	£7 7 0
AT60 less cartridge	£10 19 6		

Postage on all above 5/-

SPECIAL OFFER **GARRARD AT5 AUTOCHANGERS**

4-speed mains model—brand new and fully guaranteed.

LASKY'S PRICE with Mono Crystal Cartridge £5 19 6; with Stereo Cartridge £6 9 6 Post 5/-.

TRANSCRIPTION MOTORS	
GARRARD 401	£32 10 0
GARRARD Lab. 80, less cart.	£24 19 6
GARRARD 301 (Strobe)	£22 19 6
GARRARD Lab. A Mono/Ster.	£14 19 6
GARRARD Lab. A on plinth	£15 19 6
GARRARD SP25 Mono	£9 19 6
GARRARD SP25 Stereo	£10 19 6
PHILIPS AG/1016	£12 12 0
BRAUN PC4L Stereo	£8 19 6
CONNOISSEUR	
Craftsman II	£17 2 11
Craftsman III	£22 19 6
Model B	£25 4 0
LENCO GL58	£17 1 9
LENCO GL68	£19 10 7
LENCO G88	£15 15 0
LENCO GL70	£29 18 8
LENCO G99	£21 19 5
THORENS 135	£35 8 4
THORENS TD124	£38 7 4
THORENS TD150	£20 13 2

SINGLE PLAYERS

Auto. start and stop. With pick-up and crystal cartridge.

EMI with Stereo cartridge	£3 19 6
COLLARO JUNIOR 4-speed motor and pick-up	£3 9 6

All other current models available. Postage on all above 5/- extra.

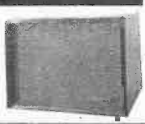
GREENCOAT RECORD PLAYER

2 speed model for 33⅓ and 45 r.p.m. 6 v. Battery operated. Complete with pick-up and fitted with crystal cartridge. Size only 7½ × 6in. Fitted with auto. stop and start.

LASKY'S PRICE **59/6** Post 2/6

SPEAKERS

PAMPHONIC S1 SPEAKER UNIT



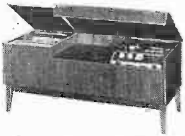
Cabinet type forward facing system. Fitted with 15 ohm 10 × 6in. elliptical double cone speaker, will handle 7 watts. Wood cabinet size 15 × 12 × 11in., finished in medium walnut. New, and guaranteed. List Price 10 Gns.

LASKY'S PRICE **£4.19.6** Post 7/6.

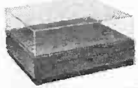
COMPLETE SYSTEMS

A Lasky's "Privilege Parcel Package Deal" allows you to purchase the complete Audio System of your choice at a worthwhile cash saving. We shall be pleased to quote our "Privileged Parcel Package Deal." Prices for any selection of equipment of your own choice. Send us details of your requirements. **H.P. Terms can be arranged on "Privilege Parcel Package Deals".**

HI-FI FURNITURE



Choose from our extensive range of equipment cabinets and speaker enclosures by Record Housing, Fisher, G.K.D., Design Furniture, etc. A full range is in stock to suit all types of equipment, furnishing styles, etc. Complete installations can be supplied to your choice, and our expert staff will be pleased to advise you.



Shown above—Lowboy equipment cabinet by Record Housing suitable for a wide range of equipment including space for record and tape storage.

Shown left—"Clearview" cabinet suitable for most types of motor/turntable units.

AMPLIFIERS

VIKING-LASKY "TRANSISTOR 50"

50 watts output. Superb amplifier for all music and P.A. work—ideal for guitars, groups, etc. Fully transistorised for maximum efficiency 4 inputs with mixing facilities plus tremelo. Fully built and guaranteed. In strong wood cabinet covered in washable material, size approx. 22 × 10 × 6in. Output imp. 3Ω. For operation on 200/250 v. A.C. mains. Last listed at 45 GNS.

SPECIAL PRICE **27 Gns.** Post 25/-.

ARMSTRONG EQUIPMENT

All the latest models in stock—H.P. Terms available.

A.F.208	£21 4 0	T.4.e	£17 19 0
Model 227M	£36 15 0	T.4.b	£20 8 0
Model 223	£28 15 0	127M	£26 10 0
Stereo 55	£29 18 0	127	£37 10 0
Model 227	£52 15 0	S.T.3. Mk. II	£25 12 0
Model 226	£61 0 0	A.20 Stereo Amp.	£23 12 6
Model 222 Amplifier	£27 10 0	P.C.U. 25 Stereo Pre-amp	£21 0 0
Model 224	£22 10 0	Optional cases	£3 10 0
Model 221	£33 15 0	Stereo Multiplex Decoder	£14 10 0

JASON EQUIPMENT

High quality home construction units for the discerning Hi-Fi enthusiast. We stock the complete range of component parts.

FM & AM/FM TUNERS

FMT1.	Can be built for	£6 15 0	Post 2/6 extra.
FMT2.	Can be built for	£10 12 0	Post 4/- extra.
FMT3.	Can be built for	£12 5 0	Post 4/- extra.
Mercury II.	Can be built for	£10 12 6	Post 2/6 extra.
JTV2.	Can be built for	£15 10 0	Post 5/- extra.
JTL Stereo Tape Link.	Complete kit	£22 1 0	Post 4/- extra.

SPECIAL INTEREST ITEMS!

PUBLIC ADDRESS AMPLIFIER/SPEAKER CABINET

An extremely well made wood cabinet—to house an amplifier in the removeable top section and a 12in. loudspeaker in the lower section. The sections are attached together by four spring catches and can be separated in an instant. Both cabinets are fitted with carrying handles and are covered in black/silver crocodile pattern washable material. Internal dimensions: amp. housing—20¾in. wide × 6in. high × 8¼in. deep (included storage compartment for mic. 3¾in. × 6in. × 4½in.), speaker housing—20¾in. × 18½in. × 9in.

LASKY'S PRICE **49/6**

Due to the size and packing required we would prefer not to send these cabinets by carrier but if required we will send at a cost of 12/6 to U.K. addresses.

VARIABLE CROSSOVER

THE HARROW CV 1. Gives variable volume control of Woofer and Tweeter. Strong metal construction. Size 4in. × 2¼in. × 1¼in. Screw tag connection

LASKY'S PRICE **22/6** P. & P. 1/6

LASKY'S RADIO FOR FINEST VALUE and COURTEOUS SERVICE!

Equipment and Components AND TAPE RECORDERS

THE FINEST RANGE OF MONO/STEREO MAINS AND TRANSISTORISED PORTABLES

LASKY'S RADIO

TAPE RECORDERS

MAGNAVOX-COLLARO 363 TAPE DECKS

The very latest 3 speed model—1⅞, 3¾, 7½ i.p.s., available with either ½ track or ¼ track head. Features include: pause control; digital counter; fast forward and rewind; new 4 pole fully screened induction motor; interlocking keys. Size of top plate 13¾ × 11in. × 5¾in. deep below unit plate. For 200/250 v. A.C. mains, 50 c.p.s. operation. New unused and fully guaranteed.

LASKY'S PRICE ½ track model £10.10.0

LASKY'S PRICE ¼ track model £13.9.6

Carriage and Packing 7/6 extra.

SPECIAL FOR OVERSEAS CUSTOMERS—the new Magnavox-Collaro 363 Deck for 110/125 v. 50 or 60 c.p.s. mains now available, prices as above. Post to any part of the world 35/-.

MARTIN TAPE RECORDER AMPS.

Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3 ohm output, speed equalising, etc For 200-250 v. A.C. mains. **PRICES:** ½ track Model £11/11/-. ¼ track Model £12/12/-. Post 2/6.

Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9 × 5in. speaker. Price complete with speaker £5/5/-. Post 5/-.

Note: These Amplifiers can be used with the Magnavox 363 deck by a simple alteration to the mounting of record/play switch assembly

SPECIAL BARGAIN SCOOP!!

PORTABLE TAPE RECORDERS BY WORLD FAMOUS MAKER

MODEL CR.1604 These recorders are extremely high quality and are brand new and unused. Many superb technical features include: simple push button operation; uses both valves and transistors; 4 track: parallel track switching on play back; 2 speeds—1⅞ and 3¾ i.p.s.; takes 7in. spools; radio and gram inputs—can be mixed with separate mic. input. 6½in. speaker; provision for foot switch; monitoring with headphones or through speaker: fast forward and rewind. Other features include: 4 digit position indicator: outputs for extra amplifier, external speaker, headphones and stereo socket; record level indicator—can be adjusted with tape stationary. Cabinet with carrying handle finished in two-tone beige polystyrene, size 14 × 14 × 7in.—space for mic. Supplied with moving coil microphone, 5in. tape and empty spool. Fully guaranteed. **Makers List Price 39 gns.**

LASKY'S SPECIAL PRICE 29½ GNS. C. & P. 15/- extra.

HIGH QUALITY TAPE RECORDERS

Supplied complete with crystal microphone, reel of tape and empty spool, also screened lead for recording from radio, pick-up, etc. The following specifications are common to all three models Tone Control, Visual Recording Indicator. Inputs: Microphone, Radio, Record-Player, Radiogram, Telephone, Adaptor, Fully Automatic Erase. **Facilities:** Fast spooling, forward and reverse. **Valves:** Latest Mullard Miniature types. **Rectifier:** S.T.C. or Westinghouse Metal Rectifier. **Loudspeaker:** Standard 3 ohm with extension speaker socket. **Microphone:** new super sensitive crystal in the new easy to hold microphone case. **Carrying Case:** Portable case with detachable lid, harmonising gold trim and automatic safety locks. Storage cubby for microphone and accessories. Covered in new type washable scratch resistant Vinyl. Size for Model B: 14½ × 14 × 5½in. Size for Models C & D: 14 × 12½ × 6½in.

MODEL B Studio Deck. **Two Track. Specification as for Four Track model above, except that this is fitted with Two Track Studio Tape Deck. Maximum** Playing Time: up to 9 hours from one reel of tape.

LASKY'S PRICE 25 GNS. Carriage and Insurance 15/- extra.

MODEL C Fitted with B.S.R. Deck, two-track version. Specification: Single speed, 3¾ i.p.s. Freq. response 10,000 c.p.s. at 3¾ i.p.s. Spool capacity: 5¾in. Mains voltage 200-250 v. 50/60 c/s. A.C. Wow and flutter: Less than 0.2% total. Output: 3 watts. Playing time up to 3 hours.

LASKY'S PRICE 18 GNS. Carriage and Insurance 15/- extra.

MODEL D Fitted with B.S.R. Four Track Deck otherwise same specification as the Model C—but maximum playing time increased up to 6 hrs.

LASKY'S PRICE 21 GNS. Carriage and Insurance 15/- extra

H.P. Terms are available on the above models.

TAPE DECK MOTORS

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size 4in. dia. × 2in. high, 1in. × ⅛in. spindle.

LASKY'S PRICE 15/11 Post 3/6

HI-FI TAPE RECORDER HEADS

	High Play	Imp. Low imp.	Record-erase.
Upper or lower track. State track required	LASKY'S PRICE	29/6	
MARRIOTT "X" Type ¼-track heads	LASKY'S PRICE	4 GNS.	pair.
¼-track heads Record/Play and Erase	LASKY'S PRICE	59/6	pair.
MICHIGAN ¼-track heads	LASKY'S PRICE	5 GNS.	pair.
BOGEN ¼-track heads	LASKY'S PRICE	7 GNS.	pair.

SPECIAL OFFER—¼ track Stereo record/replay Tape Heads. High Imp. Size ¾in. wide × ⅝in. high × ⅝in. deep. Fixing is by single 8 B.A. screw. **New and unused. LASKY'S PRICE 25/-.** Post free.

CONSTRUCTORS BARGAINS

The "Sixteen" Multirange METER KIT

This outstanding meter was featured by Practical Wireless in the Jan. '64 issue. Lasky's are able to offer the complete kit of parts as specified by the designer.

RANGE SPECIFICATION
D.C. volts: 0-2.5-25-50-250-500 at 20,000Ω/V.
A.C. volts: 0-25-50-250-500 at 1,000Ω/V.
D.C. current: 0-50μA, 0-2.5-50-250 mA.
Resistance: 0-2000Ω, 0-200kΩ, 0-20MΩ.
Basic movement: 40μA f.s.d. moving coil. With universal shunt full scale deflection current is 50μA.
Size/finish: Black plastic case—3⅞ × 5⅛ × 1⅝in.
Controls: 12 position range switch: separate slide switch for A.C. volts—D.C. ohms; ohms zero adjustment pot, meter; meter zero. External connections: Two 4 mm. sockets for test lead plugs. Power requirements: One 15 v. and one 1.5 v. batts. Complete with all parts and full construction details.

LASKY'S PRICE £5.19.6 P. & P. 5/-

H.P. Terms: 21/- deposit and 5 monthly Payments of 21/-. Data and circuit available separately, 2/6 refunded if all parts bought. Pair of batteries 2/6 extra.

THE LATEST "KUBA" IMPORTED AM/FM STEREO RADIOGRAM CHASSIS

Long, medium and short waveband coverage, plus V.H.F./F.M. Piano key wavechange. Separate flywheel tuning on A.M. and F.M. Bass, treble and balance controls. Magic-eye tuning indicator. Ferrite rod aerial. The very latest printed circuitry. Provision for multiplex. 5 valves: line-up: ECC85, ECH81, ECC83, ELL80, EAF801 Full vision tuning scale size 21 × 6in. Overall dimensions 21 × 8¼ × 8in. Made to the very highest standards.
Output: 5 watts per channel.

LASKY'S PRICE 29½ GNS. Carriage Free.

"SPECIAL PRIVILEGE PARCEL PACKAGE DEALS"

1. The "Kuba" A.M./F.M. Stereo Chassis with 2 Pamphonic 81 Speaker Systems and Garrard AT6 Stereo Autochanger. **PACKAGE PRICE £49.**
2. As above but with two 10in. P.M. Speakers. 38½ GNS.
3. As above but with two 10in. P.M. Speakers and attractive 4 speed Autochanger. 37 GNS Carriage FREE

7 TRANSISTOR RADIO CHASSIS

Superhet chassis, fully built—by famous British manufacturer—on printed circuit. Uses 7 Newmarket transistors giving 500 m/w push-pull output—3 I.F. stages: ferrite rod aerial. Covers full long and medium wavebands—200/550M and 1200/2000M and switched band spread on 208M (Luxembourg). 4½in. speaker; fitted: volume control on/off switch, tuning dial and position for car aerial socket. Uses any 9V battery. Overall dimensions—7in. × 4½in. × 2in. Absolutely complete except for cabinet.

LASKY'S PRICE 69/6 Post 5/-.

Recommended battery PP6, 2/9 or PP7, 3/3 extra.

Our branch at 33 Tottenham Ct. Rd., W.1, has been appointed as "**International Semi-conductor Centre.**" We now stock the complete range of these products for the development engineer, experimenter and service man. Send 6d to 3-15 Cavell St., E.1., for full catalogue.

MARTIN HI-FI AUDIOKITS

Using specially developed circuits, the very latest transistors and printed circuits—these kits are all fully checked and tested before leaving the factory.

KIT 1.	5 stage Matching Input Selector Unit	LASKY'S PRICE £2/7/6
KIT 2.	Pre-amplifier with volume control	LASKY'S PRICE £1/17/6
KIT 3.	3-Channel Mixer, with plug-in adaptors for individually matching each circuit. Adaptors 8/6 each	LASKY'S PRICE £3/19/6
KIT 4.	Pre-amplifier with tone/volume control stages	LASKY'S PRICE £3/2/6
KIT 5.	10 and 3 watt Main Amplifier	LASKY'S PRICE £5/12/6
KIT 6.	Power supply Converter Unit	LASKY'S PRICE £2/12/6
KIT 7.	15 ohm version of Kit 5	LASKY'S PRICE £6/12/6
KIT 8.	Power supply for Kit 7	LASKY'S PRICE £2/15/-

TRANSISTORS

ALL BRAND NEW AND GUARANTEED

GET 81, GET 85, GET 86 2/6; 837A, 874P 3/6; OC45, OC71, OC81D, 4/6; OC44, OC70, OC76 OC81 (match pair 10/6); 5/6; AF117, OC75, OC200 6/6; OC42, OC43, OC73, OC82D 7/6; OC201, OC204 15/-; OC205, OC206 19/6; OC28 24/6.

TRANSFILTERS

By BRUSH CRYSTAL CO. Available from stock

TO—01B 465 kc/s. ± 2 kc/s.
TO—01D 470 kc/s. ± 2 kc/s.
TO—02B 465 kc/s. ± 1 kc/s.
TO—02D 470 kc/s. ± 1 kc/s.
TF—01B 465 kc/s. ± 2 kc/s.
TF—01D 470 kc/s. ± 2 kc/s.

7/6 EACH Post 6d.

GORLER UT 340 FM/VHF TUNING HEART

Permeability tuned—covering 87 to 108 Mc/s. Designed for use with one ECC85 valve. Built in cast metal case, size 3 × 2¼ × 1¼in. Circuit supplied.

LASKY'S PRICE 15/11 ECC 85 valve 9/- extra. Post and Packing 2/-.

LASKY'S FOR D.I.Y. CONSTRUCTION BARGAINS

P.T.O. FOR MORE NEWS

LASKY'S RADIO

For the Finest Value and
TRANSISTOR RECEIVERS &

THE WIDEST RANGE AVAILABLE TODAY FOR HOME CONSTRUCTION OR READY BUILT TO HIGHEST STANDARDS

We consider our Construction Parcels to be the finest value available on the home construction market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded less postage.

TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE

GENERAL SPECIFICATION
7 transistor plus 2 diode superhet, 6 waveband portable receiver.
The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-49M, and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions. Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

NEW! SKYROVER MK. III (Illustrated). Now supplied with redesigned plastic cabinet, finished in black and grey with chrome trim, edgewise controls. Controls: Waveband Selector. Volume Control with on/off switch. Tuning Control. In plastic cabinet, size 10 × 6¾ × 3½in. with metal trim and carrying handle.

Can now be built for **£8.19.6** Post 5/- extra | H.P. Terms: 27/- deposit and 11 monthly payments of 15/9. | Total H.P.P. £10/0/3.

The SKYROVER De Luxe Tone Circuit is incorporated with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11¼ × 6¾ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for **£10.19.6** Post 5/- extra. | H.P. Terms: 33/- deposit and 11 monthly payments of 19/2. | Total H.P.P. £12/3/10.

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries 3/4 extra. All components available separately.

★ LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER & SKYROVER DE LUXE A simple additional circuit provides coverage of the 1100/1950M band (including 1500M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. Only 10/- extra. Post Free.
This conversion is suitable for Skyrover and Skyrover De Luxe receivers already constructed.

THE "REALISTIC" SEVEN

Fully tunable over long and medium wavebands. Uses 7 Mullard Transistors, plus Diode OA70. STAR features: ★ 7 Transistor Superhet. ★ 350 Milliwatt output 4in. high flux speaker. ★ All components mounted on a single printed circuit board, size 6¾ × 3¾in., in one complete assembly. ★ Plastic cabinet, with carrying handle, size 7 × 10 × 3½in. in blue grey. ★ Easy to read dial. ★ External socket for car aerial. ★ I.F.-frequency 470 Kc/s. ★ Ferrite rod internal aerial. ★ Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver.

Can be built for **£5.19.6** Post 4/6.

REALISTIC SEVEN De Luxe Same specification as standard model—PLUS A SUPERIOR WOOD CABINET covered in washable material, with chrome trim and carrying handle. Also full vision circular dial. ONLY £1 EXTRA.
Both models: Battery 3/9 extra (all components available separately). Data and instruction separately 2/6, refunded if you purchase parcel.

SINCLAIR SUPER MINIATURES

We stock the complete range of Sinclair Super-miniatures.

THE MICRO-6 miniature radio only 1⅘ × 1$\frac{3}{10}$ × ½in.	£2 19 6
THE SLIMLINE 2 transistor pocket radio	£2 9 6
THE MICRO-FM (tuner/receiver)	£5 19 6
THE X-20 20 watt P.W.M. amplifier	£7 19 6
Available ready built, tested and guaranteed	£9 19 6
THE X-10 10 watt amplifier and pre-amp	£5 19 6
Available ready built, tested and guaranteed	£6 19 6

EXPORT MODEL TRANSISTORISED POCKET SIZE TRANSMITTER/RECEIVER ("WALKIE TALKIE")

Model 3200 Transceiver—fully self-contained in one unit, operating from single PP3 type battery. Transmits and receives over an approximate area of ½ mile in town, considerably more in open country. Black plastic cabinets—size 5 × 2¼ × 1½in. 36in. telescopic aerial. Built-in mike/speaker. Brand new and fully guaranteed.

LASKY'S PRICE **£7.19.6** per pair. Post 7/6 (anywhere in world).

MINIATURE EARPIECES

For Transistor Radios. CR5 Crystal high imp. 5/-. MR.4 Magnetic low imp. 6/6 Post free.

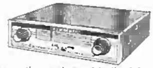
THE HARROW POWER PACK

Battery eliminator for portable radios, etc. Converts your Battery radio to A.C. mains. Replaces 4½ v., 6 v. and 9 v. batts. Size only 3in. × 2in. × 2¼in. State Voltage required when ordering.

LASKY'S PRICE **29/6** Post 2/-.

READY BUILT BARGAINS

SCOOP! FAMOUS BRITISH MAKE TRANSISTOR CAR RADIO



Uses 6 high quality transistors and one diode. Covers full Medium waveband and 1,250 to 1,600 M. on Long waveband. High output suitable for most private vehicles. Illuminated dial—7in. × 2in. front panel will fit all standard cut-outs; only 4in. front to back. Fused for use on 12 v. positive earth systems. Complete with 6in. × 4in. speaker and baffle, fixing brackets and full fitting and operating instructions. Brand new, unused and fully guaranteed.
Maker's List Price was £14 19 6.

LASKY'S PRICE **£9.19.6** Post 5/-.

TRANSISTOR POCKET RADIOS

All supplied complete with personal earpiece, battery and carrying case. Fully guaranteed—ready to use POST FREE.

BOY'S 2 TRANSISTOR In attractive plastic case. Size only 4in. × 2½in. × 1in. Fitted 2¼in. speaker. Socket for personal earpiece. Uses PP3 battery. Tunable over full medium waveband.

LASKY'S PRICE **35/-**

6 TRANSISTOR MODEL
Fully built in plastic case, 4in. × 2¾in. × 1in. with 2¼in. speaker. Uses single PP3 type battery. Tunable over full medium waveband.

LASKY'S PRICE **59/6**

2 Waveband Long and Medium Model. Size 5 × 3¼ × 1¼in. Cream/black plastic case. Incl. earpiece & carrying case.

LASKY'S PRICE **89/6**

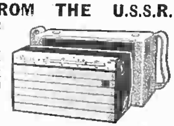
THE "TRANSWAVE" DE LUXE 8 TRANSISTOR TWO WAVEBAND RADIO

8 Sony transistors give super sensitive reception over the full Medium and Long wavebands. Internal ferrite and detachable chrome telescopic aerials. 2¼in. p.m. Speaker. Smart black plastic cabinet with metal trim—size 6¾ × 3¼ × 1½in.
Uses 3 penlight batteries. Complete with leather case and shoulder strap, earpiece and batteries.

LASKY'S PRICE **95/-** Post 2/6

2 WONDERFUL SETS FROM THE U.S.S.R.

THE "SELGA" 7 TRANSISTOR RADIO



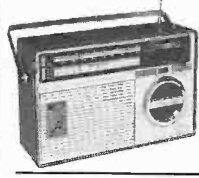
High sensitivity circuit gives excellent reception over full Medium waveband and powerful volume. P.M. Speaker. Uses PP3 type battery. Black and ivory plastic cabinet size 7 × 4 × 2in. Socket for external aerial. Complete with solid hide case and shoulder strap, earpiece and battery.

LASKY'S PRICE **£5.9.6** Post 2/6

THE "SOKOL" 7 TRANSISTOR TWO BAND RADIO

Super quality receiver covering the full Medium and Long wavebands with exclusive rechargeable battery which can be recharged from any 110/250 v. A.C. mains supply. Also operates on PP3 type dry battery. P.M. Speaker. Ivory and black plastic cabinet 6 × 3¼ × 1⅞in. Socket for external aerial. Complete with real leather case, rechargeable battery and charger dry battery and earpiece.

LASKY'S PRICE **£6.9.6** Post 2/6.



SPECIAL PURCHASE OFFER—FAMOUS MAKERS SURPLUS PORTABLE TRANSISTOR RECEIVERS

7 transistor plus 2 diode superhet, 6 waveband portable receiver. Covers the full Medium waveband and Short waveband 31-94M., and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. 500 MW output. Telescopic aerial and Ferrite rod aerial. Plastic cabinet, size 10 × 6¾ × 3½in., finished in mid-fawn with metal trim and carrying handle. Fully built and factory tested.

LASKY'S PRICE **£10.19.6**
4 U2 batteries 3/4 extra. Post 5/-.

BABY ALARM/INTERCOM

Fully transistorised miniature intercom. that has all the features of sets many times its size. Battery consumption is exceptionally low and makes this system particularly suitable for use as a Baby Alarm. Specification: 2 transistor: Sensitivity: more than 55 dB. Power: one 9 v. PP3 or equiv. (approx. life 50 hours). Size of units 4 × 2¼ × 1¼in. The sturdy plastic cabinets are finished in ivory and silver with chrome stands.

P. & P. 2/6. LASKY'S PRICE **59/6**

P.T.O. FOR MORE NEWS

LASKY'S FOR SPEEDY MAIL ORDER SERVICE

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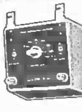
SPEEDY MAIL ORDER SERVICE

LASKY'S RADIO

TEST EQUIPMENT

TEST METER ADAPTOR



Type PE 220—this is a fully transistorised device which enables any 50 microamp D.C. Multimeter to be used in place of a valve voltmeter. On the 1 v. range an impedance of 1 megohm is offered which increases on the 1,000 v. range to 100 megohms. 7 ranges: 1 to 1,000 v. Designed for immediate connection to Avo 8 and similar size meters but quite suitable for use with any other 50 microamp meter. Size 6 × 6 × 5in. New and boxed. List Price 7 Gns.

LASKY'S PRICE 39/6 Post 2/6. Set of batteries 7/5 extra.

READY BUILT TEST METERS

All brand new—complete with test leads and batts.

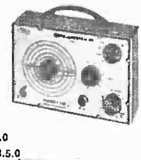
HAIKI 20,000 O.P.V.	LASKY'S PRICE	£5 19 6
TE-13 1,000 O.P.V.	LASKY'S PRICE	£1 19 6
TMK-590 30,000 O.P.V.	LASKY'S PRICE	£8 17 6
200-H 20,000 O.P.V.	LASKY'S PRICE	£5 5 0
P.1 2,000 O.P.V.	LASKY'S PRICE	£2 12 6
P-3 4,000 O.P.V.	LASKY'S PRICE	£4 2 6
MT-559 50,000 O.P.V.	LASKY'S PRICE	£10 19 6

Also complete range of Avo and Taylor Meters and Test Equipment in stock.

JASON TEST EQUIPMENT

AG 10 Audio Generator	Can be built complete for	£15 19 0	Post 4/- extra.
OG 10 Scope	Kit price excluding tube	£17 19 6	Post 4/- extra.
W 11 Wobbulator	Can be built complete for	£14 19 0	Post 4/- extra
EM 10 Valve voltmeter	Can be built complete for	£23 0 0	Post 4/- extra.

NOMBREX TEST EQUIPMENT



MODEL 27 TRANSISTORISED SIGNAL GENERATOR (illustrated)

Wide range—150 kc/s. to 350 Mc/s. Accuracy better than 2%. Direct calibration AF, RF and MOD. Battery operated. Light weight and strongly made. Complete with test leads and batt.

LASKY'S PRICE £9.16.9 Post Free.

OTHER NOMBREX MODELS AVAILABLE.

MODEL 63. Wide range AUDIO GENERATOR 10-100 Kc/s. £16/15/0.

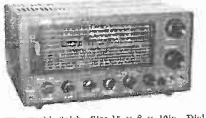
MODEL 66. Wide range INDUCTANCE BRIDGE. 1μH to 100H in 4 ranges. Measures Q. £18/0/0.

POWER SUPPLY UNIT 1 to 15 v. D.C. up to 0·1 amp. 230/250 v. A.C. mains. £6.10.0

MODEL 62 RESISTANCE CAPACITY BRIDGE £8.5.0

COMMUNICATION RECEIVERS

MODEL KT 320 KIT

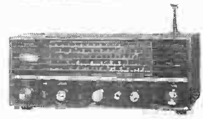


Supplied in sub-assemblies for easy building. Covers range from 540 Kc/s to 30 Mc/s. Ham Band is provided with a scale for direct reading and can also be band spread. 9 valves. Facilities: A.N.L., A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity (all coils and I.F.s are supplied pre-aligned). 2 Aerial Sockets. Stand-by position for use with a transmitter S meter fitted. 200-250 v. A.C. mains. Steel cabinet, grey crackle finish. Size 15 × 8 × 10in. Dial 12 × 4in. All parts new and fully guaranteed. Complete with full construction data and operating manual.

LASKY'S PRICE 25 GNS. POST FREE

Also available ready built and tested 29 gns. H.P. Terms Available.

NEW MODEL SR 150



Covers full medium waveband and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s. and 11.0-30.0 Mc/s. in separate switched band spread ranges. Two aerials are fitted, an internal loop and external telescopic. Controls include: B.F.O. Sensitivity. C.W., A.N.L., tone switch, receive/stand-by, S meter. Easy to read illuminated dial with logging scale. For 200/250 v. A.C. 4 valves plus rectifier. Fitted with internal speaker and socket for phones or external speaker. Cabinet size 13½ × 8½ × 5½in. Complete with full instruction manual.

LASKY'S PRICE 20 GNS. H.P. Terms £5 dep. and 11 monthly payments at £1/14/-. Total H.P. £23/14/-. Post 10/-.

MODEL HE80

14-valve super sensitive communication receiver. Freq. range 540 Kc/s—30 Mc/s and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage. Single R.F. stage, two I.F. stages on all other bands. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter band spread on amateur bands, large illuminated dial with logging scale. All controls fitted. Outputs for speaker and phones. Valve line-up: 4×6AQ8, 3×6BA6, 2×6BE6, 1×6BL8, 6AL5, 6AQ5, 6CA4 and OA2. Steel case 17 × 7½ × 10in. For 200/250 v. A.C. mains. Brand new with full instruction manual. No kits available.

LASKY'S PRICE 59 GNS. H.P. Terms £12 19 - dep. and 11 monthly payments of £4/18/-. Total H.P.P. £66/17/-. Carriage & Packing FREE.

STILL A FEW AVAILABLE · FULLY BUILT

MODEL HE30. LASKY'S PRICE 33 Gns. MODEL HE40. LASKY'S PRICE 18½ Gns.

WE WILL ACCEPT YOUR OLD SET IN PART EXCHANGE

INTERNATIONAL TAPE

Fully Guaranteed at record low prices.

3in.	Message tape. 150ft.	3/6
3in.	Message tape. 225ft.	4/11
3in.	Message Tape. 300ft.	7/6
3¼in.	Triple play. 600ft. Mylar base	15/-
4in.	Triple play. 900ft. Mylar base	17/6
5in.	Double play. 1,200ft. Mylar base	15/-
5in.	Long play. 900ft. Acetate base	10/-
5in.	Standard play. 600ft. P.V.C. base	8/6
5in.	Triple play. 1,800ft. Mylar base	35/-
5¾in.	Double play. 1,800ft. Mylar base	22/6
5¾in.	Long play. 1,200ft. Acetate base	12/6
5¾in.	Standard play. 850ft. P.V.C. base	11/6
5¾in.	Triple play. 2,400ft. Mylar base	45/-
5¾in.	Long play. 1,200 ft. Mylar base	15/-
7in.	Standard play. 1,200ft. Acetate base	10/-
7in.	Standard play. 1,200ft. Mylar base	12/6
7in.	Long play. 1,800ft. Mylar base	19/6
7in.	Double play. 2,400ft. Mylar base	25/-
7in.	Long play. 1,800ft. Acetate base	15/-
7in.	Triple play. 3,600ft. Mylar base	58/6

Post 1/- extra per reel. 4 reels and over Post Free.

TELEPHONE AMPLIFIER

Powerfully amplifies the incoming call. Fully transistorised. Pick-up suction fixed to phone. Battery-operated. Fitted with on/off switch and vol. control. Size 4½ × 3 × 1¾in. Complete with PP3 battery. **LASKY'S PRICE 69/6** Post 2/6.

U.H.F. TUNERS

Limited quantity only. Complete with P.C.88 and P.C.86 valves. Fully variable tuning capacitor, etc. British manufacture. New and unused. Size 4¼in. × 5¼in. × 1¾in. We regret no circuit or data available. Knobs included.

LASKY'S PRICE 59/6 Post 2/6.

EXPORT MODEL—TV OFFER
LIMITED QUANTITY ONLY

625 line T.V. chassis (Export Model). For 200-250 v. A.C./D.C. mains. Fitted with Bands I-III turret tuner. Fully loaded with 12 sets of coils for all CCIR channels in these bands. F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus/magnetic deflection. Will take 17in., 19in., 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves, (less CRT speaker and cabinet). Circuit data included.

LASKY'S PRICE £14.19.6 Carr. & packing in U.K. 10/-. Anywhere overseas 50/-.

CRYSTAL PICK-UP CARTRIDGES
LOWEST PRICES EVER!

All complete with Styli L.P. and Standard, fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Post 1/-

Garrard GC2	17/6
Garrard GC8	15/-
Garrard EVZ6A	19/6
Acos G.P. 67/1	10/6
STEREO Acostereo 73/1, with 2 sapphires	25/-
Acostereo 73/2, with diamond LP/Stereo and sapphire standard	29/6
Ronette Stereo O.V. Turnover with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with 2 sapphires	25/-
Ronette Stereo Type 105 and 106 with diamond LP/Stereo and sapphire standard	35/-

Full range of Goldring and Philips cartridges stocked.

AND EVEN LOWER PRICES

Save Money! Some of these cartridges are cheaper than styli

C.T.1 Mono, 2 sapphires	4/11
Collaro 2 sapphires, stereo	15/-
Collel SC1 diamond LP, stereo	10/6
Sonotone 8T, stereo	19/10
Sonotone 2TA mono	15/-

Postage 1/- extra each.

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Open type—as used by most makers. With reset knob. **3 DIGIT 7/6. 4 DIGIT 10/6.** Post 9d. on each.

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Tel.: MUSeum 2605. Open all day Saturday. Close 1 p.m. Thursday.

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Tel.: FLEet St. 2833. Open all day Thursday. Close 1 p.m. Saturday.

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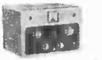
Thoroughly **HEATHKIT** DAYSTROM *dependable*

AMATEUR TRANSMITTER KIT
Model DX-40U



Covers all amateur bands from 80 to 10 metres, crystal controlled. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for VFO. Filters minimise T.V. interference. Modulator and power supplies are built-in. Single knob band switching is combined with a pi-network output circuit for complete operating convenience. A high-grade moving-coil meter indicates the final grid or anode current. Provision is made for the use of 3 crystals with access through a trap-door in the back of the cabinet. A 4-position switch selects the appropriate crystal or a jack for external VFO which can be used instead of the crystal(s).

Kit ... £33.19.0 Assembled ... £45.8.0

SINGLE SIDEBAND ADAPTER KIT
Model SB-10U

May be used with most A.M. transmitters with certain provisions. Allows full use of existing equipment for SSB facilities. Band coverage: 80, 40, 20, 15, 10 m. Unwanted sideband suppression; better than 30 dB. Carrier suppression: better than 40 dB. Power requirements: 300 v. D.C. 85 mA. (average) 30 mA. (standby), 140 mA (transmit), 6.3 v. A.C., 3.5 A. Meter: 2½in. Scale edge reading, 200μA movement, indicates carrier null and relative power output. Cabinet 11in. high x 8in. wide x 14¾in. deep.

Kit ... £39.5.0 Assembled ... £54.18.0

AUDIO SINE-SQUARE WAVE GENERATOR KIT. Model AO-1U

Covers 20 c/s. to 150 kc/s. in four ranges with choice of sine or square waves. The latter up to 25 kc/s. Output 10 v. max. and distortion less than 1%. Ideal for audio testing. Size 9½ x 6½ x 5in.

Kit ... £14.15.0 Assembled ... £21.5.0

GRID-DIP METER KIT. Model GD-1U

Functions as oscillator or absorption wavemeter. With plug-in coils for continuous frequency coverage from 1.8Mc/s. to 230 Mc/s.

Kit...£10.19.6 Assembled...£13.19.6

Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 17/6.

TRANSISTOR INTERCOM KITS
Models XI-1U and XIR-1U

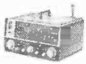
Ideal for home or business use. Up to five remote stations can be operated with each Master. The Master unit can call any one, any combination, or all five Remote stations and any Remote station can call the Master. A private call to any Remote station cannot be interrupted or overheard by any other while a conversation is in progress. Any Remote station can talk to any one or all others provided the Master is manned. These kits have been designed for easy construction and high performance. The mahogany veneered wooden cabinets are supplied completely assembled and finished. The Master unit has a 4-transistor amplifier and is operated by an internal 9 v. battery as are the Remote units. Batteries are not included with the Kits.

Model XI-1U (Master)
Kit ... £10.19.6 Assembled ... £16.19.6

Model XIR-1U (Remote)
Kit ... £4.7.6. Assembled ... £5.16.0

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE.
Send for Lists and Prices.

"MOHICAN" GENERAL COVERAGE RECEIVER KIT
Model GC-1U



This fully transistorised receiver which includes 4 piezo-electric transfilters, is in the forefront of receiver design. It is an excellent portable or fixed station receiver. The R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Its many features include a 10-transistor circuit, printed circuit board, telescopic whip antenna, tuning meter, and a large slide-rule dial giving a total length of approximately 70 inches. Housed in a steel cabinet and powered by two 6 volt dry batteries (not supplied), mounted internally, it gives frequency coverage from 580 kc/s. to 30 Mc/s. in five bands; thus enabling world-wide reception. Electrical bandspread covers the amateur bands from 80 to 10 metres—each band having a scale length of approximately 8 inches. BFO tuning and Zener diode stabiliser. Size 6⅞ x 12in. x 10in.

Please write for specification leaflet.

Kit ... £37.17.6 Asmbld. ... £45.17.6

STABILISED POWER PACK
Models MSP-1M and MSP-1W

Specially recommended for industrial and laboratory use, meeting the need for a reliable and versatile stabilised power pack capable of a very high performance. Input 200-250 v. 40-60 c/s., A.C., fully fused. Outputs: H.T. 200-410 v. D.C. at 0-225 mA. in 3 switched ranges. Unstabilised A.C., 6.3 v. at 4.5 A. centre-tapped. Two 3in. "easy-to-read" meters for reading voltage and current simultaneously. Separate L.T. and H.T. supply transformers. All output circuits are isolated. Size 13in. x 8¼in. x 9½in.

MSP-1M (with meters)
Kit ... £36.12.6 Asmbld. ... £43.12.6

MSP-1W (less meters)
Kit ... £29.17.6 Asmbld. ... £36.17.6

BALUN COIL UNIT KIT

Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300Ω impedance. Frequency range 10-80 m., input up to 200 watts.

Kit ... £4.15.6 Asmbld. ... £5.8.6

TAPE PRE-AMPLIFIER KITS
Models TA-1M and TA-1S

This Combined Tape Record/Replay Amplifier is available in both monophonic and stereophonic models. Model TA-1M can be modified to the stereo version with modification kit TA-1C.

TA-1M Kit £19.8.0 Asmbld. £28.18.0
TA-1S Kit £25.10.0 Asmbld. £35.18.0
TA-1C Kit ... £6.15.0

All prices include free delivery in the U.K.

Deferred Terms
are available on all orders above £10

AMATEUR TRANSMITTER KIT
Model DX-100U
The World's most popular Amateur TX Kit

- Completely self-contained. 150 w. D.C. input.
- Built-in highly stable VFO and all Power Supplies.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Keying on CW is via the VFO and buffer amplifier cathodes: the other RF valves are biased beyond cut-off.
- Provision has been made for remote control operation.
- Covers all Amateur bands up to 30 Mc/s. 'phone or CW.

Kit ... £79.10.0 Assembled...£104.15.0

AMATEUR BANDS RECEIVER KIT

Model RA-1 The ideal economically priced fixed station, portable or mobile receiver covering the Amateur bands from 160-10 m., each band separately calibrated on a large illuminated slide-rule dial. Features: Signal strength meter, tuned RF amplifier stage, half-lattice filter, adjustable noise limiter. Freq. coverage 160, 80, 40, 20, 15, 10 metre bands. I.F. 1620 kc/s.

Kit ... £39.6.6 Assembled ... £52.10.0

AMERICAN HEATHKIT
SINGLE SIDE BAND EQUIPMENT

For direct delivery from U.S. Plant. Send for details of models. Fully illustrated American Catalogue of Heathkit range sent for only 1/- post paid.

REFLECTED POWER METER KIT

Model HM-11U. Indicates, reliably but inexpensively, whether the R.F. power output of your transmitter is being transferred efficiently to the radiating antenna.

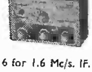
Kit ... £8.5.0 Assembled ... £10.10.0

VARIABLE FREQUENCY OSCILLATOR KIT. Model VF-1U

Specially designed to meet the demand for the maximum possible flexibility from an amateur Transmitter which would otherwise be subject to certain limitations imposed by crystal control. Calibrated for all Amateur bands 160-10 metres, fundamentals on 160 and 40 m. Ideal for Heathkit DX-40U and similar transmitters.

Kit ... £10.17.6 Assembled ... £15.19.6

Q MULTIPLIER KIT. Model QPM-1



A reasonably priced Q Amplifier for the amateur and short-wave enthusiast. This self-powered unit (200-250 v. 50/60 c/s.) may be used with communications receivers to provide both additional selectivity and signal rejection.

Models QPM-1 for 470 kc/s. IF. QPM-16 for 1.6 Mc/s. IF.

Kit, either model £8.10.0
Assembled £12.14.0

By arrangement with RECORD HOUSING we can now supply you with any one of their large range of fully finished Equipment Cabinets.
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In response to the request of many customers, we have opened a showroom and retail stores at
233 TOTTENHAM COURT ROAD, W.1.
When you are in town we hope that you will visit us there.

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DAYSTROM LTD., Dept. WW3, GLOUCESTER, ENGLAND.

HIGH GAIN TV PRE-AMPLIFIER BAND I B.B.C. Tunable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price 32/6 or 55/- with power pack. Details 6d. (PCC84 valve if preferred for 0.3a. heater chains) BAND III I.T.A. same prices. Tunable channels 7 to 13. Gain 17dB.
COILS & CIRCUIT ONLY 9/6. CHASSIS 4/9. BAND I OR III.

FULL WAVE BRIDGE SELENIUM RECTIFIERS: 2, 6 or 12 v. outputs, 1½ amps., 8/9, 2 a. 11/3, 4 a. 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amp., 15/6; 2 amps. 17/6; 4 amps. 22/6. Circuit included. Amp. meter 0 to 5 amp., 16/6

BEST BRITISH PVC RECORDING TAPES

L.P. 7in. 1800ft.	19/6	D.P. 7in. 2400ft.	29/6
L.P. 5¾in. 1200ft.	14/6	D.P. 5¾in. 1800ft.	24/6
LP. 5in. 900ft.	11/6	D.P. 5in. 1200ft.	18/6

MOVING COIL MULTIMETER TK20A. 0-1,000 v. A.C./D.C. ohms. 0 to 100 K., 0-150 mA. Pocket size 2in. scale, 49/6

NEW MULLARD TRANSISTORS

OC71 6/-; OC72 7/6; OC81D 7/6; OC81 7/6; AF115 10/6; AF114 11/-; OC44 8/-; OC45 8/-; OC171 9/-; OC170 8/6; AF117 9/6; OC26 12/6; Transistor Holders 1/3. Sub-Miniature Condenser. 0.1 mfd., 30 v. 1/3; 1, 2, 4, 5, 8 16, 25, 30, 50, 100, 500, 1000 mfd. 15 volt 2/6.

VALVE HOLDERS. EA50 6d. MOULDED Int. Oct. 6d. Mazda Oct. 6d.; B7G, B9A, B8G, B9A, 9d.; Screen Cans B7G, B9A, 1/-. Ceramic Oct. EF50, B7G, B9A, 1/-. Valve base plugs 2/3.

Volume Controls

Long spindles. Midget Pots ½ K. ohms to 2 Meg. LOG or LIN. L/S. 3/-. D.P. 5/-. Stereo L/S 10/6. D.P. 14/6. Linear or Log Tracks.

80 Ohm CABLE Coax

Semi-air spaced 6d. yd. 40 yds. 17/6. 60 yds. 25/-. Low loss 5dB per 100ft. at 500 mc/s. Ideal 625 lines **1/6 yd.**

COAXIAL PLUG 1/-. PANEL SOCKETS 1/-. LINE SOCKETS 2/-. COAX OUTLET BOXES, SURFACE OR FLUSH 4/6.

BARGAIN XTAL PICK-UP ARM

Complete with ACOS LP-78 Turnover Head 20/- ....Stereo 30/-

TRANSISTOR MAINS ELIMINATORS 29/6

PP1-6 v., PP9-9 v. "Same size as batteries." DOUBLES 42/6. PP1 + PP1, PP9 + PP9, PP11 — 4½ + 4½. Miniature 9 v. 19/6

WEYRAD P50

RA2W 6in. Ferrite Aerial with car aerial coil	12/6
Osc. P50/1AC	5/4
1st and 2nd I.F. P50/2CC 470 kc/s.	ea. 5/7
3rd. I.F. P50/3CC	6/-

— Transistor Coils

Spare Cores 6d. Book	2/-
Driver, Trans. LFDT4	9/6
Printed Circuit, PCA1. Ready drilled and printed	9/6
J.B. Tuning Gang	10/6
3 ohm OP Transf.	10/6

Baker Reproducers

LABORATORY STANDARD LOUDSPEAKERS

Utilising the D.W.I. (Differential Wave Impedance) CONE, as described in the March to June 1965 issues of *Hi-Fi News* (Patent No.45620/64) Designed expressly for quality checking by Professional Engineers and for Hi-Fi enthusiasts who wish to acquire outstanding smoothness, crystal clear transient response and freedom from coloration. These features will be immediately apparent to all discerning listeners.

	12in. Model	15in. Model
Max. Power:	15 watts (30w. U.S.A.)	20 watts (40w. U.S.A.)
Bass Resonance:	22-27 c.p.s.	18-25 c.p.s.
Flux Density:	15,000 gauss	15,000 gauss
Voice Coil Impedance:	15/16 ohms	15/16 ohms
Material:	Aluminium	Copper
Response ± 5dB:	50-15,000 c.p.s.	50- 8,000 c.p.s.
Useful Response:	20-18,000 c.p.s.	20-12,000 c.p.s.
Chassis Material:	Solid Aluminium	Solid Aluminium
Price	£22. 10. 0.	£28. 10. 0.

Full specification, details of the 1966 range of Baker Speakers and enclosure plans on request.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER, 200/250 V. A.C. 35/-

Garrard "1000" Changers Mono	£6 10 0	Stereo 10/- extra
Garrard Model 50 Changers Mono	£8 10 0	
Garrard Model AT60 Changers Mono	£10 10 0	

C.R.T. BOOSTER TRANSFORMERS.. 15/6 for heater cathode short circuit or tubes with failing emission. Full instructions supplied. mains input. **Optional 25% and 50% boost 2 v. or 6.3 v. or 12.6 v. State voltage required**

JACK SOCKETS Std. open-circuit 2/6 close-circuit 4/6. Lead jack 6/-. Grundig type 3-pin 1/3; Grundig Lead Type 3/6. Phono Plugs 1/-. Socket 1/-. Banana Plugs 1/-. Sockets 1/-. JACK PLUGS STANDARD. Screened 3/-. Grundig 3-pin 3/6. BULGIN NON-REV PLUGS and SOCKETS P74 2-pin 4/3 P73 3-pin 4/6; P194 6-pin 6/6; P466 6-pin 12/6; P360 4/-.
RESISTORS. Preferred values 10 ohms to 10 meg. ½ w., ¼ w. 1 w. 20% 4d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.
HIGH STABILITY. ½ w. 1% 2/-. Preferred values. 10 ohms to 10 meg. HIGH STABILITY 5% 10 ohms to 22 meg. 9d.

5 watt	Low ohms 0.5 to 8.2 ohm 3 w.	1/6
10 watt	WIRE-WOUND RESISTORS	1/9
15 watt	10 ohm to 6,800 ohms	2/-

10K 15K 20K 25K 10W.......3/-
MAINS DROPPERS. Midget. With sliders. 0.3a., 1K., 0.2a, 1.2 K., 0.15a., 1.5K., 0.1a, 2 K ....each 6/-
LINE CORD 100 ohms ft. 3-way 1/- ft.

WIRE - WOUND Pots 3 WATT miniature T.V. Type. All values 10 ohms to 25K 3/- ea.; 30K 4/-; Carbon 30K. to 2 meg. 3/-

WIRE - WOUND 4 WATT STANDARD SIZE POTS LONG SPINDLE VALUES 50 OHMS to 50 K., 6/6; 100 K., 7/6.

SPEAKER-FRET. Tygan various colours, 52in. wide from 10/- ft.; 26in. wide from 5/- ft. Samples, large, S.A.E.
EXPANDED METAL. Gold or Silver 12 × 12in., 6/-.
ARDENTE TRANSISTOR TRANSFORMERS
D3035, 7.3 CT; 1 Push Pull to 3 ohms for OC72, OC81......11/-
D3034, 1.75: 1 CT. Push Pull Driver for OC72, OC81......11/-
D3058, 11.5: 1 Output to 3 Ohms for OC72, OC81..........11/-
D239, 4.5: 1 Driver; D240, 8.5: 1 Driver ....ea. 11/6
ARDENTE TRANSISTOR POT 5K., switched VC1545....... 5/3

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BLANK ALUMINIUM CHASSIS. 18 s.w.g. 4 sides, riveted corners, lattice fixing holes, 2½in. sides 7 × 4in., 5/6; 9 × 7in. 6/6; 11 × 3in. 6/6; 11 × 7in. 7/6; 13 × 9in. 9/6; 14 × 11in. 12/6; ALUMINIUM PANELS 18 s.w.g. 12 × 12in. 5/6; 14 × 9in. 4/6. 12 × 8in. 3/6; 10 × 7in. 2/9; 8 × 6in. 2/-; 6 × 4in. 1/6.

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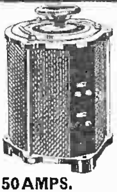

50 AMPS.

1 AMP.

INPUT 230 v. A.C. 50/60 ~. BRAND NEW. Carriage Paid. Buy direct from the importer, keenest prices in the country. All Types (and Spares) from ½ to 50 amp. available from stock.

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0-260 v. at 2.5 amps.	......	5	17	6
0-260 v. at 4 amps.	......	8	7	6
0-260 v. at 5 amps.	......	9	0	0
0-260 v. at 8 amps.	....	13	10	0
0-260 v. at 10 amps.	......	17	0	0
0-260 v. at 12 amps.	......	19	10	0
0-260 v. at 15 amps.	......	22	0	0
0-260 v. at 20 amps.	......	32	10	0
0-260 v. at 37.5 amps.	......	65	0	0
0-260 v. at 50 amps.	......	85	0	0

15 DIFFERENT TYPES AVAILABLE FOR IMMEDIATE DELIVERY.

INSULATED TERMINALS available in black, red, white, yellow, blue and green. New 15/- per doz. P. & P. 1/-.

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Reversible 1/12th h.p. 1,450 r.p.m., ⅜in. dia. 1 in. long shaft. Mounted in anti-vibration cradle. **Supplied complete with precision 20-1 reduction gear box, and pulleys.** Made to highest standard for computer work. Ex equip. First class condition.
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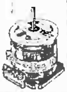
Designed for Panel Mounting
Input 230 v. A.C. 50/60 ~. Output variable 0-260 v.

½ amp.	....	£3 3 0
1 amp.	....	£4 17 6
2½ amp.	....	£5 12 6

½ AMP. **1 AMP.**



SLIDER RESISTANCES

1 ohm, 12 amp., 17/6; 1 ohm, 20 amp. 27/6; 1.2 ohm, 14 amp. 27/6; 75 ohm, 2 amp. 37/6; 200 ohm, 1.25 amp. 37/6; 36 ohm, 6.5 to 2.8 amp., tapered winding, geared drive (less knob), 37/6. P. & P. 3/6.

100 WATT POWER RHEOSTATS (NEW)

Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty. AVAILABLE FROM STOCK IN THE FOLLOWING 9 VALUES: 10 ohm, 3 a.; 25 ohm, 2a.; 50 ohm, 1.4 a.; 100 ohm, 1 a.; 250 ohm, .7 a.; 500 ohm, .45 a.; 1,000 ohm, 280 mA.; 1,500 ohm, 230 mA.; 2,500 ohm, .2 a.; Diameter 3½in. Shaft length ⅞in., dia. 5/16in. 27/6. P. & P. 1/6.

NOW ALSO AVAILABLE IN 25 WATT

10 ohm, 1.5 a.; 25 ohm, 1 a.; 50 ohm, .75 a.; 100 ohm, .5 a.; 250 ohm, .3a; 500 ohm, .2 a; 1,000 ohm, .15 a; 1,500 ohm, .12 a.; 2,500 ohm, .1 a; all at 14/6. P. & P. 1/6.

7 Amp. A.C./D.C. Variable Output Power Unit

Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 v. A.C. OR 0 to 230 v. D.C. at 7 a. Robustly constructed in metal case, complete with safety fuse, neon indicator and voltmeter. Size 17 × 13 × 7in. Weight 36 lb. Price £34/10/-. Carriage 20/-.

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Transformer to suit the above. Input 200-240 v. A.C., 12 volt 36 watts, 16/6. P. & P. 2/6. Input 200-240 v. A.C. 12 volt 60 watt, 22/6. P. & P. 3/6.
Set of 4 Colours FLUORESCENT PAINT. Red, yellow, green and cerise. In ½ oz. tins. Ideal for use with the above Ultra Violet Bulbs, 9/6. plus 1/6 P. & P.

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SIEMENS SEALED HIGH SPEED RELAYS

H96A, 2.2 ohm + 2.2 ohm. H96G, 50 ohm + 50 ohm. H96C, 145 ohm + 145 ohm. H96E, 1,700 ohm + 1,700 ohm. All at 12/6 each. P. & P. 1/- on each Relay.

P.O. RELAYS, Type 3000

100 ohm, 3 c/o, 2 make, 2 break. 200 ohm, 6 c/o. 300 ohm, 1 Heavy duty c/o. 500 ohm, 4 Heavy duty make. 2,000 ohm, 4 make, 4 break. 10,000 ohm, 2 make, 2 break. All at 12/6 each. 20,000 ohm, 2 Heavy duty make. Plus 1/- P. & P.

SOLENOID. Overall length 3⅛in., stroke ⅛in. to ¼in. Maximum push 8 oz. 12-24 v. D.C. operation. D.C. resistance 35 ohm. Price 8/6. P. & P. 1/6.

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M1069 5,000 ohm, 2 c/o. M1084 180 ohm, 4 c/o. M1092 670 ohm, 4 c/o. M1095 670 ohm, 2 m. 2 b. M1100 670 ohm, 2 c/o. Ex new equipment. All at 12/6 each, plus 1/- P. & P.

14,000 OHM SEALED RELAY. High Speed single c/o. Platinum contacts. Super-sensitive, ideal for Transistor circuitry. Will operate, on 1 milliamp, 25/-. P. & P. 1/-.

CARPENTER POLARISED RELAY. Type 5A7 TR 2×1,900 turns at 55 ohm. Including Base 25/-. P. & P. 1/-.

12-18 VOLT D.C. RELAY

168 ohm coil, 3×5 amp. N.I. c/o contacts. New, 16/6 plus 1/- P. & P.

"CABY" MULTI-RANGE TEST METER

Model B10. D.C. volt, 0.5 v. 2.5 v. at 10,000 ohm per volt. Ideal for transistor circuit testing. A.C. and D.C. volt, 10 v., 50 v., 250 v., 500 v., 1,000 v. at 4,000 ohm per volt. Resistance, 2K ohm, 200 K ohm, 2 megohm, 20 megohm. Fully guaranteed, complete range of spares available from stock. Price includes Test Leads, Battery, Instruction book, Packing and Post (U.K.). Price £6/2/6. Three additional models available. Prices from 54/- to £14/14/-. Leaflet gladly sent on request.

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4 figure 10 impulses per second. Type 100D, 4.1 ohm coil, 3-6 v. D.C. operation. Type 100A, 500 ohm coil, 18-24 v. D.C. operation. Type 100B, 2,300 ohm coil, 36-48 v. D.C. operation. Any type, 15/- each, plus 1/6 P. & P.

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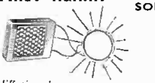
4 figure 1,000 ohm coil, 36-48 v. D.C. operation. £3/10/-. P. & P. 1/6.

FIRST AGAIN! TYPE 34R SILICON SOLAR CELL



Four .5 volt units series connected in high impact polystyrene case, flying lead connections. Specially designed diffusing lens system to ensure maximum light pick-up. Output—up to 2 v. at 16-20 mA in bright sunlight. Wider spectral response, and thirty times the efficiency of selenium cells. As used to power earth satellites! 37/6 and 1/- P. & P.

JUST PUBLISHED "SOLAR CELL & PHOTO-CELL EXPERIMENTERS' GUIDE." Teaches the principles of light sensitive devices and their application. 26/-, post paid.

MINIATURE IMMERSION HEATER. 6in. × ½in., 240 volt, 120 watts, 6/6, plus 2/- P. & P.

230 v. A.C. RELAY. Type 1, 2 c/o. 2 amp. contacts. 9/6. Type 2.2 × 15 amp. break, 2 × 2 amp. make, 1 × 2 amp. break. 11/6. Both types, ex new equip. P. & P. 1/6 each.

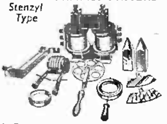
HIGH SPEED BLOWER UNIT

200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. 17/6, plus P. & P. 2/6.

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/6/6 each. P. & P. 4/6. 500 watt type £3/7/6 each. P. & P. 6/6. 1,000 watt type £4/10/- each. P. & P. 7/6.

UNIVERSAL DEMONSTRATION TRANSFORMERS

Stenzyl Type



A complete composite apparatus, comprising a robustly built Transformer and electro-magnet with removable coils and pole pieces. Coil tapped for 230 v., 220 v., 110 v., 115 v.; 6, 12, 36, 110 v. A.C. These coils are also used for D.C. experiments. Complete with all accessories as shown. £17, plus 10/- carr. Leaflet on request.

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RS300 Series. All types 1.5 amp. wire ended.
RS310, 100 v. P.I.V. 4/– RS350, 500 v. P.I.V. 8/–
RS330, 300 v. P.I.V. 6/– RS360, 600 v. P.I.V. 9/–
RS340, 400 v. P.I.V. 7/– RS380, 800 v. P.I.V. 10/–
4 can be used to make 3 amp. bridge. Not Seconds. Brand New Stock. Post paid.

230 VOLT A.C. GEARED MOTORv

Type D15G 5 r.p.m. 1.7lb. inch £2/9/6. P. & P. 2/6.
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UNISELECTOR 8 bank, 25 way, all non-bridging, full wipers, twin coil, 950 ohm. Unused £3/2/6. P. & P. 4/6.

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Kit and parts including ORP.12. Cadmium Sulphide Photocell, Relay, Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operations. Price 25/-, plus 2/6. P. & P. **ORP.12 and Circuit 8/6, post paid.**

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Incorporates main transformer, rectifier and special relay with 3×5 amp. mains c/o contacts. Price inc. circuit 47/6, plus 2/6 P. & P.

0-4 MINUTE MECHANICAL TIMESWITCH. 16 amp. D.P. switch, complete with knob. Will switch off any setting between 0-4 min. As new, fraction of maker's price. 10/-. P. & P. 2/6.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY. 7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2¼lb. £4/12/6, post paid. (Illustrated).

TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230 v. A.C. or Battery operated. Incorporates built-in monitor Oscillator Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price £16/10/- plus 4/6 P. & P.

TRANSISTORISED MORSE OSCILLATOR Fitted 2½in. Moving Coil Speaker. Uses type PP3 or equiv. 9 v. battery. Complete with latest design Morse Key. 22/6, plus 1/6 P. & P.

KEYING LEVER. Especially designed for use with electronic keyers. Fully adjustable micro-switch action, precision made, finely polished parts, screw down base. Price £4/4/-, post paid.

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1st grade			Brand new
OC29* ..18/–	OC139 .. 12/–	AF115 ..10/–
OC41 .. 7/–	OC140 ..19/–	AF116 ..10/–
OC44 .. 6/6	OC171 .. 9/–	AF117 .. 9/6
OC45 .. 5/–	OC200 ..10/6	BCZ11 ..10/–
OC71 .. 5/–	Get 104 6/–	
OC72* .. 7/–	Get 104 6/–	**DIODES**
OC73 .. 6/–	Get 105 10/–	
OC75 .. 7/–	Get 573 12/6	OA91 .. 3/–
OC76 .. 6/–	2S019 ..30/–	SX781 .. 4/–
OC81 .. 8/–	AC107 ..14/6	IS111 .. 4/–
OC83* .. 6/–	AF114 ..11/–	ZS10B .. 3/–

*Available in Matched Pairs.

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All ¼ watt 5% at 10/- each, 4.3 v., 4.7 v., 5.1 v., 5.6 v., 6.2 v., 6.8 v., 7.5 v., 8.2 v., 9.1 v., 10 v., 12 v., 15 v., 16 v., 22 v.

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All primaries 220-240 volts.

Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36 v. at 5 amps.	£2/19/6	6/–
2	30, 40, 50 v. at 5 amps.	£4/15/-	6/–
3	10, 17, 18 v. at 10 amps	£3/2/6	4/6
4	6, 12 v. at 20 amps.	£3/12/6	6/6
5	17, 18, 20 v. at 20 amps.	£5/2/6	6/6
6	6, 12, 20 v. at 20 amps.	£4/15/-	7/6
7	24 v. at 10 amps.	£3/9/6	5/6
8	28, 29, 30, 31 v. at 21 amps.	£6/15/-	10/–

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.
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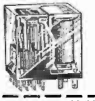
VEROBOARD The perforated Copper Board for Modern Circuitry.
15 × .15 pitch, 2.5 × 3.75, 3/-; 2.5 × 5, 3/8; 3.75 × 3.75, 3/8; 3.75 × 5, 5/-. Spot face cutter, 9/-. Special Veropins, pkts. 200 14/-. P. & P. on all items 1/-.

VAN DE GRAAF ELECTRO-STATIC GENERATOR,

fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price £6/6/- plus 4/- P. & P. *Leaflet on request.*



Latest type **SIEMENS MINIATURE RELAY** in Transparent Case. 2 c/o 700 ohm coil, size ⅞ × ⅞ × 1⅜in. 15/- including base.

Similar to above. Mfg. by GRUNER 4 c/o, 2,400 ohm coil. New, 12/6, less base.

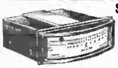
12 VOLT D.C. RELAY

Single c/o, 600 ohm coil. New. 2 for 10/- plus 1/6 P. & P.

ELECTRIC CHECK METER (Sangamo Weston). 200/240 volt A.C., 40 amp. As new 35/- plus 3/6 P. & P.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY "37/6". The ideal instrument for workshop lab. or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. 37/6, plus 3/- P. & P.

SANGAMO WESTON



Type S32
2½ Edgewise Meter
250 Micro-amp., scaled in dB.'s. New 29/6, P. & P. 1/-.

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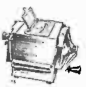

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8in., W. 4in., H. 6in. Weight 6lb. 500 volt 500 megohms. Price £22, carriage paid. 1,000 volts, 1,000 megohms, £28, carriage paid.

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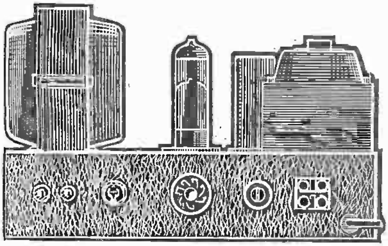
Justly famous—superb Hi-Fi designs from the Mullard Applications Research Laboratory, meticulously executed by Stern and Veritone. Buy them as hand-built and tested units, or in Stern-Clyne's famous Homebuild Kit form. Either way provides performance per £ unequalled anywhere. If you are working to a budget, kits offer a real saving plus real building satisfaction. Each is absolutely complete and backed by comprehensive, easy-to-follow building instructions.



FIVE-TEN AMPLIFIER

One of the most famous amplifiers ever made—thousands are in service as the nucleus of high quality installations throughout the world. Check the phenomenal performance unmatched by any other amplifier obtainable in this price range: Freq. response 5 c/s. to 30 kc/s. flat ± 1 db. Distortion 0.1% at full 10 watts output. Noise —65 db. below 10 watts. Input signal 40 mV. for 10 watts. Out. Imp. 3 or 15 ohms. Valves EZ81, EF86, ECC83, 2 × EL84. Size overall: 10 × 7 × 6½in. high. Incorporates mains outlet for gram and aux. supply of 250 v. at 45 mA. and 6.3 at 2½ amps. for pre-amp, tuner, etc. To full Mullard specification.

Assembled and tested **£13-10-0** Kit **£10**

Carr. 6/6.

FIVE-TEN AMPLIFIER AND TWO-VALVE PRE-AMP. Assembled and tested £21/10/-
Add 8/6 carriage. Kit 15 gns

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Assembled and tested £25/10/-
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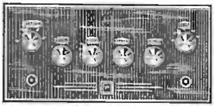
TWO-VALVE PRE-AMPLIFIER

Specially designed for use with the Mullard series of 3, 10 and 20 watt amplifiers but entirely suitable for all Hi-Fi power units not requiring input of more than 250 mV for full output. Features include inputs for crystal and variable reluctance pick-ups with RIAA equalization, plus radio, sensitive microphone, and tape replay direct or from pre-amp. Controls include 6-position selector, volume, and wide range bass and treble boost. Valves 2 × EF86, size 9¼ × 4¼ × 2¼in. high. Panel 10½ × 2¾in. Requires 300 v. at 3 mA. and 6.3 v. at 0.6 amps.

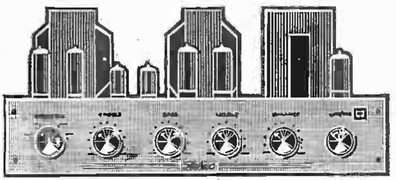
Assembled and tested **£9-10-0**
Add 6/- carriage. Kit **£6-6-0**



THREE-VALVE PRE-AMPLIFIER

Specially recommended for use with the 5-10 amplifier, but also suitable for use with all Mullard series mono amplifiers and any high quality unit requiring an input of up to 250 mV. for full output. Features include: wide range Bass and Treble controls, high and low pass filters, auxiliary input and record output sockets, switched inputs for crystal or magnetic pick-ups, radio, tape playback and auxiliary. Power required 250 v. at 6 mA. and 6.3 v. at 1 amp. Valves 2 × EF86 and ECC83. Size 11 × 4¼ × 4in. high. Panel 12 × 4¾in.

Assembled and tested **£13-13-0**
Add 5/- carriage. Kit **£10-10-0**



TEN PLUS TEN STEREO AMPLIFIER

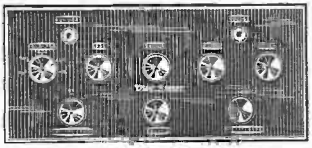
Basically two Five-Ten amplifiers with design variations that exploit the exceptional qualities of the Mullard ECL86 Triode/Pentode. Add Stern engineering to a very exacting specification and the result is Stereo performance of the highest quality at astonishingly low cost. Freq. response 5 c/s. to 60 kc/s. flat ± 3 db. Sens. 23 mV. for full 10 watts output each channel. Noise —65 db. below 10 watts. Cross talk —60 db. Distortion 0.2% at 10 watts. Out. Imp. 3.75, 8 and 15 ohms from sectionalized secs. of special Ultra Linear output trans. Valves 2 × EF86, 4 × ECL86, GZ34, Size 14 × 6¼ × 6¼in. high. Aux. output for pre-amp. 300 v. at 6 mA. and 6.3 v. at 1½ amps. Illustration shows amplifier fitted with Passive Control Unit (see right).

Assembled and tested **£20-0-0**
Add 8/6 carriage. Kit **£16-0-0**

PASSIVE CONTROL UNIT

Specially designed, self-contained unit for use with the Ten plus Ten, either for direct attachment to chassis or for remote fitting. Incorporates switched inputs for crystal or ceramic pick-up, radio and tape replay, together with Vol., Bass, Treble and Balance controls on an attractively styled and finished front panel. Sens. 230 mV. for 10 watts. Imp. 500 K. Size 14 × 2 × 2in. Panel 15¾ × 2¾in. For dynamic or low output pick-ups, use Dual Channel pre-amplifier described below.

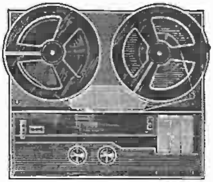
Passive Control Unit, assembled and tested and complete with Ten plus Ten Amplifier **£24-0-0**
Kit **£20-0-0**
Add 10/- carriage.



DUAL CHANNEL PRE-AMPLIFIER

Actually twin Two-valve Pre-amplifiers which together provide an extremely versatile and sensitive input arrangement for the Ten plus Ten amplifier in place of the Passive Control Unit. Features include dual inputs for mono and stereo Magnetic, Variable Reluctance, Crystal and Ceramic pick-ups, dual inputs for direct and pre-amplified tape playback and radio; separate continuously variable Bass, Treble, and Volume and Balance controls. Switching permits Mono or Stereo operation, equalization conforms to RIAA on disc replay. Power input 250/350 v. at 6 mA. and 6.3 v. at 1 amp. Size 11 × 5 × 4in. high. Panel 12 × 4¾. **Assembled and tested and supplied complete with Ten plus Ten Amplifier. £34. Kit £27.** *Add 10/6 carriage.* **Dual channel pre-amplifier only. Assembled and tested £15. Kit £12/10/-.** *Add 5/- carriage.*

MAGNAVOX 363 TAPE TRANSPORTER



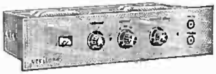
Manufactured to precise limits that permit recording and tape playback to the highest standard set by the Music Industry.

Simple, reliable design employs a single high-duty motor with heavy flywheel. Features include, fast wind on and rapid rewind, pause control, 3-speed selection with interlock. Built-in revolution indicator, piano key controls. Speeds 1⅞, 3¾ and 7½ i.p.s. Wow and flutter 0.15% on 7½ i.p.s. Max. spool size 7in. Playing time up to 120 mins. per track from 1,200ft. standard tape. Size 13¼ × 11in. plus 5¼in. below mounting board.

With ½ track heads, **£10-10-0**
With ¼ track heads, **£13-19-6**

Add 10/- carriage and insurance.

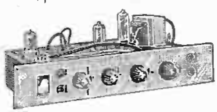
TAPE PREAMPLIFIER TYPE "C"



Specially developed by Mullard Laboratories for use with high quality replay systems, and supplied specifically matched for use with the Magnavox 363 tapedeck.

Features include: Ferroxcube pot core inductors for treble equalization, push pull oscillator incorporating ferroxcube transformer, adjustable output for matching to existing high-quality amplifier systems inputs for Mic., Pick-up, Radio etc. Valves: 3 × EF86, ECC82 & EM81. Totally enclosed in case, size 11¼ × 6¼ × 3¾in. high. (Panel 11¾ × 3¼in.). Power supply of 300v dc at 25 mA. and 6.3 v. at 1.5 A. Is on separate sub-chassis size 6¼ × 4½ × 4¼in. high to facilitate remote location from tape heads. **Pre-amp and power pack Kit of parts £14. Assembled and tested £19/10. Add 7/6 carr**

HF/TR3 TAPE AMPLIFIER



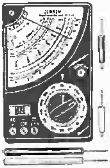
Easily the best complete tape amplifier available to the home builder. Supplied already matched for the Magnavox 363 tapedeck.

Features include: switched equalization for all speeds (CCIR standards at 7½ i.p.s.). Treble boost incorporated during Record, Bass boost during playback, speaker output matched for 3, 7.5 and 15 ohms, additional outputs for extension speaker, phone monitoring on Record and Hi-Fi playback through existing systems, Inputs for Mic. pick-up and VHF Radio. Valves: EF86, ECC83, EL84, EM81, EZ81. Size overall: 11 × 6 × 6in. (Panel: 13¼ × 3in.). Power pack on separate chassis, size 7¼ × 3 × 4¾in. **Amp. Power Pack, Kit of Parts. £13/13 Assembled and tested £19.** *Add 7/6 carr*

CLEAR-OUT OFFERS OF WELL KNOWN HIGH-GRADE EQUIPMENT

Prices slashed to make way for new stock ranges!

Genuine Bargains! Original prices quoted are exactly those at which we have sold previously.



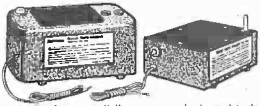
Type 200H—20 ranges, 20,000 ohms per volt sensitivity.

FAMOUS MULTI-TESTER AT TWO-THIRDS USUAL PRICE

Size only 3¼ × 4½ × 1in. deep with ingenious design providing an extra large, easily read scale. Magnificently damped jewelled meter movement. Fitted with low loss, long life ceramic selector switch, complete with leads and test prods, battery and full instructions.
Ranges: D.C.v.: 0-5-25-50-250-2500. A.C.v.: 0-10-50-100-500-1,000. D.C. Currents: 0-50μA, 0-2·5, 250mA. Resistance: 0-6K-6M. Cap.: 10μμF-0·001μF and 0·001μF-0·1μF. Output: −20 to +22dB.

WAS £5.5.0 NOW £3.10. SAVE £1.15. Add 2/6 p. & p.

BULK TAPE ERASERS



These are actually miniaturized, high quality versions of the powerful demagnetizers used in instrument and aircraft manufacture, and represent the most effective way of restoring recorded or noisy tape to its original unmarked condition. Essential when using high fidelity recorders in conjunction with high-grade tape: pays for itself over and over in preserving expensive tape performance. Bulk erasers can also be used to demagnetize small parts and tools, and for demonstration purposes, etc. Recommended types available:

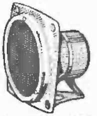
Model NT-120
Cleans up to 7in. reels of tape in seconds. For 230/250 v. A.C. operation. Size: 4¾ × 4 × 2½in. high. Finished grey crackle.

WAS £5.5.0 NOW 67/6 SAVE £1.17.6 Add 4/- carr.

Model 176
Extra powerful, professional model. Cleans tape reels in all sizes up to 10in. diam. Size 7¼ × 4¼ × 3¾in. high. Finished grey crackle.

WAS £7.7.0 NOW £5 SAVE £2.7.0 Add 6/- carr.

WESTWELL CT-2B TWEETER



Adds sparkle and realism to the performance of almost any high quality reproducer. Nominal 2¼in. diam. moving coil unit is attached to translucent bronze flange with matt black grille for mounting in or outside cabinet; alternatively, detachable bracket can be used. Impedance 16 ohms. Rating 10 w. max., 5 w. nom. Recommended crossover frequency 3,000 c/s. Sensitivity 102dB/W. Size overall: 3 × 3 × 1⅞in. deep.

WAS 27/6 NOW 19/6 SAVE 8/- Add 2/- p. & p.

EXCLUSIVE OFFER OF TOP QUALITY RECORDING TAPE

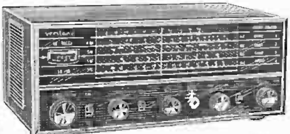
New American branded tape by world renowned manufacturers and equal in quality to the best obtainable anywhere. Guaranteed splice free, red oxide, coated, with full frequency response and uniform output. Resistant to moisture, heat, cold and abrasion. Available in a wide range of Acetate and polyester qualities, each distinctively boxed and cellophane wrapped in colour coded cartons showing recording times at 7½, 3¾ and 1⅞ i.p.s. Compare the prices!

Range available:
Both types post and packing 1/- per reel. Four or more reels post free.

Acetate
- 5in. 600ft. Standard **8/6**
- 5in. 900ft. Long Play **10/-**
- 5¾in. 1,200ft. Long Play **12/6**

Polyester
- 3¼in. 600ft. Double Play **11/6**
- 7in. 1,200ft. Standard **12/6**
- 5in. 1,200ft. Double Play **15/-**
- 7in. 1,800ft. Long Play **20/-**
- 5¾in. 1,800ft. Double Play **22/6**
- 7in. 2,400ft. Double Play **25/-**

NEW ADVANCED DESIGN - Veritone Compact Communications Receiver

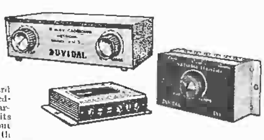


New, highly developed, extremely compact design. Veritone SR.150 has portable radio proportions and a DX performance comparable with many highly expensive, professional receivers. Frequency coverage is continuous from 540 Kc/s to 30 Mc/s in 4 bands, plus band-spread on Ham frequencies of 3·5, 7, 14 and 28 Mc/s. Features include: extra large, clearly marked dial "S" meter, variable pitch BFO, noise limiter, built-in loudspeaker and extending rod antenna to receive all but most distant stations.

20 gns. Carriage and Insurance 15/-

Extras include phone output jack, standby switch, etc. Size only: 13¼ × 5 × 8in. deep. Valves 12BE6, 12AV6, 12BA6 and 50C5 plus silicon rect. Invaluable for DXer's, marine band listeners etc. Housed in handsomely finished metal case. For 200/250 volts A.C. or D.C. *Supplied with 128 page "Wireless World Guide to Broadcasting Stations."*

DUVIDAL CROSSOVER NETWORKS



Superb construction using selected high-grade components, each handsomely finished and constructed in metal case with integral mounting feet. Inputs and speaker outputs are made to standard screw terminals. Full instructions supplied.

CV-1 Variable Crossover—Standard 2-way unit for use with low to medium power woofer and tweeter arrangement. Variable control permits adjustment of bass and treble output levels. In bronze finished case with black plastic panel size 4 × 2⅝ × 1½in. high.

WAS £1.2.6 NOW 12/6 SAVE 10/- Add 2/- p. & p.

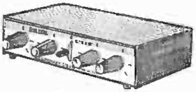
CN-2 Crossover Network—Hi-Fi 2-way iron-cored choke and filter system offering high frequency crossover at 2,500 or 3,500 cycles/sec. Totally enclosed in bronze finished case size 3¼ × 2⅝ × 1½in. high.

WAS £2.9.6 NOW 25/- SAVE £1.4.6 Add 3/- p. & p.

HN-3 Variable Crossover—3-way, medium and high power variable level unit offering mid-range crossover at 500 c/s and tweeter crossover at 3,300 c/s, together with "L" Pad variable level controls for mid-range and tweeter outputs. Matching arrangements also permits use as 2-way crossover, or without level controls when speaker efficiencies are equal. Handsomely finished in 2-tone grey metal case size 6 × 3 × 2in. high.

WAS £4.10.0 NOW 50/- SAVE £2 Add 3/6 p. & p.

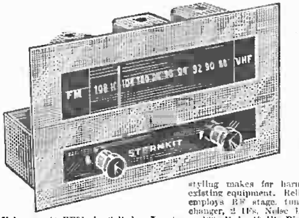
DUVIDAL SM-5 TRANSISTORISED MONO/STEREO MIXER



Compact, self-contained 4-channel audio mixer providing 4 separate, infinitely variable inputs on mono or twin inputs for left and right channels on stereo. Superbly constructed and handsomely styled, and finished in bronze enamelled case size 6 × 3 × 2in. high. Internal PP3 battery gives approximately 400 hours operation. Input suitable for xtal, loudspeaker used as mike, low imp. mike with trans. radio, tape, etc. Max. input 1·5 v., max. output 2·5 v. gain 6dB. Inputs through standard jack plug socket; outputs through phono plugs.

WAS £3.17.6 NOW £2.15.0 SAVE £1.2.6 Add 3/6 p. & p.

SUPERB NEW STERN—CLYNE F.M.I. VHF TUNER



Features sparkling performance:—inherent stability.

Specially designed for the Amateur builder, a new, sensitive tuner unit that provides stable, interference-free reception of BBC FM transmissions. High quality output signal ensures optimum performance from any Hi-Fi audio system; superb styling makes for harmonious installation with existing equipment. Reliable, easily aligned circuit employs RF stage, tuned-anode, tuned-grid freq. changer, 2 IFs, Noise Limiter & Ratio Detector. Valves are 4 × EF91 plus 2 diodes. Input sens. 100mV. for 40 dB. Dist. less than 1% at full deviation. Power freq. 200 v. at 20 mA and 6·3 v. at 1·8A. Panel black and silver-grey, size 8 × 5in. Chassis: cadmium plated, overall depth 4½in.

FM1 Kit of parts with Instruction Handbook, **£7/9/6,** *carriage 4/-.*
FM1 Assembled and tested, **£10/9/6,** *carriage 4/-.*
Optional Power Pack Type D Kit of Parts, **£2/15/-,** *carriage 3/6.*
Power Pack Type D, assembled and tested, **£3/10/-,** *carriage 3/6.*

Handbook only 3/- Post free. Descriptive leaflet on request

GUARANTEED BY STERN-CLYNE Value for money, Quality Facility. Merchandise offered by Stern-Clyne is critically selected and exhaustively tested before it is offered for general sale; where suitable equipment does not exist, certain items are exclusively manufactured to our own rigid specifications. In all cases, Stern-Clyne offers are value and quality selected. Satisfaction guaranteed.

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PORTABLE OSCILLOSCOPE CT.52
A compact general purpose instrument with many unusual features. Size 9in. high, 8in. wide, 16½in. deep. Time base 10 c/s. to 40 Kc/s. Y plate sensitivity 40V per cm. Tube 2¾in. Frequency compensated amplifier up to 38 dB gain. Bandwidth up to 1 Mc/s. Single sweep facilities. Operates from A.C. mains 100-250 volts 50 c/s. Complete with all test leads, metal transit case, instruction book and circuit diagram. BRAND NEW. Tested and guaranteed. £22/10/-. Carr. 10/-

MICROAMMETERS
R.C.A. 0-500 microamps, 2¼in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. 15/-. P. & P. 1/6.

AR-88 SPARES

R.C.A. Headphones	12/6
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Knobs. Large size..............	5/6
Block Condenser (3 × 4 mfd.) ..	12/6

AR-88D RECEIVERS
A good selection is available for callers at from £30. All are in good condition and are functioning perfectly. Realigned.

HEAVY DUTY TRANSFORMER
Input 220 volts to 250 volts at 50 cycles. tapped every 5 volts. Secondary, 50 volts at 15 amps. Very conservatively rated. Size 7¼×5¼×7in. Wt. 28 lb. Brand new. £5/19/6. Carr. 7/6.

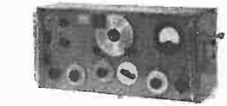
SILICON RECTIFIER. 800 P.I.V. The Modern Marvel. ⅜in. × ⅜in. Can be used to replace T.V. rectifiers up to 500 mA. (40Ω ballast resistor). 7/-.

TS-175 HETERODYNE FREQUENCY METER
A high frequency version of the well known BC-221. Accuracy 0.05%. Frequency range 80 to 1,000 Mc/s. As new condition with original calibration book. Tested and guaranteed. £75.

BC221 FREQUENCY METER 125 Kc/s to 20 Mc/s.
This crystal controlled heterodyne frequency meter is too well known to need further description. Those we offer are complete with correct individual calibration book and are carefully tested and guaranteed. New condition. Carr. 10/-. **£25**
Laboratory Standard

CINTEL OSCILLOSCOPE
A 12in. demonstration oscilloscope with all controls at rear. **BRAND NEW** £80.

SANGAMO WESTON VOLTMETERS
S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 mA. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed 32/6. Post 2/6.



STANDARD SIGNAL GENERATOR MARCONI TF-144G Carr. 30/- **£25**
Overhauled, guaranteed accurate and in perfect working order. Complete with mains lead and technical manual.

SIGNAL GENERATOR CT-218 (FM/AM)
MARCONI TF 937. Covers 85 Kc/s to 30 Mc/s in 8 switched ranges. Effective length of film scale is 50ft. Output level variable in 1 dB steps from 1μV to 100 mV (75Ω). Also 1V Outputs down to 0·1μV from an outlet at 7.5Ω. Int. mod. at 400 c/s, 1 Kc/s, 1.6 Kc/s and 3 Kc/s. FM at frequencies above 394 Kc/s. Variable mod. depth and deviation. Crystal calibrator 200 Kc/s and 2 Mc/s. Monitor speaker for beat detection. Fully metered, blower cooled, Panclimatic. A.C. mains 100 to 150 and 200 to 250 volts, 45 to 100 c/s. 17 × 20½ × 17½in. Weight 117 lbs. Fully tested and guaranteed. Under 10% of original price. £65. Carr. 50/-.

CINTEL EQUIPMENT
ELECTROLYTIC CAPACITANCE AND INCREMENTAL INDUCTANCE BRIDGE. No. 36601
A modern instrument, all solid state, which accurately measures the capacity of electrolytic condensers from 0.1μF to 1,000μF under operating conditions. Leakage current and polarizing voltage are separately metered. Inductances from 100 mH to 100 H can also be measured with currents up to 100 mA. A.C. mains operation. Unused with handbook. £100.
WIDE RANGE CAPACITANCE BRIDGE. No. 1864.
A matching instrument to the above. All solid state. Mains operation. Measures from 0.002pF to 100μF. Unused with handbook. £100.

V.H.F. SIGNAL GENERATOR
MARCONI TF-801A. Covers 10 to 300 Mc/s (4 bands). DIRECTLY calibrated. Int. Mod. at 400, 1,000 and 5,000 c/s. Attenuated or force output. Guaranteed overhauled, accurate and in perfect working order. £32/10/-. Carr. £1.

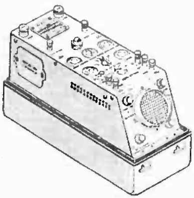
AN/USM-44A. A precision signal generator. U.S.A. manufacture. A.M. only. 10 to 420 Mc/s. (5 bands). Directly calibrated. An instrument of the finest possible quality with 1 Mc/s and 5 Mc/s. Xtal calibrators. Separate "set carrier" and "set mod" meters. Output cont. variable from 0.1μV to 350 mV. **BRAND NEW.** £150.

DISTORTION FACTOR METER
MARCONI TF-142E. This instrument measures the percentage of total harmonic distortion in the fundamental frequency range 100 to 8,000 c/s. The lowest scale engraving is 0·05%. Will handle 2 watts (continuous) and will give satisfactory readings with only 1mW input. Mains operated. Output impedance 600 ohms. Very good condition. £30. Carr. £1.

MINIATURE RELAYS. 240 v. A.C. coils. Contact assembly 2 "makes" and 1 C.O. 5 amps. Size 2 × 1½ × 1in. Unused and removed from brand new equipment. 8/6 post paid.

B. & R. RELAYS Type CO3. 230 volt A.C. coils. Very heavy duty contact assembly. 4 makes. Size 4in. × 1¾ 3in. × 2½in. Weight 2 lb. BRAND NEW. 27/6. P. & P. 2/6.

HICKOCK OSCILLOSCOPE OS-8B/U
A high grade general purpose instrument made to exacting U.S.A. Navy specification. Detachable cover with carrying handle. Compact (13¼ × 6 × 8¾in.), weight 17 lbs. Green trace 3in. tube. Bandwidth "Y" amplifier D.C. to 2 Mc/s (D.C. coupled). Sensitivity 40 mV/cm. "X" amp. can be used separately, similar spec to "Y" amp. Leads are housed in case. For A.C. mains 105 to 125 v. 50 to 1,000 c/s. BRAND NEW, tested and guaranteed. £25. Carr. 10/-.
Auto transformer 15/6 extra.



CHARLES BRITAIN (Radio) LTD.

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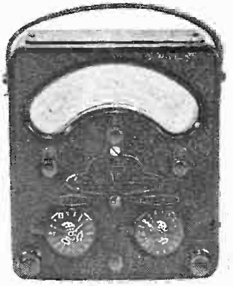
Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.



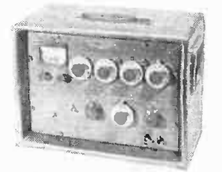
AVOMETER MODEL 7
Complete with leather carrying case, leads and batteries ready for use. Fully guaranteed. £13/13/-. Post 7/-.

PHASE MONITOR ME-63/U (AN/URM-67)
Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1%. Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by Control Electronics Inc. and ex-U.S.A. Air Force. In first class condition with handbook. A complex instrument with 19 valves. £40. Carr. 30/-.

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 1035
Those we offer are the modern Mark 3 version and are in really first class condition. Please do not confuse these with older well used instruments. One glance will convince you they are a bargain at £45. Carr. 30/-.

T.C.C. VISCONAL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71°C. CP 152 v. Size 3 × 1¾ × 5in. high. BRAND NEW (boxed). 8/6 each. **DUBILIER NITROGOL.** 8 mfd. 350 v. D.C. wkg. at 71°C. Size 1¾ × 1¾ × 4¾in. high. With fixing clips. BRAND NEW (boxed) 5/-. each. **T.C.C. or DUBILIER.** 4 mfd 600 v. wkg. CP 130T or similar. 1¾ × 1¾ × 4¾in. high. BRAND NEW (boxed). 4/6 each. All post paid.

STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4×3½×2½in. ALL BRAND NEW. 21/- each. Post 2/6.
Type 1. 250-0-250 v. 80 mA. 6.3 v. 3 a. tapped at 4 v. 4 a. 6.3 v. 1 a. tapped at 4 v. and 5 v. 2 a.
Type 2. As above but 350-0-350 v. 80 mA.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v 4 a. Ideal for chargers.



LOW CAPACITANCE BRIDGE
MARCONI TF 1342. Range 0.002 pF. to 1,111 pF. Accuracy 0.2%. Three terminal transformer ratio arm bridge allows "in situ" measurements. Internal oscillator frequency 1,000 c/s. 12×17×8½in. Weight 52 lbs. A.C. mains 200 to 250 and 100 to 150 v. 40-100 c/s. With leads and handbook **ABSOLUTELY BRAND NEW.** £45.

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STAFF REQUIRED AT VARIOUS BRANCHES Full or Part Time. Experience unnecessary.

JASON FMT1 F.M. TUNER All parts inc. valves and instr. book. **£6/19/9** Carr. 5/-.

TRIPLETONE SELF-POWERED ASSEMBLED F.M. TUNER
For 200-250v. A.C. **£15/14/6** or Terms

POWER PACK KITS Fully smoothed output 250 v. 60 mA. H.T. and L.T. 6.3 v., 1.5 amps. Consists of chassis, mains trans. 200-250 v. Double wound, Rectifier, Choke, Electrolytics and circuit. **19/11**
Or with case in lieu of chassis 25/-.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves EZ81, ECC83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost". Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass and balance. Output for 3 ohms speaker. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list 1/9. **8 GNS.** Carr. 10/-. Or supplied assembled and tested 59/6 extra. Deposit 2 gns. and 9 monthly payments of 24/2 (Total £12/19/6).

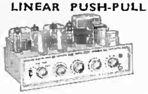
Full range of Hi-Fi equipment. Cash or Terms.
ARMSTRONG, LINEAR, LEAK, TRUVOX, TANDBERG, JASON, FANE, FERROGRAPH, RESLO GARRARD, GOLDRING, W.B., CONNOISSEUR, GOODMANS, GRAMPIAN, WHARFEDALE, ROGERS, QUAD.

HEAVYDUTYSELENIUM RECTIFIERS
12 V. 15 AMPS. F.W. (BRIDGE) **19/9**

EX. GOVT. SMOOTHING CHOKES
60 mA. 10 h. 400 ohms **3/11**. 100 mA. 10 h. 100 ohms **6/9**. 150 mA. 10 h. 100 ohms **10/11**. 120 mA. 12 h. 100 ohms **9/9**. 200 mA. 5-10 h. 100 ohms **11/9**. 250 mA. 5 h. 50 ohms **10/9**.

R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER

Providing 10/14 WATTS ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL

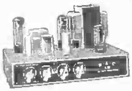


Features include:
- ★ Four-position tone and compensating Input Selector switch.
- ★ Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.
- ★ Separate Bass "lift" and "cut" and treble "lift" and "cut" controls.
- ★ Neon panel indicator, ★ Handsome Perspex Frontplate.

S.A.E. for leaflet. Complete set of parts with point-to-point wiring diagrams and instructions Carr. 10/-. **13 Gns.** or Factory assembled, tested and supplied with our usual 12 months' guarantee for 18 gns. or DEPOSIT £2/17/- and nine monthly payments of 39/10 (Total £20/15/6). SUITABLE for "MIKE," GRAM., RADIO OR TAPE. INTENDED FOR HOME OR STUDIO. Employing valves ECC83, ECC83, ECL86, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohms speakers on each channel. FREQUENCY RESPONSE ±2 D.B. 30-20,000 c.p.s. HUM LEVEL 65 D.B. down. SENSITIVITY: 15 millivolts maximum. HARMONIC DISTORTION (each channel) 0.2 per cent. For operation on 200/250 v. A.C. mains.

R.S.C. A10 30 WATT AMPLIFIER

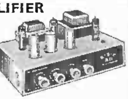
HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT



SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut." An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram., etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA and 6.3 v. 1.5 A. FOR RADIO TUNER. Price in kit form with wiring diagram. ONLY Carr. 10/-. **12 Gns.** Or factory built using latest EL34 output valves with 12 months' guarantee. 15 GNS. TERMS ON ASSEMBLED UNITS. DEPOSIT £2/8/- and 9 monthly payments of 33/3 (Total £17.7.3). Protective cover with handles available for 21/-.
Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ±3 D.B. 30-20,000 c/s. Tone Controls ±12 D.B. at 50 c/s. +12 D.B. to −6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish gold hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS. SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc. etc. We can supply Microphone, Speakers, etc. etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10. High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High quality sectionally wound output transformer specially designed for Ultra Linear operation. Reliable components. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ±3 D.B. 30-20,000 c/s. Six negative feedback loops. Hum-level 60 D.B. down. ONLY 23 millivolt INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and mikes. Comparable with the very best designs. For gram., radio or tape. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc.
OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12×9×7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied (or factory built 51/6 extra). ONLY Carr. 10/-. **8 Gns.**
If required louvred metal covers with 2 carrying handles can be supplied for 19/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 33/3 and 9 monthly payments of 24/1. (Total £12/10/-) S.A.E. for illustrated leaflet of Cabinets, Speakers, "Mikes" etc.

AUDIOTRINE HI-FI TAPE RECORDER KIT

Only 4 pairs of soldered joints plus mains

Build a high quality recorder in the £50 class for only **$25\frac{1}{2}$ Gns.** Carr. 18/6.
Can be assembled in one hour. S.A.E. for leaflet. 4 track 3 gns. extra OR DEPOSIT 4 gns. and 12 monthly payments of 42/- (Total 28 Gns.). Cash price if settled in 3 months. INCORPORATING THE LATEST MAGNAVOX TAPE DECK. THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 17½×14½×8½in. finished in complementary shades of Rexine and Vynair, Connection diagram for wiring amplifier to transcriptor provided. FEATURES INCLUDE: ★ 3-SPEEDS ★ FREQUENCY RESPONSE 50-11,000 cps ★ SWITCHED TONE COMPENSATION FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ HEAVY DUTY MOTOR ★ TAPE MEASURING & CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

COMMUNICATION RECEIVER RX 60 DE-LUXE

4 Band 535 Kc/s to 30 Mc/s. Slide Rule Tuning Dial with Bandspread and "S" Meter. A.V.C. Noise Limiter. B.F.O. Phone Jack. Built in speaker. Stand-By Switch with terminal for transmitter. Built in Antenna for long range reception. High Sensitivity. For 200-250 v. A.C. mains. Handsome chrome decorated cabinet. 13¾in. × 5¼in. × 8¾in. **19 Gns**
Or Deposit £5 and 9 monthly payments 37/8 (Total £21/19/-) Carr. 10/-.

R.S.C. TRANSFORMERS

Fully Guaranteed. Interleaved and Impregnated.

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

MIDGET CLAMPED TYPE 2½×2¾×2¼ins.

250 v., 60 mA., 6.3 v., 2 a.	13/9
250-0-250 v. 60 mA., 6.3 v. 2a.	14/9

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a. 0-5-6.3 v. 2a. 2½-3-3in.	18/9
250-0-250 v. 100mA., 6.3 v. 5 a., 0-5-6.3 v. 3 a.	20/9
300-0-300 v. 100mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	36/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
350-0-350 v. 150 mA., 6.3 v., 4 a., 0-5-6.3 v., 3 a.	38/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	59/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a.	63/9
450-0-450 v. 250 mA., 6.3 v. 4 a. c.t. 5 v. 3 a.	69/9

TOP SHROUDED DROP-THROUGH TYPE

200-0-250 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a. 0-5-6.3 v. 2 a.	21/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v., 3 a.	28/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0-5-6.3 v. 1 a. suitable for Mullard 510 Amplifier	35/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	37/9

FILAMENT TRANSFORMERS
12 v. 1a. **7/9**; 6.3 v. 1.5 a. **6/9**; 6.3 v. 2 a. **7/6**; 6.3 v. 3 a. **9/9**; 6.3 v. 6 a. **17/9**; 12 v. 3 a. or 24 v. 1.5 a. **17/9**.

AUTO (Step UP/Step DOWN) TRANSFORMERS
0-110/120 v.-200-230-250 v.

50-80 watts	14/9	250 watts	49/9
150 watts	29/9	500 watts	89/9

CHARGER TRANSFORMERS

0-9-15 v. 1½ a.	12/9	0-9-15 v. 5 a.	19/9
0-9-15 v. 2½ a.	14/9	0-9-15 v. 6 a.	23/9
0-9-15 v. 3 a.	16/9	0-9-15 v. 8 a.	28/9

OUTPUT TRANSFORMERS

Standard Pentode 5,000Ω to 3Ω or 7,000Ω to 3Ω	6/6
Push pull 8 watts EL84 to 3Ω or 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	18/9
Push pull 10-12 watts to match 6V6 to 3, 5, 8 or 15Ω	19/9
Push pull EL84 to 3 or 15Ω 10-12 watts	18/9
Push pull Ultra Linear for Mullard 510, etc.	29/6
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound. EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	49/9

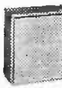
MICROPHONE TRANSFORMERS

120-1 High quality, clamped	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350Ω	5/6
150 mA., 7-10H. 250Ω	11/9	60 mA., 10 H., 400Ω	4/11
100 mA., 10 H., 200Ω	8/9	1 amp. 0.5Ω L.T. type	6/6

LOUDSPEAKERS IN CABINETS



12in. 10 WATT. Walnut Veneered Cabinet. Size 15×15×8in. approx. High quality 12in. 10 watt 12,000 line speaker, 3 ohms or 15 ohms **£4/19/6.** Carr. 5/6. Or Deposit **15/-** and nine monthly payments **10/10** (Total **£5/12/6**).

12in. 20 WATT. High Quality, 15,000 line l/speaker 15 ohms in Cabinet, finished as above. Size 18×18×8in. **£7/19/6.** Carr. 8/6. Or Deposit **24/6** and 9 monthly payments of **17/-** (Total **£8/17/6**).

12in. 30 WATTS. 17,000 lines, in walnut finished cabinet. Terms: Deposit **32/-** and 9 monthly payments of **22/-**. Total **£11/10/-**. **10 Gns.** Carr. 10/-.
All above available in Rexine covered cabinets for **£1** extra.

R.S.C. BATTERY CHARGERS & KITS

FOR A.C. MAINS: 200/250 v. 50 c/s. *ASSEMBLED* 4 amps 6/12 v. Fitted Ammeter and variable charge rate selector. Also selector plug for 6 v. or 12 v. charging. Steel case with stoved grey hammer finish. Fused and ready for use with mains and output leads and battery clips. **59/9** Carr. 4/6. Terms: Deposit **12/-** and 5 monthly payments of **12/-** (Total **£3/12/-**).

CHARGER KITS Consisting of Mains trans., rectifier, Meter, Enamelled Case, Fuses and Holders, Grommets, Panels, Clips and Circuit. 6/12 v. 2 a. **35/9,** 6/12 v. 4 a. **52/9.**

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps., variable output
Mains transformer 0-200-230-250 v. F.W. (Bridge). Selenium Rectifier, Ammeter, Variable Charge Rate Selector panels, Plugs, Fuses, Fuse-holder and circuit. Carr. 4/6 **59/9**

R.S.C. BATTERY TO MAINS CONVERSION UNITS.

Type B.M.1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v.
Complete kit with diagram **39/9** or ready for use **49/9**

FANE 122/10 20 WATT HEAVY DUTY LOUDSPEAKERS 12in. 15 ohm. With exceptionally robust 2in. diameter voice coil assembly. **5 GNS.** Post 5/6
Model 122/10A with Dual Cone 6 Gns.

WW—144 FOR FURTHER DETAILS.

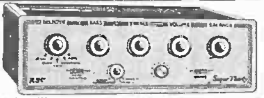
R.S.C. SUPER 15 HI-FI AMPLIFIER

FULLY TRANSISTORISED

- ★ 200-250v. A.C. Mains Operation.
- ★ OUTPUT R.M.S. CONTINUOUS
  10 WATTS into 15 ohms.
  15 WATTS into 3 ohms.
- ★ Max. Instantaneous Peak Power Output 28 watts.
- ★ PRINTED CIRCUIT CONSTRUCTION
- ★ LATEST MULLARD TRANSISTORS
  AD149, AD149, OC127Z, OC81Z, OC44, OC44, OC81Z, OC44, AC107 (Total of nine).
- ★ 5-POSITION INPUT SELECTOR SWITCH
  EQUALIZATION to Standard R.I.A.A. and C.C.I.R. Characteristics for Gram and Tape Heads
- ★ FULL TAPE MONITORING FACILITIES
- ★ SENSITIVITIES: Magnetic P.U. 4 m.v.
  Crystal or Ceramic P.U. 400 m.v.
  Microphone 4.5 m.v., Tape Head 2.5 m.v.
  Radio/Aux. or Ceramic P.U. 110 m.v.
- ★ FREQUENCY RESPONSE: 20-20,000 c.p.s. ±2d.b.
- ★ TREBLE CONTROL +15 d.b. to −14 d.b. at 10 Kc/s.
- ★ BASS CONTROL +12 d.b. to −15 d.b. at 50 c/s.
- ★ HARMONIC DISTORTION AT 10 Watts R.M.S. 1,000 c.p.s. 0.35%.
- ★ HUM LEVEL: −75 d.b.
- ★ NEGATIVE FEEDBACK 52 d.b

INTRODUCING TWO COMPLETELY NEW UNITS WITH TECHNICAL SPECIFICATIONS COMPARING MORE THAN FAVOURABLY WITH SIMILAR AMPLIFIERS OFFERED AT 2-3 TIMES THE COST.

IMPORTANT NOTE. Rated output figures are given in R.M.S. and not speech and music or I.H.F.M. otherwise we could obviously quote much higher outputs.



Complete Kit of parts with full constructional details and point-to-point wiring diagrams. Carr. 10/-. **9½ Gns.**

If preferred printed circuit can be supplied with parts soldered in and tested for **21/-** extra. Handsome Wooden cover, beautifully finished in walnut or teak 6 gns. Or unit factory built and tested, with our usual 12 months' guarantee and fitted cover mentioned above.

19½ Gns. Carr. 12/6.

Or Deposit **£3/2/0** and nine monthly payments of **43/3**. (Total **£22/11/3**).

All parts, point-to-point wiring diagrams and detailed instructions. Carr. 12/6. **18 Gns.**

Printed circuits supplied with appropriate components assembled, soldered and tested **for 2 GNS.** extra. Terms: Deposit 6 gns. & 9 m'thly. paym'ts of **36/6** (Total **£22/14/6**) Walnut or Teak finished cover **6 Gns.** Or Deposit **19/-** and 9 monthly payments **13/2** (Total **£6/17/6**).

Or unit completely assembled ready for use, fitted cover as above.

Carr. 15/- **29 Gns.**

Or Deposit **£4/12/-** and 12 monthly payments **48/-** (Total **£33/8/-**).

R.S.C. SUPER 30 STEREO AMPLIFIER

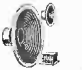
A DUAL CHANNEL VERSION OF THE SUPER 15 Employing Twin Printed Circuits

Send S.A.E. for leaflet.

- ★ Close Tolerance Ganged Pots
- ★ Matched Components
- ★ CROSS-TALK −52 d.b. at 1,000 c.p.s.
- ★ CONTROLS: 5 Position Input Selector, Bass Control, Treble Control, Volume Control, Balance Control, Stereo/Mono Switch, Tape Monitor Switch, Mains Switch.
- ★ INPUT SOCKETS (Matched Pairs) (1) Magnetic P.U. (2) Ceramic or Crystal P.U. (3) Radio/Aux. (4) Tape Head/Microphone
- ★ Operation of the Input Selector Switch assures appropriate equalization.
- ★ Rigid 18 s.w.g. Chassis. Size approx. 12in. wide, 3in. high and 8in. deep.
- ★ Attractive Facia Plate and Matching Knobs.
- ★ NEON PANEL INDICATOR

Above facilities etc., except for Ganging and Balance Control, apply also to Super 15. ALL COMPONENTS ETC. ARE OF A HIGH STANDARD AND SUPPLIED BY LEADING BRITISH MANUFACTURERS. THESE UNITS ARE EMINENTLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MICROPHONE (Crystal, Ceramic, Magnetic, Moving Coil, Ribbon). REGARDLESS OF THE COST. SUPERB SOUND OUTPUT QUALITY CAN BE OBTAINED BY USING WITH FIRST RATE ANCILLARY EQUIPMENT.

Audiotrine High Fidelity Speaker Systems



Designed to provide a smooth frequency response from 40-20,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. **Crossover Unit and Tweeter.** Highly recommended for use with any High Fidelity Amplifier, **10 Watt Unit.**

£4/19/9. Carr. 5/6 or Deposit **15/-** and nine monthly payments of **10/10** (Total **£5/12/6**) 20 Watt Unit **£6/19/9** Carr. 7/6 or Deposit **21/-** and nine monthly payments of **15/-** (Total **£7/16/-**)

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/19/9.** Please state whether 3 ohm or 15 ohm required.

AUDIOTRINE HF100D 10in. 15 watt HI-FI SPEAKER

Heavy cast construction. 2in. Diameter VOICE COIL. Dual Cone, plastic treated surround. smooth frequency response 20-20,000 c.p.s. Speech Coil 3 ohm or 15 ohm.

Exceptional value at **£5/15/0**

AUDIOTRINE HIGH FIDELITY LOUDSPEAKER ENCLOSURES

All types are of pleasing modern "slimline" design acoustically lined and in alternative finishes of light teak or medium walnut.

SE8 Designed for optimum performance with any Hi-Fi 8in. speaker. Size 22in. high, 15in. wide, 6in. deep. **Deposit 18/-** and 9 monthly payments **12/3** (Total £6/8/3). Carr. 7/6. **£5/15/0**

SE10 For 10in. High Fidelity Speaker with provision for tweeter. Especially recommended for use with Audiotrine HF100D speaker. Size 24in. high, 15in. wide, 6¾in. deep. Carr. 10/- **£6/19/9** Or Deposit **21/-** and 9 monthly payments **15/-** (Total **£7/16/-**).

SE12 For outstanding performance with any 12in. Hi-Fi speaker but especially suitable for types with low fundamental resonance. A tweeter cut out is provided. Size 24in. × 20in. × 6¾in. approx. Deposit **27/-** and 9 monthly payments **17/10** (Total **£9/7/6**). Carr. 10/-. **Only 8 Gns.**

INTRODUCING A NEW RANGE OF HIGH FIDELITY LOUDSPEAKER UNITS

AUDIOTRINE 'PETITE'

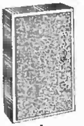
Size only 10¾in. × 6¾in. × 7¼in. Rating 8 watts. Frequency range 45-20,000 c.p.s. Cabinet beautifully finished in Teak (light) or Walnut (medium). Fitted specially designed heavy cast 5in. speaker with large pole pieces extra long voice coil and rubber surround. Impedance 3 ohms or 15 ohms. **8 Gns.** Carr. 7/6.

Or Deposit **27/-** and 9 monthly payments **17/10** (Total **£9/7/6**).

The AUDIOTRINE 'MINI-TEN' Size only 12¾in. high, 6¾in. wide, 8¼in. deep. Rating 10 watts. Impedance 15 ohms. De luxe Teak or Walnut finished cabinet acoustically lined. Heavy cast 5in. Bass speaker with extra high flux density ceramic magnet and rubber surround giving low fundamental resonance. Choke/Capacity Cross-over and Tweeter. Really astounding performance. Frequency range 45-20,000 c.p.s. Deposit **£2** and 9 monthly pyts. **27/9** (Total **£14/9/-**). **12½ Gns.** Carr. 8/6.

The 'GLOUCESTER' Handsome 'slimline' cabinet, acoustically lined. Size 24in. high, 20in. wide, 6¾in. deep. Finished light teak or medium walnut. 12in. high flux 12,000 line speaker, Cross-over unit, and Tweeter. Rating 10 watts. Smooth response 40-20,000 c.p.s. Impedance 15 ohms. Deposit **36/-** and 9 monthly payments **24/8** (Total **£12/18/-**). Carr. 15/-. **11 Gns.**

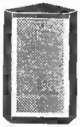
The 'BRONTE.' Handsome cabinet of modern styling. Acoustically lined and finished Teak or Walnut. Size 22in. high, 15in. wide, 7¾in. deep. Fitted Wharfedale Super 8 RSDD Speaker, with Roll surround and dual cone. Rating 6 watts. Impedance 15 ohms. Or Deposit **39/-** and 9 monthly payments **26/10.** (Total **£14/6/-**). Carr. 15/-. **12 Gns.**



The 'DORCHESTER' Attractive cabinet in luxurious Teak or Walnut finish. Acoustically lined. Size 24in. high, 15in. wide 8¾in. deep. Incorporating specially designed **10in.** heavy cast speaker with massive 2in. pole pieces and dual cone with plastic treated surround. Frequency response 20-20,000 c.p.s. Rating 15 watts. Impedance 15 ohms. Deposit **48/-** and 9 monthly payments **33/-** (Total **£17/7/3**). Carr. 15/-. **15 Gns.**

The 'STANWAY.' Attractive contemporary styled cabinet finished Teak (light) or Walnut (medium). Acoustically lined. Size 24in. high, 20in. wide, 8¾in. deep. Fitted 12in. high flux Bass speaker with plastic treated surround giving extremely low fundamental resonance and high sensitivity. The smooth frequency response 20-20,000 c.p.s. is achieved by addition of high flux tweeter and choke/capacity cross-over system. Rating 20 watts. Impedance 15 ohms. Deposit **3 GNS.** and 12 monthly payments **32/6.** (Total **£22/13/-**). **19½ Gns.** Carr. 17/6.

AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.



JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20in. × 11in. × 8in. Only **49/9.**

STANDARD MODEL. To take up to 10in. speaker. Size 27in. × 18in. × 18in. **5 gns.** Carr. 7/6.

SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30in. × 15in. × 15in. (Recommended for use with Audiotrine speaker system). **8 Gns.** Carr. 7/6, or terms.

R.S.C. JUNIOR BASS REFLEX CABINET. Designed for above speaker, but suitable for any good quality 8in. or 10in. speaker. Acoustically lined and ported. Medium walnut veneer finish. Size 18in. × 12in. × 10in. Strongly made. Handsome appearance. Ensures superb reproduction for only **£4/7/6.** Deposit **14/6** and 9 mthly. pmts. of **10/4.** (Total **£5/7/6**).

R.S.C. A15 20 WATT AMPLIFIER WITH INTEGRAL PRE-AMP and TONE CONTROL STAGES. High Fidelity Output.

Fully Transistorised Orthodox Circuitry. Full Output without thermal run-away.

Maximum Output 20 watts R.M.S. (28 watts music rating)
Sensitivity 2 millivolts for full output.
Frequency Response ±1 d.b. 20-20,000 c.p.s.
Harmonic Distortion 0.1% measured at 1,000 c.p.s.
Bass Control +8 d.b. to −14 d.b. at 40 c.p.s.
Treble Control +9 d.b. to −13 d.b. at 10 Kc/s.
Extremely high signal to noise ratio.
Kit of parts consisting of printed circuit, all required resistors, condensers, transistors and Heat Sink. Full diagrams and instructions. **£6/19/9**
Or with printed circuit fully wired and tested **£2** extra. Post 5/-
Power pack available for **39/6** in kit form or **59/6** ready for use.

Suitable for 3, 7.5 or 15 ohm speakers.
for inputs of any impedance.
for Hi-Fi in the home or public address.

SPECIAL TAPE RECORDING OFFER

Very limited number of Lincar LT45 high quality Tape Amplifiers, retail price **12 GNS.** Magic Eye Record. Level indicator. Output 4-5 watts. For mains 200-250v. A.C. Equalisation for 3¾in. and 7½in. per sec. Supplied with latest Magnavox "363" Tape deck for only **19Gns.** Carr. 15/-. Both units fully guaranteed.

LATEST MAGNAVOX 363 TAPE DECKS

3 speeds 1⅞in., 3¾in., 7½in. per sec. A robust high quality Deck with high fidelity recording heads. Includes: Digital Counter, pause control, Heavy 4 pole fully screened motor, Record Interlock to prevent accidental erasure. For 200-250 v. A.C. mains.

Two Track Model **10 Gns.** Carr. 7/6

Four Track Model **£13/19/6** Carr. 7/6

Terms on 4 Track Model only Deposit **47/9**, and 9 monthly payments **28/11** (Total **£15/8/-**).

R.S.C. 4 WATT GRAM. AMPLIFIER KIT

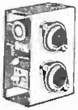
Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains Isolated chassis. Separate Bass and and Treble controls. Output for 2-3 ohms speaker. For 200-250 v. A.C. **59/9**

HENRY'S RADIO LTD.

303 EDGWARE ROAD, LONDON, W.2
PADdington 1008/9
Open Mon. to Sat. 9-6. Thurs. 1 p.m.
Open all day Saturday.

(10)

(1)



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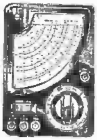
NEW 1966 CATALOGUE 150 PAGES

Fully detailed and illustrated components, equipment and Hi-Fi. All types and makes. 5000 Stock lines. The Finest and most comprehensive Range available. A mine of information. Price 6/- post paid.

FREE with Catalogue, 6/- value Discount vouchers gives 2/- in pound discount on purchases.

CATALOGUE COSTS NOTHING AFTER USING VOUCHERS



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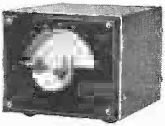

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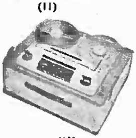

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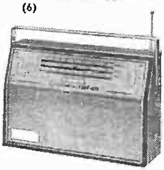

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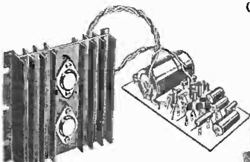

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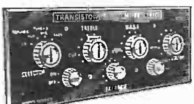

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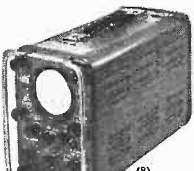

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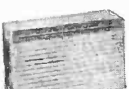

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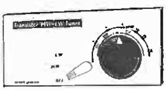

(1) ROADSTER MW/LW CAR RADIO

Supplied as Preassembled Panels. Permeability tuned superhet. Push-button wave-changer. Push-pull output. Fits any car. 7 × 4 × 2in. 12 volt (+) earth.
Assembly £8/19/6, p.p. 3/6. Total cost
(Speaker/Baffle/Car Fixing Kit 20/-).

(6) VHF F.M. TUNER

Sensitive Superhet circuit. Covers 87-105 Mc/s. Geared tuning. 9-volt operated. Up to 1 volt output. For valve or transistor amplifiers. 4 × 3½ × 2½in.
Total cost £6/19/6, p.p. 2/6. to build
(Cabinet assembly, 20/- extra.)

(2) GLOBEMASTER MW/LW/SW PORTABLE

Full tuning on 3 wavebands. Push - button wavechange. Superhet circuit. 1 Watt push-pull. Attractive cabinet with chrome fittings. 11 × 7½ × 3½in. (S.W. 17-50 m.)
Total cost £8/19/6, p.p. 3/6. to build

(11) MULTI-METERS

PT34 1kΩ/volt	£1 19 6
M1 2kΩ/volt	£2 9 6
TP10 2kΩ/volt	£3 15 0
EP10K 10kΩ/volt ..	£3 19 6
EP20K 20Ω/volt ..	£4 19 6
ITI-2 20kΩ/volt (illus)	£4 9 6
TP5S 20kΩ/volt	£5 19 6
EP30K 30kΩ/volt ..	£6 10 0
500 50kΩ/volt	£8 17 6
EP50K 50kΩ/volt ..	£8 15 0
EP100K 100kΩ/volt	£10 10 0

25 WATT AMPLIFIER

8 transistor plus 2-rectifier design. Output for 7½ to 16 ohm speakers. 150mV input to 33K ohm ± 1dB 30 c/s to 20 Kc/s. For use with valve or transistor preamplifiers for 25 watts rms output—50 watts peak (overall size 2¾ × 2¾ × 6½in.).
Suitable for preamplifiers (9M) and (9) below.
Price Built and Tested £8/19/6, p.p. 3/-.
Mains Unit 79/6, p.p. 2/6.

(8) MINIATURE OSCILLOSCOPE MODEL OT52

High sensitivity 'scope, fully portable with Mullard DG7/5 2¾in. tube.
10 c/s to 40k c/s. FREE running Time Base. Single Sweep. Pulse Monitoring 50 m/sec. to 0.1u sec. Y Plate Sensitivity 40 v. per cm. 3 dB 25 c/s. to 2 Mc/s and up to 35 dB Gain on Amplifier. Full Input Facilities and Controls. 110 to 250 volt A.C. mains operated. Complete in portable case with leads. In new condition.

£22.10.0 Carr. & Pkg. 10/-.

FULL HANDBOOK AND CIRCUIT

(13) TRANSMITTER/ RECEIVERS

★ Up to ½ mile range. Price per pair £7/19/6, p.p. 2/6.
★ Up to 5 miles. Price per pair £22/10/-, p.p. 3/6.
* FM Wireless Microphone, £15

(5) REGENT-6 MW/LW POCKET SET

6 Transistor Superhet, geared tuning. Push - pull output. Attractive cabinet 5 × 3 × 1½in.
Total cost 85/-, p.p. 2/-. to build

(4) SINCLAIR DESIGNS

Micro FM (VHF) Kit	£5 19 6
Micro 6 (MW) Kit ..	£2 19 6
Slimline (MW) Kit ..	£2 9 6
X20 Kit (Mains	£7 19 6
X20 Built (Unit 99/6)	£9 19 6
Z12 Built	£4 9 6

(Z12 Mains Unit, 54/-)

(3) 5-WATT AMPLIFIER

6 Transistor push-pull to 3 ohms. 6 mV to 1 k. input, 12/18 volts operated. Size only 2¾ × 2 × 1½in., 25 c/s to 16 kc/s. Ideal general purpose sensitive amplifier with 5 watts RMS output.
Built and Tested 79/6, p.p. 2/-.
(Optional mains unit, 54/-.)

(15) NEW MW/LW TUNER SUPERHET TO BUILD

MW/LW Superhet tuner. Output up to ½ volt peak. Full coverage with excellent sensitivity and selectivity. 9 volt operated. Complete with front panel, etc.
Total cost to build 79/6, p.p. 2/-.

SPECIAL OFFER

DEAC Rechargeable Batteries.
(A) 3.6 volt 500 mA/H, 1½ × 1¾in. dia. Price 12/6, p.p. 1/6.
(B) 9.6 volt 225mA/H. 2¼ × 1in. dia. Price 20/-, p.p. 1/6.
BRAND NEW STOCKS

(12) BUILD A QUALITY TAPE RECORDER

THREE-SPEED RECORDERS

Using New '363' Decks.

★ **TWO-TRACK.** Deck £10/10/-. Amplifier £11/11/-. Cabinet and Speaker £5/5/-. Complete kits with FREE 7in. 1200ft. tape, spare spool and Acos 40 Microphone, £26, p.p. 8/6.

★ **FOUR TRACK.** Deck £13/10/-. Amplifier £12/12/-. Cabinet and speaker £5/5/-. Complete kits with FREE 7in. 1200ft. tape, spare spool and Acos 40 Microphone, £30, p.p. 8/6.

FREE New 16-page valve transistor / rectifier and quartz crystal catalogue on request.

QUARTZ CRYSTALS

1 mc/s. HC6U (miniature)	20/–
100 Kc/s 3 pin	15/–
100 Kc/s Octal	25/–
500 Kc/s.	15/–
100 Kc/s + 1 Mc/s	19/6
HC6U 6/12 volt 80°c. oven	22/6

(10) NOMBREX TEST EQUIPMENT

150 Kc/s.-350 Mc/s.

RF Generator ..	£9 10 0
Resistance / Capacitance Bridge	£8 5 0
Transistorised Power Supply	£6 10 0
10 c/s-100 Kc/s Audio Generator	£16 15 0
Sensitive Inductance Bridge	£18 0 0

10 AND 20 WATT MONO AND STEREO TRANSISTOR AMPLIFIERS AND PREAMPLIFIERS

(7) POWER AMPLIFIER

10 watts R.M.S. output.
10 mV. sensitivity, 30 c/s to 20 Kc/s. MPA10/3, 3 to 5 ohm Speaker. MPA10/15 12 to 16 ohm Speakers. Panel size 4 × 2½ × 1in. H/S size 4 × 4 × 1in.
***MPA10/3**, £5/10/-, p.p. 2/6.
***MPA10/15**, £5/19/6, p.p. 2/6.
(Mains Unit, 59/6, p.p. 2/6. State type required.)

(9M) MONO PREAMPLIFIER

For 10 watt or 25 watt amplifiers Full range of controls. 8 inputs from 1½ mV. Sel./Treble/Bass/Filter/Vol. Controls. For use with Valve or Transistor Amplifiers. 150 mV. RMS output. Size 9 × 2½ × 2in.
***MP2** £5/10/-, p.p. 2/- (Front panel 8/6).

(9) STEREO PREAMPLIFIER

Two Channel Preamplifier for (2) 10 watt or 25 watt amplifiers. 8 inputs per channel. Sel./Treble/Bass/Balance/Vol./etc. Controls. 1½ mV. input. For P.U.'s, Tuner, Tape, mic., etc. Size 9 × 3½ × 1⅜in.
***SP2** £10/19/6, p.p. 3/6.
(Front Panel 12/6.)

ALL UNITS SUPPLIED BUILT AND TESTED WITH FULL DETAILS AND INSTRUCTIONS
FULLY ILLUSTRATED AND DETAILED LEAFLET ON REQUEST

GARRARD DECKS—BRAND NEW FULLY GUARANTEED—WITH CARTRIDGE UNLESS STATED

1000 mono	£6 10 0	AT5 stereo	£6 6 0	AT60 less cart.	£11 10 0	AT6 mono	£8 19 6
1000 stereo	£6 19 6	SP25 less cart.	£10 10 0	AT60 mono	£11 19 6	AT6 Stereo	£9 10 0
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ALL MAKES OF HIGH FIDELITY EQUIPMENT IN STOCK. VISIT OUR HI-FI ROOM.
LET US QUOTE FOR YOUR REQUIREMENTS FOR EQUIPMENT AND COMPONENTS.

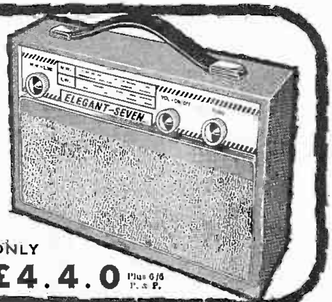
'ELEGANT SEVEN' MK. II

POWER SUPPLY KIT to purchasers of Elegant Seven parts, incorporating mains-transformer, etc. A.C. mains 200-250 v. Output 9 v. 50 mA 7/6d. extra.

COMBINED PORTABLE & CAR RADIO. The Radio with the STAR features. 4in. SPEAKER.

- ★ 7-transistor superhet. Output 350mW.
- ★ Wooden cabinet fitted handle with silver coloured fittings. Size 12¼in. × 8½in. × 3½in.
- ★ Horizontal tuning scale, size 11½in. 2½in. in silver and black lettering.
- ★ All stations clearly marked.
- ★ Ferrite-rod internal aerial.
- ★ I.F. Neutralisation on each stage. 460 kc/s.
- ★ D.C. coupled output stage with separate A.C. negative feed back.
- ★ All components, ferrite rod and tuning assembly mounted on printed board.
- ★ Operated from PP9 battery.
- ★ Full comprehensive instructions and point-to-point wiring diagrams.
- ★ Printed circuit board, back printed with all component values.
- ★ Fully tunable over medium and long waveband.
- ★ Car aerial socket.
- ★ Full after-sale service.

Parts list and circuit diagram 2/6. Free with parts.



ONLY **£4.4.0** Plus 6/6 P. & P.

'MAYFAIR' 5-Transistor TAPE RECORDER

Capstan-driven, battery operated. 7½ and 3¾ i.p.s. Precision made. Push-button controls. High quality 2¾in. speaker. Push-pull circuit. Output: 400 mW. Frequency response: 200-7,000 kc/s. Fast rewind. Up to 1 hour twin track playing time. Automatic erasing for re-recording. Dimensions: 8in. × 11in. × 3¾in. Weighs only 7lb.

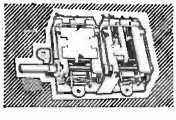
£11.11.0 plus 7/6 P. & P.

40W. FLUORESCENT LIGHT KIT

Incorporating GEC Choke size 8½in. × 1¾in. × 1¾in., 2 bi-pin holders, starter and starter holder. **11/6** P. & P. 4/6.

Similar to above: 80W. Fluorescent Light Kit incorporating GEC choke size 11½in. × 1¾in. × 1¾in. 2 bi-pin holders, starter and starter holder. **17/6** P. & P. 5/6.

CYLDON A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION



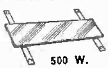
Size 2¼in. × 2¼in. approx. By famous manufacturer. A.M.-I.F. 470 kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1,620 kc/s.-525 kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6. FREE with Tuner. 1st, 2nd, 3rd A.M.-I.F.'s, 1st, 2nd, 3rd and 4th F.M.-I.F.'s, V.H.F. Osc. choke A.M.-F. trap. All the above are the R.F. end of an A.M./F.M. receiver car radio etc. The above items: **£2.10.0**

SILICON RECTIFIERS 250 v. P.I.V. 750 milliamps. Six for 7/6, post paid.

BSR MONARCH UA16 With FUL-FI HEAD

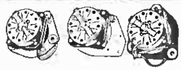
4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in., and 12in. records of the same speed. Has manual play position; colour, brown. Dimensions: 12½ × 10¾in. Space required above baseboard 4¾in., below baseboard 2¾in. Fitted with Ful-Fi turn-over crystal head, **£4.19.6** P. & P. 7/6.

G.E.C. FLAT HEATER ELEMENT



Can be used for wash boilers, washing machines etc. Five or six elements can be used in parallel to give 2,500/3,000 watts. Size 5½in. × 1¼in., copper enclosed, 2/6 ea. P. & P. 1/-. 4 or more post paid.

MAGNAVOX COLLARO



Set of three Tape Deck Motors. These are made for 110 v. but suitable auto. transformer is supplied. Three motors. 39/6, P. & P. 6/-.

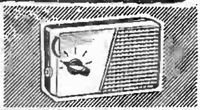
FIRST QUALITY PVC TAPE

5¾in. Std. 850ft.	9/-	5in. L.P 850ft. ..	10/6
7in. Std. 1200ft. ..	11/6	3in. T.P. 600ft. ..	10/6
3in. L.P. 240ft. ..	4/-	5in T P 1800ft. ..	25/6
5¾in. L.P. 1200ft. ..	11/6	5¾in. T P 2400ft. ..	32/6
7in. L.P. 1800ft. ..	18/6	7in. T.P. 3600ft. ..	42/6

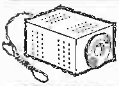
P. & P. on each 1/6, 4 or more post free.

TRANSISTORISED SIGNAL GENERATOR

Size 5½in. × 3½in. × 1¼in. For I.F. and R.F. alignment and A.F. output. 700 c/s frequency coverage 460 Kc/s to 2 Mc/s. in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested. **39/6** P. & P. 3/6.



POWER SUPPLY KIT



In metal case, size 3¾in. × 2½in. × 2in. incorporating mains transformer, rectifier and condensers. 230/250 A.C. Mains. Output: 9v. 100 mA. Price 10/6 plus 3/- P. & P.

OSCILLOSCOPE for D.C. & A.C. Applications

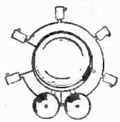
Push-pull X amplifier; Fly-back suppression; Internal Time-base Scan Wave form available for external use; pulse output available for checking TV line O/P Transformers, etc. Provision for external—I/P and C.R.T. Brightness Modulation. A.C. mains 200/250 v., £18/18/-. P. & P. 10/-. FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.

3 to 4 WATT AMPLIFIER KIT. Comprising chassis 8¾in. × 2½in. × 1in. Double wound mains transformer, output transformer. Volume and tone controls, resistors, condensers, etc. 6V6, ECC81 and metal rectifier. Circuit 1/6, free with kit. 29/6 plus 4/6 P. & P.

RINGO BURGLAR ALARM

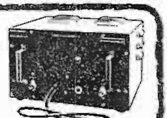
A.C. Mains 200/240 volt. Fire salvage slightly tarnished. List price 7 gns. Our price complete with double gong bell, five micro switches and full instructions.

P. & P. 5/-. **49/6**



FIXED FREQUENCY SIGNAL GENERATOR

Crystal control in metal case, size 10in. × 6in. × 6in. Incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. 39/6, plus 7/- P. & P. A.C. Mains 200/250 volts.



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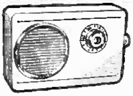


NEW TRANSONA FIVE

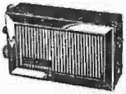
★ 7 Stages—5 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Bands. Incorporating ferrite rod aerial, tuning condenser, volume control, and new type fine tone super dynamic 2½in. speaker, attractive case. Size 6¼ × 4½ × 1½in. approx.

Total cost of all parts NOW ONLY **42/6** P. & P. 3/6.

Parts price list and easy build plans 2/-. (Free with kit).

POCKET FIVE



★ 7 Stages—5 transistors and 2 diodes. Covers Medium and Long Waves and Trawler Bands, a feature usually found in only the most expensive radios. On test, Rome, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive ferrite rod aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3¼in. (Uses 1289 battery, available anywhere).

Total cost of all parts NOW ONLY **42/6** P. & P. 3/6.

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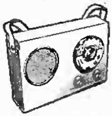

ROAMER SIX NEW!!

★ 8 Stages—6 transistors and 2 diodes. ★ 6 wavebands.

★ Now with Philco micro-alloy R.F. transistors.

Listen to stations half a world away with this 6 waveband portable. Tunable on M. and L. Waves. Trawler Band and three Short Waves. Push-pull output. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1½in. ★ Extra band for easier tuning of LUX, etc.

Total cost of all parts NOW ONLY **£3.19.6**

Parts price list and easy build plans 2/-. (Free with kit). *Carrying Strap 1/6 extra.* P. & P. 3/6

NEW! ROAMER SEVEN Mk. IV

7 WAVEBAND PORTABLE OR CAR RADIO AMAZING PERFORMANCE AND SPECIFICATION

★ *NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS.*

★ Fully tunable on all wavebands.

★ 9 stages—7 transistors and 2 diodes.

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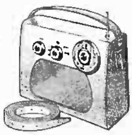
★ Extra band for easier tuning of pirate stations, etc.

Total cost of all parts NOW ONLY **£5.19.6** P. & P. 5/6.



Parts price list and easy build plans 3/-. (Free with kit)

SUPER SEVEN

★ 9 Stages—7 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Band. The ideal radio for home, car or can be fitted with carrying strap for outdoor use. Completely portable—built-in ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF stages, push-pull output, 3in. speaker (will drive larger speaker). Size 7¼ × 5¼ × 1½in. (Uses 9 v. battery, available anywhere).

Total cost of all parts NOW ONLY **£3.19.6**

Parts price list and easy build plans 2/-. (Free with kit). P. & P. 3/6

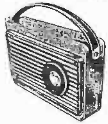
NEW!! TRANSONA SIX

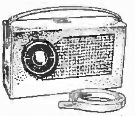
★ 8 stages—6 transistors and 2 diodes.

A top performance receiver covering full M. & L. Waves and Trawler Bands. Push-pull output. High-grade speaker makes listening a pleasure. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6¼ × 4½ × 1½in. (Uses PP4 battery, available anywhere).

Total cost of all parts **59/6** P. & P. 3/6.

Parts price list and easy build plans 2/-. (Free with kit).





MELODY SIX NEW!!

★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering M. and L. waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6¼ × 3½ × 1½in. approx. with gilt speaker grille and hand and shoulder straps. Total cost of all parts **£3.9.6**

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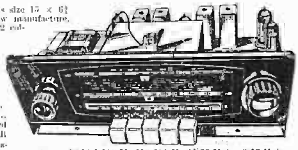

A.C. ONLY. Chassis size 15 × 6½ × 5½in. high. New manufacture. Dial 14½ × 4in. in 2 colours predominantly cream. Pick-up, Extension Speaker, Ae., E., and Dipole Sockets. Five "piano" push buttons — L.W., M.W., S.W., F.M., and Gram. Aligned and tested. With all valves and O.P. Transformer. Tone Control fitted. Covers 1,000-1,900 M; 200-550 M; 88-98 Mc/s.; 6-17 Mc/s. Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85.

ELLIPTICAL SPEAKERS 10in. × 6in. **25/-**, 13in. × 8in., **35/-**, to purchasers of this chassis.

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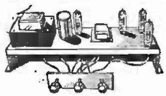
M.W., S.W.1, S.W.2, V.H.F., Gram., Stereo Gram. Two separate channels for Stereo Gram. with balance control. Also operates with two speakers on Radio. Chassis size 15in. × 7in. × 6½in. high. Dial cream and red 15in. × 3in. Valves ECC.85, ECH.81, EF.89, 2 × ECL.86, EM.84 and Silicon Rect. Price **£17/17/-**, carr. paid or **£4** deposit and 6 monthly payments of **50/-**. Total H.P. price **£19**. Cream moulded escutcheon for dial **7/6** extra.



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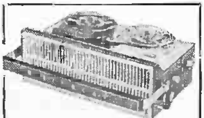

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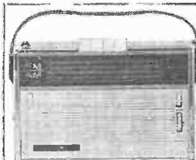
6J5GT	4/3	12BH7	8/9	DK92	7/-	EL84	6/6	PY31	8/-	UU8	11/-
6J6	2/6	12E1	17/6	DK96	7/3	EM34	8/6	PY32	9/6	VP41	5/6
6J7G	4/9	12J7GT	8/-	DL92	5/-	EM80	7/9	PY33	9/6	UY21	9/6
6J7G	7/6	12K7GT	4/-	DL94	6/6	EM81	6/9	PY80	6/6	UY41	6/-
6K6GT	6/-	12K8	9/9	DL96	7/3	EM84	8/9	PY81	5/9	UY85	5/-
6K7	5/9	12K8GT	9/6	EABC80	6/6	EM85	8/6	PY82	5/9	VR105	5/-
6K7G	1/-	12Q7GT	5/-	EAF42	3/3	EY51	7/6	PY83	5/9	VR150	7/9
6K7GT	4/6	12SA7	6/3	EB41	5/-	EY86	7/3	PY88	9/-		
6K8	8/6	12SK7	2/9	EB91	2/-	EY88	8/6	PY800	8/3	X66	7/9
6K8G	5/-	12SQ7	7/6	EBC33	4/9	EZ40	6/6	PZ30	9/6	Z66	8/6



HITACHI XM1002 AM/FM RADIOS

Unusual opportunity to purchase the up to the minute wonderfully styled guaranteed 10-transistor with full long and medium waves. Size 9¼ × 6 3/16 × 12 11/16in. Magnificent reproduction. 12 months' guarantee against faulty manufacture. Genuine retail price £28.7.6. Unrepeatable. **17 Gns.**

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BRANCH
NOW OPEN
10 TOTTENHAM COURT ROAD, LONDON, W.1.

TRANSISTORS
GUARANTEED TOP QUALITY

Huge reduction. Red Spot standard LF type now only **1/6**
White Spot R.F. **2/-**
Mullard Matched Output Kits OC81D and 2-OC81 **12/6**
R.F. Kits OC44, OC45 (2) 3 transistors **12/6**

AF114	8/-	OC44	5/6
AF115	7/-	OC45	5/-
ZF116	7/6	OC72	5/-
AF117	6/-	OC81	5/6
AF127	7/6	OC81D	5/6
OC26	9/-	OC82	6/-
OC36	14/-	OC170	8/6
		OC171	8/6

GERMANIUM DIODES

General Purpose miniature detector A.V.C. etc. or 6/6 doz. **8d.**
Gold Bonded highest quality Individually tested. 9/6 doz. **1/-**

SILICON RECTIFIERS

Guaranteed performance. Top makes. Tested 250 v. working.
120 ma. (3 for 8/6) **3/9** 500 ma. (3 for 19/6) **7/6**

CRM141 CRM142. Special bulk purchase enables us to offer these tubes at this low price (carr. 9/-). **39/-**

BASE SPEAKERS

25 WATT. Very heavy coned 12in. cast chassis. There is nothing to touch it for power handling and quality at the price. Plus 5/- p.p. **£4.19.0**

CONNECTING WIRE

P.V.C. Bright Colours. Five 25ft. coils only. **4/-**

100 RESISTORS 6/6

Excellent. Sizes ⅛-3 watt.

Post 1lb. 1/6, 1½lb. 2/6, 2lb. 2/9, 3lb. 3/-, 4lb. 3/3, 5lb. 3/6, 6lb. 4/-, 8lb. 4/6, 10lb. 5/6 (C.O.D. extra). ALL VALVES LESS 5% AND POST FREE IN DOZENS.

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Devonian Court, Park Crescent Place, Brighton. Tel.: 680722

AVO METER CALIBRATION TEST UNIT TYPE CT155. A modern precision instrument, giving 7 standard voltages 1 v. A.C.-2.5 v. A.C.-10 v. A.C.-25 v. A.C.-100 v. A.C.- and 250 mV. A.C. Also 250 mV. D.C. from internal standard cell. Internal power supply 110-250 v. A.C., contained in portable carrying case. Size 11×8×7in. Brand new equipment. **£12/10/-.** P.P. 10/6.

MUIRHEAD KEY SWITCHES

Very latest type twelve C/O heavy duty silver contacts, these switches were designed for normal panel mounting, complete with chrome escutcheon plate and screws. Price **9/6** each. Special terms for quantities. Hartley/Erskine Double Beam Oscilloscopes, Type 13a, perfect condition. £25.

L.T. TRANSFORMER

5 v. C.T. three times, at 6 amps., 230 v. primary. These U.S.A. transformers are excellent for charging purposes. New boxed, **22/6.** Carr. 3/6.

RELAYS TYPE 3000

8 C.O. double wound coil 10+55 ohms, special latching type, a reverse polarity current to either coil release armature, operating voltage 6 or 12 v. d.c., brand new stock by famous manufacturer .... **17/6** ea.
6 C.O. 500 ohms, new stock .... 10/- ea.
6 C.O. 300 ohms, new stock .... 10/- ea.
6 C.O. 350 ohms, new stock .... 10/- ea.

RELAYS, MINIATURE

S.T.C. 4184GD, 24 v. 700 ohms, 2 C.O.
S.T.C. 418GB, 6 v. 45 ohms, 2 C.O.
S.T.C. 4184GE, 48 v. 2,700 ohms, 2 C.O.
S.T.C. 4186KA, 1 v. 2 ohms, 2.C.O.
All above relays **8/6** each, plus P.P. on all relays 1/-.

GCRE FS10 AUDIO FSK TERMINAL UNITS

Completely self contained, with internal mains supply, input and output sockets, carpenter type 5A6, mark space meters, etc., in perfect working order, condition as new. Size 19×9×5in.
Price .... **£8/10/-.** P.P. 15/-.

STABILISED POWER SUPPLY SUB UNIT

Brand new equipment by Cintell, GA5470 A.C. input 200-250 v., stabilised D.C. output continuously variable between 200 and 400 v. at 125 mA., plus 3 6.3 vac at 5 amps each. Size 10 × 6 × 8in. Price **£10/10/-.** P.P. 7/6.

COMMUNICATIONS RECEIVERS

★AR88D, as new .... **£45.** P.P. 25/-.
BC342 1.5-18 Mc/s. .... **£22.** P.P. 20/-

TEST EQUIPMENT BARGAINS

G.R. R.F. Oscillator, frequency range 95 to 520 Mc/s., direct reading. P.S.U. for 115v. A.C. .... **£15.** P.P. 7/6
Record Circscale Watt Meter, direct reading 0-1000 watts, 6 inch scale, clear concise measurements for 250 v. A.C. **£12/10**
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TS419U R.F. Signal generator range 900-2,100 Mc/s., very latest equipment, as new condition **£45**
Taylor sweep oscillator type 92A .... **£9/19/6.** P.P. 7/
Marconi Valve Millivoltmeter type TF899 .. **£12.** P.P. 6/6.
Solartron Laboratory Amplifier type AWS 51A **£35**
Cossor Oscilloscope type 339A Double Beam.... **£12/10**
Solartron Oscilloscope type 316 .... **£20**
Dynatron Scaler type 1009A **£15**
Cossor Telecheck type **£17**

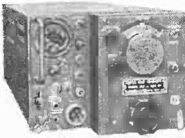
Ferranti 7.5 KVA M/C Constant Voltage Regulators output constant 230 v. A.C. regardless of voltage swings in perfect working order **£65**
Ferranti 20 KVA Combined Auto Transformer and M/C Voltage Regulator for 3 phase 50 c/s. supply, oil-cooled type, unused condition. P.U.R.

Ediswan Regulated and Stabilised P.S.U. variable from 200 v. to 350 v. at 150 mA. + 6.3 v. at 5 amps. Fully equipped with volt and amp. meters etc., not new but perfect order for bench or rack mounting **£15.** P.P. 17/6.
A.P.T. Regulated and Stabilised P.S.U. Variable from 50 v. to 500 v. at 250 mA. + 6.3 v. at 10 amps., meter indication, perfect condition, only .... **£25.**

Goodmans Industries POWER OSCILLATOR TYPE D120. Frequency Range 10 c/s. to 100 kc/s. in three directly calibrated ranges, power output 1,000 watts supply 240 v. A.C., with vibration equipment as new condition, price **£95.**

P. F. RALFE
423 GREEN LANES, HARRINGAY, LONDON, N.4
MOUNTVIEW 0939

AN/APR4 VHF COMMUNICATIONS AND SEARCH RECEIVERS



For the first time offered in new boxed condition. Frequency Range 38-1,000 Mc/s. Accuracy 1%. Five I.F. stages. Output impedance 600 or 4,000 ohms. Power supply 115 v. A.C. (internal). Price complete with three tuning units. **NEW £90.**

BC221 FREQUENCY METERS

Complete with calibration book, in first-class condition. **£18/10/-.** P.P. 10/-.

POWER UNIT TYPE 234A

A source of power to operate your 1392 R/X or any equipment that requires a fully smoothed output of 250 v. D.C.+6.3 v. at 6 amps., for bench or 19in. rack mounting, fully fused tapped input 200 to 250 v. A.C., brand new cased units at only **55/-.** P.P. 12/6.

PERFORMANCE TESTER TYPE 9170

Ideal for VHF and 2-meter enthusiasts small portable instrument, comprising signal generator, RF watt meter to 30 watts, and AF output meter, frequency range 100 to 150 Mc/s., complete with all leads and plugs, internal 24 v. power supply. New, boxed instruments. Price **£12/10/-.** P.P. 10/-.

FACSIMILE TRANSCEIVER TT-41B/TXC-1B

An electro-mechanical-optical facsimile set of the revolving drum type for the transmission and reception of page copy. It is used for transmission of maps, photographs, sketches, etc., over normal voice communication channels, either wire or radio the equipment will receive or transmit a page of copy 12 by 18in. complete with power supply, brand new, crated P.U.R.

LONDEX AERIAL C/O RELAYS

Type 7026. Price **25/-.** P.P. 2/-

WW—148 FOR FURTHER DETAILS.

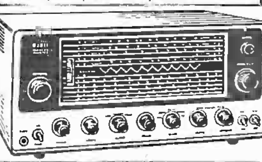
GEE's TAPE!

Attractively boxed, guaranteed Brand New

5in.	Std.	600ft.	8/6
7in.	Std.	1,200ft.	12/6
8¼in.	Std.	1,750ft.	23/6
10in.	Std.	2,400ft.	32/6
5in.	L.P.	900ft.	10/-
5¾in.	L.P.	1,200ft.	12/6
7in.	L.P.	1,800ft.	15/-
4in.	D.P.	600ft.	9/-
5in.	D.P.	1,200ft.	15/-
5¾in.	D.P.	1,800ft.	22/6
7in.	D.P.	2,400ft.	25/-
3in.	T.P.	600ft.	15/-
4in.	T.P.	900ft.	17/6
5in.	T.P.	1,800ft.	35/-
5¾in.	T.P.	2,400ft.	45/-
7in.	T.P.	3,600ft.	58/6

P. & P. 2/6 per order

As supplied to Govt. depts. industry, schools.
SPECIAL DISCOUNTS FOR QUANTITY BUYERS!
SPARE SPOOLS 3in. 1/-; 3¼in. 1/6; 4in. 1/8; 5in. 2/-; 5¾in. 2/-; 7in. 2/6; 8¼in. 4/6; 10in. 11/-.
Send S.A.E. for comprehensive Tape List.



GEE BROS. RADIO LTD.

15 LITTLE NEWPORT STREET, LONDON, W.C.2. GER. 6794/1453

Open 9-6 Mon-Fri. 1 p.m. Sat. Adjoining Leicester Square Tube

GARRARD RECORD PLAYER BARGAINS

Brand New with Maker's Guarantee. Buy now at these unrepeatable prices:

GARRARD AUTOSLIM Mono or Stereo	**5 GNS.**	*Full range of all other Garrard units in stock at competitive prices.*
GARRARD 1000 Mono only	**6 GNS.**	
GARRARD 3000 Stereo only	**8 GNS.**	
GARRARD SRP10 Precision Player Mono only	**90/-**	*S.A.E. for illus. list.*

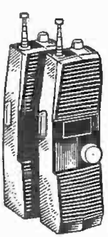
GARRARD SP.25 player Mono or Stereo **10½ GNS.**
Carriage and Packing 5/- extra.

LAFAYETTE DE LUXE COMMUNICATION RECEIVERS

MODEL HA-230. 4 Bands, 550-1600 kc/s., 1.6-4.8 mc/s., 4.8-14.5 mc/s., 10.5-30 mc/s., 8 valve Superhet Circuit, 1 RF plus 2 IF Stages for High Gain Reception. Easy to Read, Illuminated, Slide Rule Dial, Built-in Q Multiplier, Aerial Trimmer for Optimum Performance on all Bands, Calibrated Electrical Bandspread on Amateur Bands. 80 through 10 Metres, 0-100 Logging Scale for SWL's. Effective Automatic Noise Limited AVC-MVC Selector on Front Panel, Stable Oscillator and BFO for clear AM CW and SSB Reception. Built-in Edgewise S-Metre. PRICE **33 gns.**

MODEL HA-225. 5 Bands 150-400 kc/s., 1.6-4.8 mc/s. 4.8-14.5 mc/s. 10.5-30 mc/s. 48-54 mc/s. 14 valves Superheterodyne Circuit, Extra RF Stage, Mixer/Osc. for Dual Conversion on 6 metres, 1 RF Plus 2IF Stages for High Gain Reception on all other Bands, New Product Detector Circuit for Improved SSB Reception, Separate BFO and Q-Multiplier Circuits, Crystal Calibrator, Improved Automatic Noise Limiter. PRICE **48 gns.**
S.A.E. for descriptive leaflet.

SUPER WALKIE TALKIES



13 TRANSISTOR
1 DIODE 1 THERMISTER
28 GNS. PAIR
NEW IMPROVED MODEL

MODEL HE-100B. Crystal controlled Transmit and Receive, A.V.C. Squelch, Push Pull Audio Output Range up to 7 miles under favourable conditions. Built-in separate speaker and mike for better modulation—gives increased range. Complete with carrying cases, batteries and telescopic aerials. Size 3in. wide, 9in. high, 2¼in. deep.

A.C. POWER PACK FOR ABOVE Heavy duty 115/230 v. Replaces 8 penlight batteries. 6½ gns.

9 TRANSISTOR AND 1 DIODE **£22.10.0** Pair
MODEL HE-29C. Crystal control on both Transmit and Receive. Push to talk operation. Earphone for personal listening. Complete with carrying cases, batteries and telescopic aerials. Size 6⅞in. × 2¼in. × 1⅜in.

3 TRANSISTOR **£7.17.6** Pair
MODEL HA.70A Crystal controlled transmit. Super sensitive regenerative circuit. Size 5¼in. × 2¼in. × 1¼in. Complete with carrying cases, batteries and telescopic aerials.

ALSO LARGER 2-CHANNEL MODELS AVAILABLE. S.A.E. FOR DETAILS.

LAFAYETTE AIRCRAFT RECEIVER. LATEST IMPROVED MODEL HA-55A
Covers 108-136 mc/s. Listen to Aircraft Communications with this de luxe receiver. Two R.F. stages with 6CW4 Nuvistor for high sensitivity. 11 valve performance. Transistorised power supply. Built-in 4in. speaker, adjustable squelch, front panel phone jack. Easy read illuminated slide rule dial. Brand new and guaranteed. Size 11 1/16in. × 5¼in. × 7⅛in.
GEE'S PRICE £19/7/6. Carr. 10/0.

WW—149 FOR FURTHER DETAILS.

MINI WALKIE-TALKIE

The latest craze! Push-button operation; crystal control. Fully transistorised (3-transistor circuit) for perfect reception. Tremendous commercial scope. Complete with strap, battery and 8-section antenna. Uses 9v. PP3 battery and operates up to half mile in open country. Measures 5¼ × 2¼ × 1⅜in. Frequency 27.125 Mc/s.

ONLY £6.19.6 pair *(Post & insurance 4/6).*

A G.P.O. Transmitting Licence is necessary if this set is used in U.K.

MINY PORTABLE TAPE RECORDER Mk. II

Now, a reasonably priced, small, portable tape recorder that gives exceptional results. Precision-engineered throughout. Hand microphone has thumb switch for automatic stop/start record/playback etc. Ideal sales reports and dictation etc. Tough, unbreakable fawn plastic case with deck cover for mobile recordings. Complete with earphone, microphone, tape, two spools, batteries. Size 5in. × 7¾in. × 2¼in.

Usually £12.12.- **OUR PRICE £6.15.0** *(Post & insurance 4/6).*

BATTERY MAINS MODEL, 220-250v. *(Post & insurance 4/6).* **£7.15.0**

DE LUXE TELEPHONE AMPLIFIER

You've waited years for this! Just insert PP3 battery, plug sensitivity cone to side of 'phone, and an incoming call is amplified. No need to stop work waiting for numbers to answer! Used with tape recorder (e.g. MINY, see above) perfect, recording of conversation can be made. Ideal field sales reports.

ONLY 59/6 *(Post & insurance 4/-).*

BATTERY ELIMINATOR

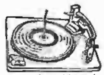
Convert your transistor radio to mains operation and save £££s. Easy to fit, takes the place of most 9v. batteries. Boosts expended batteries for re-use.

PP3 model **17/6** PP9 model **26/-**
(Post & Insurance 3/6)

ELECTRAMA

WINDMILL HILL · HAILSHAM · SUSSEX

50% SAVING! AUTO RECORD DECKS



Factory - fresh, up-to-the-minute Garrard & B.S.R. decks. 200-250 v. A.C. Adjustable stylus pressure. Takes mixed record selection. Speeds 78, 45, 33 and 16. Fitted mono-head, but wired stereo. Limited number only.

GARRARD 2000 **£6/19/6** *(Post & ins. 5/-).*
GARRARD AT6. **£5 15/-** *(Post & ins. 5/-).*
B.S.R. UA 16. **£4/15/-** *(Post & ins. 5/-).*
GARRARD 3000 **£8 8 -** *(Post & ins. 5/-).*

STEREO CABINETS

Portable. Include auto changer cabinets 15in. × 15in. × 7¼in., with hinged lids. Two extension speaker boxes 15in. × 7¼in. × 3¼in., chrome speaker frets. Covered black leathercloth. Cost £7 to manufacture.

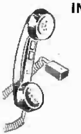
£3.10.0 *(Post & insurance 5/-).*

CLEARANCE OFFER! SOLDERING IRONS

1,000 new portable soldering irons. 230/250 v. with copper bit and rapid heat element. Shaft cover converts into pistol-type grip. Ideal printed circuit work.

11/6 *(Post & insurance 2/-).*

TELEPHONE HANDSET INTERCOM



New from Japan. Beautifully made 2-way transistor telephone handset with wall brackets. Built-in call system with crystal clear amplification. Works over amazingly long distances. Two way connection. Complete with two U7 batteries.

£6 10/- pr. *(Post & insurance 5/-).*

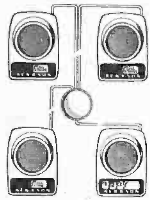
MULTIMETER BARGAIN

Just arrived from Japan! Miniature vest pocket meter only 4in. × 3in. × 1⅛in. Beautifully engineered for close tolerances, using damped M/C meter. Guaranteed.

SPECIFICATION:

VOLTS A.C. 0-15-150-1,000 v. (1,000 ohms).
VOLTS D.C. 0-15-150-1,000 v. (1,000 ohms).
D.C. current 150 mA. Resistance 100k/ohms.

39/6 *(Post & insurance 2/6).*



BARGAIN OF THE MONTH

SAVE £7 ! !

BENKSON 4-way Intercom

Bulk purchase has cut retail price by half! A top quality, fully transistorised system designed for hard office and professional use. Consists of one master unit and three sub-stations with built-in call system. Absolute privacy to each extension. Push-button control. Crystal clear reproduction through 3in. speakers. Suitable desk or wall mounting (size 6 × 4in.). Supplied complete with 50 yds. cable, junction box, instructions, etc.

£7.10.0 *(Post & insurance 5/-).*

SPEAKER BARGAINS

Manufactured by famous English Company 10in. high flux, high density, heavy cone model for quality and wide range reproduction. 3 or 15 ohms.

29/6 *(Post & insurance 4/-).*

12in., specification as above but with built-in Tweeter, 3 or 15 ohms.

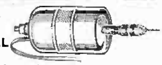
39/6 *(Post & insurance 4/6)*

QUALITY TWEETERS FROM JAPAN

10 w., 6.5 cm., 16 ohms.

27/6 *(Post & insurance 2/6)*

MINI DRILL



Powerful precision-made miniature drill for electronic engineers and model makers. Ideal printed circuit work. Accessories include drill, buffer, polisher, etc. Revs. to 5,000 r.p.m. off two U2 batteries.
(Post & insurance 3/6). **39/6**

50% SAVING! SONY Transistor Radios

Now at 50% off, the complete range of Transwave Sony transistor radios. Really powerful, top-quality sets. All supplied complete with batteries, leather carrying cases and personal earphones.

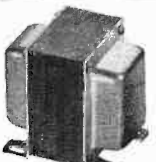
★606 S—six transistor. Receives all those pirates with amazing clarity.
56/- *(post & insurance 2/6)*

★720 S/L—seven transistor. Two band de luxe model. Beautiful tone.
84/- *(post & insurance 2/6)*

★820 S/L—eight transistor. The big brother with telescopic aerial and shoulder strap.
95/- *(post & insurance 2/6)*

RETAIL SHOP

ELECTRAMA, 46 WINDMILL HILL RUISLIP. Tel.: 5780.



TRANSFORMERS

STANDARD RANGE
OR
TO YOUR OWN SPECIFICATION.

The following Transformers are always in stock :—

MAINS TRANSFORMERS

INTERLEAVED & IMPREGNATED — FULLY SHROUDED
COLOUR CODED FLYING LEADS
Primaries 0-200-220-240 v. 50 c/s.

	250–250 v. 100 m/A.	6.3 v. 3½ amps. 6.3 v. 1 amp.	19/–
E.S.	250–250 v. 60 m/A.	6.3 v. 3 amps. 5 v. 2 amps.	18/6
E.S.	250–250 v. 100 m/A.	6.3 v. 4 amps. 5 v. 3 amps.	25/–
E.S.	250–250 v. 70 m/A.	6.3 v. 2 amps. 5 v. 2 amps.	16/–
	250–250 v. 100 m/A.	6.3 v. 2 amps. 6.3 v. 1 amp.	19/6

CHARGER TRANSFORMERS

0-210-220-240 v. 50 c/s.	0-3.5-9-17 v. 1A.	11/–
	0-3.5-9-17 v. 2A.	13/–
	0-3.5-9-17 v. 4A.	15/–
	0-9-17 v. 6A.	21/–

BATTERY ELIMINATOR PP.9.

Input 240V. A.C. Output 9 V. D.C. 200 m/A. 22/–.
Write for price list for full range of stock items. Discounts for quantities.
Terms cash with order. Packing and Postage 3/– each item.

Hours of business: Mon. to Fri. 9 to 6; Sat. 9 to 4.

OLYMPIC RADIO COMPONENTS LTD.

224 HORNSEY RD., LONDON, N.7. *Tel: NOR 2914*

VALVES SAME DAY SERVICE

NEW! TESTED! GUARANTEED!

SETS 1R5, 1S5, 1T4, 3S4, 3V4, DAF91, DF91, DK91, DL92, DL94. Set of 4 for **15/-**. DAF96, DF96, DK96, DL96, 4 for **24/6**.

1A7GT	7/6	10C2	11/6	DH76	3/6	EF86	6/9	PFL200	17/6	UF41	6/9
1H5GT	7/3	10F1	9/9	DH77	4/-	EF89	4/3	PL36	8/9	UF80	6/-
1N5GT	7/9	12AT7	3/9	DH81	12/6	EF91	2/9	PL81	6/9	UF89	5/9
1R5	4/9	12AU6	4/9	DK32	7/9	EF183	6/9	PL82	5/6	UL41	7/3
1S4	4/9	12AU7	4/9	DK91	4/9	EL33	6/6	PL83	6/-	UL44	15/-
1S5	8/9	12AX7	4/0	DK92	8/-	EL38	11/9	PL84	6/3	UL84	5/9
1T4	1/9	12K7GT	3/6	DK96	6/6	EL41	7/3	PL500	14/-	UY21	8/9
3A5	6/9	12K8GT	8/6	DL33	6/9	EL84	4/6	PL801	7/6	UY41	4/9
3Q4	5/6	12Q7GT	3/6	DL35	5/-	EL90	4/9	PX25	7/9	UY85	4/9
3S4	4/9	19BG6G	6/9	DL92	4/9	EL95	5/-	PY32	8/9	VP4B	11/-
3V4	5/6	20L1	11/9	DL94	5/6	EM80	5/9	PY33	8/9	W76	3/6
5U4G	4/6	20P3	10/9	DL96	6/-	EM81	7/3	PY80	5/3	W77	2/9
5Y3GT	4/11	20P4	13/6	DY86	6/9	EM84	5/9	PY81	5/3	X79	24/6
5Z4G/GT	6/9	20P5	11/6	DY87	6/9	EM87	6/6	PY82	5/-	Z77	2/9
6/30L2	8/9	25U4GT	11/6	EABC80	6/-	EY51	6/3	PY83	5/9	**Transistors**	
6AL5	2/-	30C18	8/-	EAF42	7/6	EY86	6/-	PY800	6/6	AC107	13/6
6AM6	2/9	30F5	8/6	EB41	4/-	EZ40	6/3	TH21C	9/6	AC127	9/6
6AQ5	4/9	30FL1	9/6	EB91	2/-	EZ41	6/6	TH233	6/6	AD140	22/6
6AT6	4/-	30L15	10/3	EBC33	6/-	EZ80	4/-	U25	8/6	AF102	25/-
6BA6	4/6	30L17	12/-	EBC41	6/6	EZ81	4/6	U26	8/9	AF115	6/0
6BE6	4/3	30P4	13/6	EBF80	6/-	FW4/500	6/3	U47	8/6	AF116	6/9
6BH6	5/-	30P12	7/6	EBF83	7/6	GZ33	12/6	U52	4/6	AF117	5/-
6BJ6	5/6	30P19	13/6	EBF89	5/9	GZ37	8/9	U54	8/9	AF118	17/6
6BW6	7/9	30PL1	9/6	ECC40	6/9	KT61	6/6	U78	3/6	AF124	10/-
6F13	3/6	30PL13	10/9	ECC81	3/9	MU14	4/-	U191	9/9	AF125	10/6
6F14	9/-	30PL14	11/-	ECC82	4/9	N18	5/6	U301	10/9	AF126	10/-
6F23	9/-	35L6GT	6/3	ECC83	7/-	PC97	5/9	U801	15/-	AF127	9/6
6K7G	1/6	35W4	4/6	ECC84	6/3	PCC84	5/6	UABC80	5/9	OC22	21/6
6K8G	4/3	35Z4GT	4/6	ECC85	5/6	PCC89	9/9	UAF42	7/9	OC25	11/6
6K8GT	7/6	53KU	8/6	ECF80	7/6	PCC189	9/-	UBC41	6/6	OC26	6/9
6P28	9/6	85A2	5/9	ECF82	6/-	PCF80	6/6	UBC81	6/3	OC44	4/3
6Q7G	5/9	6063	12/6	ECF86	10/9	PCF82	6/-	UBF80	6/-	OC45	3/3
6SL7GT	4/9	AZ31	9/3	ECH35	6/-	PCF86	8/3	UBF89	5/9	OC65	22/6
6V6G	3/6	B36	4/6	ECH42	8/3	PCF805	8/-	UBL21	9/-	OC66	25/-
6V6GT	5/6	CL33	9/6	ECH81	6/-	PCL82	6/3	UCC84	8/-	OC71	3/6
6X4	3/6	CY1	12/6	ECL80	6/3	PCL83	8/6	UCC85	6/6	OC72	4/9
6X5GT	6/3	DAC32	7/3	ECL82	6/9	PCL84	8/3	UCF80	8/3	OC81	3/6
7B6	10/6	DAF91	3/9	ECL86	8/6	PCL85	8/-	UCH21	8/-	OC81D	3/6
7B7	7/9	DAF96	6/-	EF39	3/9	PCL86	8/6	UCH42	7/6	OC82	5/9
7C5	7/9	DCC90	6/9	EF41	6/3	PENA4	6/6	UCH81	6/6	OC82D	5/6
7C6	5/9	DF33	7/9	EF80	4/9	PEN36C	15/-	UCL82	7/3	OC170	7/6
7H7	4/9	DF91	1/9	EF85	5/-	PEN383	9/6	UCL83	9/3		
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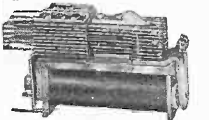

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MINIATURE SEALED RELAYS

OVER 120 TYPES IN STOCK. SEND FOR LIST.

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	1,700Ω + 1,700Ω		H96E	22/6
G.E.C.	2,500Ω	4CO	M1008	19/6
	2,500Ω	1CO	M1022	15/-
	5,000Ω	2CO	M1052	17/6
	670Ω	2m2bHD	M1095	17/6
	2,500Ω	2C2K	M1417	19/6
	5,000Ω	2CO	M1452	17/6
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	40Ω	2CO2K	M1482	19/6
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	180Ω	2m2bHD	M1487	17/6
	180Ω	2C2K	M1490	19/6
	670Ω	2C2K	M1493	19/6
	670Ω	4K	M1567	19/6
S.T.C.	45Ω	1mHD	4186EB	19/6
	170Ω	1mHD	4186EC	19/6
	700Ω	2COMD	4190HD	19/6
	2,500Ω	2CO	4184GE	19/6
ERICSSON	7,500Ω	2CO	N22305AZ1	17/6
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LEDEX SOLENOID DRIVEN WAFER SWITCHES. SIZE 5S. From **90/-.** 11 Way and off, 3 to 24 Pole, also 4 Pole 12 Way and 54 Pole on/off. Commutating switch section and control wafers available.

EQUIPMENT RACKS with 6ft. channel uprights drilled for 19in. panels, welded top and base **£6/10/-.** Also available 5ft. lighter type, **£5.** Carriage 20/-.

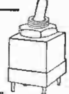
RELAYS. 24 volt D.C. 4 Make, 4 Break, 10 amp. 5C/3044 with Dust Cover, **12/6** each.

SIEMENS MINIATURE RELAYS Type TRLS 154d. 24 volt, 2 change-over contacts, heavy duty with transparent dustproof cover and base, **17/6.**

SIEMENS HIGH SPEED OPEN TYPE RELAYS with usual adjustments, 1,700Ω, 1 change-over, **17/6** each.

MAGNETIC CONTACTOR. 240 volts 50 c/s. 30 amp. Arrow Electric, **70/-** Post 3/6.

ONE HOLE FIXING SWITCHES



SINGLE POLE Double Throw, 3 amp. 250 v. A.C., can be used as ON/OFF or CHANGE-OVER switch.

12/- per dozen, 75/- per 100

VEEDER-ROOT MAGNETIC COUNTERS WITH ZERO RESET 800 COUNTS PER MINUTE. COUNTING TO 999,999. 230 volts A.C., **65/-.** Post 2/9.

PRECISION SILVER MICA CAPACITORS. 0.1 mfd. ½% **10/-**; 1%, **7/6**; .02 mfd. 1%, **5/-**; 0.05 mfd. 1% **5/-**; 0.15 mfd. 2%, **7/6**; 0.25 mfd. 2%, **15/-.**

SUBMINIATURE MICRO SWITCHES. HONEYWELL 11SM1-TN13. S.P.D.T. 6/6 ea.

METERS GUARANTEED

2in. Moving Coil Flush Round Microamps 0/500, **25/-.** **Milliamps** 0/1, 0/5 or 0/30. **Volts** 0/20, 0/30 or 0/40. **Amps** 0/5. All D.C., **27/6** ea.

2½in. Moving Coil Flush Round, Microamps 0/50, unscaled **70/-.** 0/100, **40/-**; 0/150, **70/-.** **Milliamps** 0/2, **50/-**; 0/50, **35/-.** **Amps** 0/30, **42/6**; 0/250, **60/-.** **Volts** 0/2, **46/-**; 250-0-250, **60/-.**

3½in. MC FLUSH ROUND 0/500 Microamps, **70/-,** 0/2 Milliamps, **60/-,** 0/500 Milliamps, **54/-,** 0/10 amps, **45/-.** 0/40 amps, **72/-.** A selection of our stocks.

M.C. RECTIFIER A.C. METERS. 3½ FR10 Milliamps, **70/-,** 50 or 100 v., **72/-**; 200 volts, **75/-.**

MOVING IRON A.C. AMMETERS. 0/10 2½in. fr **44/-.** 0/60in. Projection Round, **90/-.**

DIRECT ON STARTERS by Crabtree B15 **95/-.**

WEE MEGGER INSULATION TESTERS 500 VOLT SERIES 3. BRAND NEW in leather case, £18/10/-.

AVOMETER POWER FACTOR WATTAGE UNIT, £7.

MEGGER, Series 2. 500 volt 100 megohms, leather case, leads, key, etc. **Brand new. £37/10/-.**

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New production by famous British Manufacturer. Rated 100 w. at 12 v but light output is actually a tremendous 2,900 lumens at colour temp. of 3,300°K. Life expectancy more than twice conventional filament projection lamp. Size only 42 mm. × 10 mm. dia. Complete with ceramic holder.

25/- P. & P. 1/-.

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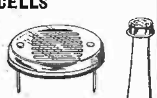
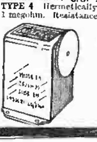
New, inexpensive photo-conductive cells which act as light-sensitive resisters that increase conductivity with increased light. These are 1,000 times more sensitive than selenium cells, with greater reliability and can easily be built into a wide range of simple circuits. Typical uses include automatic light controls for home and car, flashing barricade or breakdown lights, exposure meters, brightness controls, relay operation, and many other devices. Require only simple low power source from battery or mains transformer. Four types available.



TYPE 1 TYPE 2

TYPE 1—Plastic encapsulated 1in. diam. × ¼in. thick. Time response 2 megohms. Resistance 100 Lux—700 to 3,000 ohms. Max. volts 200. Max. current 250 mW. **10/-.** Post free.
TYPE 2—Plastic encapsulated. ½in. diam. × ¼in. thick. Time response 1 megohm. Resistance 100 Lux—500 to 2,000 ohms. Max. volts 150. Max. current 7 mW. **8/6.** Post free.
TYPE 3—Glass sealed with M.E.S. base. Glass envelope ³⁄₁₆in. diam.; overall length 1in. Time response 90 megohms. Resistance 100 Lux—0.05 to 0.15 megohms. Max. volts 150. Max. current 75mW. **6/6.** Post free.
TYPE 4 Hermetically sealed, glass window faced. ¼in. diam. × ¼in. thick. Time response 1 megohm. Resistance 100 Lux—15,000 to 50,000 ohms. Max. volts 100. Max. current. **5/-.** Post free.



RESETTABLE MAGNETIC COUNTERS

Made by famous British Manufacturer. Mechanism constructed on diecast frame and totally enclosed by one-piece cover. For pedestal mounting. Max. speed 250 c.p.m. Consumption 4-5 watts. Size 1¼ × 2¼ × 2¼in. high. 3 types available: 3 digit, 250 volts A.C. mains operation; 4 digit 24 volts D.C.; and 24 volts A.C. operation. State which required

30/- Carr. 1/6.

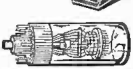
HIGH INTENSITY LAMP 49/6 P. & P. 2/6.

Provides a concentration of intense pure white, glare-free, shadowless light that can be directed straight on to illumination area. Ideal for reading, stamp and minute object examination, delicate craft work and watch repair, table-top photography, etc. Ingenious design combines function with attractive appearance: tough plastic base has on/off switch and is weighted by built-in transformer that reduces mains voltage to permit use of enormous headlamp power of car bulb over small area, 21 watt lamp actually provides greater light intensity than conventional 100 watt bulb, with electrical consumption less than one-fifth of usual mains lamp. Gold anodised flexible pillar facilitates light direction from any angle. For 200/240 v. A.C. only: spare bulbs readily obtainable Base 2¾in. × 3¾in. × 2in. Height overall 16in.

DEKATRON TYPE GS10E

by Ericsson, supplied brand-new, boxed and complete with performance and connection data. **Max.** operating speed: 10 kc/s. Anode voltage: 440/475 v. Current: 0.8 mA. Cathode voltage: 35 v. max. Pulse Amplitude: 120 v. min. Size overall 1.3in. dia. × 2.64in. Fitted with standard duodecal base.

15/- post free.



DIRECT READ-OUT TUBES

YN3 " Numicator " read-out indicator scaled 0-9 and for operation from 180-300 volts D.C. Unit is contained in cylindrical glass envelope size ¾in. diam. × 1¾in. high with wire-ended connections. Figure height ⅜in. Can be used in single circuits to give numerical indication or to form basis for electronic counters with speeds up to 5 kc/s. New current production units complete with specification: performance data and typical circuits.

15/- each. P. & P. 1/6.

Set of cold cathode tubes to make one counting stage of 150 c/s. counter, **10/6** extra. *Cold cathode tubes for high speed counters can also be supplied. Send for details.*

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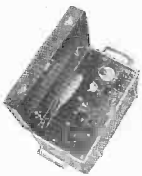
3-CENTIMETRE ECHO BOX TYPE 100



The Echo Box (Resonator) consists of a high "Q" resonant cavity adjustable over a frequency range of 9,170 to 9,445 Mc/s directly calibrated in Mc/s. and a calibrated piston attenuator coupled direct to the cavity. A crystal detector coupled to the cavity detects the resonance and the crystal current deflects the tuning meter. For connecting to the directional coupler, a *lossy* coaxial cable is provided, having a socket at one end and a waveguide-to-coaxial transformer at the other.

PRICE, unused and fully guaranteed **£32 0 0**
Packing and carriage 15/-.

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8in. mirror scale calibrated from 0 to 160V. Polish teak case with lid. Screen terminal connections, overall dimensions, 9in. × 9in. × 3½in. .... PRICE NEW **£3 0 0**
Packing and carriage 15/-.

TRANSISTOR CIRCUIT COMPONENTS

Set of three 450 kc/s. I.F. Coils	**10/6**
Variable Twin Gang Miniature Tuning Capacitor, two section, 4-165 pF. and 3-65 pF., with 1-8 pF. trimmer, complete with Broadcast Band Oscillator Coil	**6/6**
Driver Transformer, impedance ratio 2 : 1	**3/6**
Output Transformer for push-pull output, 250 mW	**3/6**
5,000Ω Edgewise volume control with switch	**4/9**

Packing and carriage 1/5 per item.

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.05μF 10,000 DCWV, T.C.C. VISCONOL	**7/6**
.1μF 5,000 DCWV, Dubilier	**7/6**
.5μF 2,500 DCWV, Dubilier	**7/6**
4μF 400V. DCWV, Dubilier or T.C.C.	**3/-**
4μF 600V. DCWV, miscellaneous U.S. makes	**3/-**

RELAYS

4189GD (S.T.C.), removed from equipment, 700Ω coil, 2 changeover contacts, 1⅝in. × 1½in. × ⅞in.	**4/-**
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55340 (R.B.M.), new, 270Ω coil, 1 make, 1½in. × 1½in. × 1in.	**4/-**
22240-4 (R.B.M.), new, sealed, 14-pin base, 200Ω coil, 6 makes	**5/-**
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TYPE 234. 19in. rack mounted fully smoothed and fused for 230 V. A.C. input. H.T. output adjustable from 180 V. to 270 V. at 80 mA. by means of primary taps and high-low switch in the secondary winding. L.T. output 6.3 V. A.C. at 4 amps. Fitted with M.I meter to read A.C. input and D.C. output volts. Second-hand, tested, in good condition. **£3 19 6**
DITTO, model without meter **£3 10 0**
Packing and carriage 15/-.

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24μF at 275V.	**2/-**	100-400μF at 275 V.	**3/6**
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20-20μF at 450 V.	**3/-**		
50-100μF at 275 V.	**3/-**		

All voltages are D.C. working. Postage 2/- per order.

PORTABLE TRANSISTOR TESTER TYPE ZQM

For quick testing of N-P-N and P-N-P low and medium power transistor, germanium and silicon diodes. Current gain range 5-300. The instrument can also be used as an ohmmeter in the range of 200Ω to 1MΩ. Powered by internal battery. This instrument replaces previously advertised AT-1.
PRICE .... **£7 7 0** P.P. 5/-

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DLR5 BALANCED ARMATURE with sound powered inserts; D.C. resistance 40Ω per insert .... **10/-** ea.
CHR MOVING IRON. D.C. resistance 4,000Ω .... **15/-** ea.
MOVING COIL, with moving coil microphone fitted with press-to-talk switch. **D.C.** resistance 40Ω per insert. Large rubberised felt lined earpads. Very comfortable to wear. **15/-** ea.
TANNOY MOVING COIL, similar to the above but fitted with heavy die-cast carbon microphone .... **12/9** ea.
No. 10 ASSEMBLY—Generally similar to item 2 above but with rubber earpads. BRAND NEW **17/6**
Secondhand, tested .... **7/6** P.P. 3/6 per headset

"Electron" Outdoor Aerial

3 strong tubular light alloy sections 3ft. long each on an insulated aerial base fitted with wall mounting bracket. Complete with down lead. PRICE, brand new, **15/-**, P.P. 5/-.

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500μA D.C. MC 1in. round flush, ringnut mounting, calibrated 0 to 1	**17/6**
500μA. D.C. MC 2in. round flush, ringnut mounting	**17/6**
500 μA D.C. MC 2in. round flush, for clip fixing, undrilled flange	**10/-**
1mA. D.C. MC 2in. round flange mounted, sealed, calibration 0-3/30/300	**12/-**
1mA. D.C. MC 2½in. round flange mounted	**17/6**
1mA. D.C. MC 2½in. square flange mounted	**17/6**
30mA. D.C. MC 2½in. round flange mounted	**10/-**
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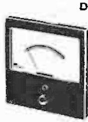
100mA. D.C. MC 1¾in. round flange mounted	**15/-**
100mA. D.C. MC 2½in. round flange mounted	**12/6**
150mA. D.C. MC 1¾in. round flush, clip mounted	**12/6**
500mA. D.C. MC 2½in. round flange mounted	**12/6**
25A D.C. MI 3½in. round projecting	**7/6**
100A A.C. MI 2½in. round flush, clip mounted	**12/6**
15V. A.C. MI 2½in. round flange mounted	**12/6**

METERS
PHILIPS FIRST-CLASS MIRRORS SCALE 1mA D.C. M.C. METERS



Square flange 4.6in. × 4.6in. flush mounted. Scale length 4in. Body 3.8in. dia. × 1½in. deep. Calibrated 0 to 1 mA. Price **65/-**

TPYE 108-IT MULTI-METER

21-range precision portable meter, 5,000 o.p.v. **D.C.** Volts: 2.5-10-50-250-500-2500V. A.C. Volts: 10-50-100-250-500-2500V. D.C. current 0.5-5-50-500mA. Resistance: 2000-20,000 ohms-2-20 megohms. Power output calibration for 600 ohms line. **£5/5/-** P.P. 7/6.

POCKET MULTIMETERS TYPE U-1

Sensitivity 1,000Ω/V. **D.C.** and A.C. voltage ranges 0-10-50-200-500-1,000 V. **D.C.** current ranges: 0-100-500 mA. Resistance ranges 2,000Ω-200,000Ω. Brand new. **£2/2/-** P.P. 7/6.

VARIABLE AUTOTRANSFORMERS

Type B2, 2.5 A. max.	**£5 19 6**	P.P. 7/6.
Type SB5, 5 A. max.	**£9 0 0**	P.P. 10/-
Type SB10, 10 A. max.	**£18 5 0**	P.P. 12/6
Type SB20, 20 A. max.	**£32 10 0**	P.P. 15/-

VARIABLE A.C. POWER SUPPLY UNIT

Portable Power Unit fitted with 1.5 amps. Variable Transformer, switched and fused, with A.C. Voltmeter and panel indicator lamp. **£8 10/-**, P.P. 8/6.

FERRITE ROD AERIALS

OSMOR FW/FR1 **for pocket superhet, long** and medium waves **8/6**
WEYRAD RA2W **for transistor** radios using OC44 or similar transistor; **long and medium** wave. Car aerial coil. **12/6**
FERRITE RODS, 5in. long .... **1/9** ea.
10/- per doz. P.P. **1/6 per** order.

LA2 POT CORE ASSEMBLY

Size 1$\frac{3}{16}$ × 1$\frac{3}{16}$ × ⅞in.; up to 100 kc/s. Number of turns for 1 mH. is 65 .... **7/6** P.P. 9d.

MISCELLANEOUS SILICON HALF WAVE POWER RECTIFIERS

DD000 (Lucas) 50 p.i.v. 500 mA.	**5/-**
SJ102A (AEI) 100 p.i.v. 2.4 A.	**7/6**
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BYZ13 (Mullard) 200 p.i.v. 6 A.	**10/-**
DD006 (Lucas) 400 p.i.v., 500 mA.	**6/-**
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TEXAS SILICON FULL-WAVE BRIDGE RECTIFIERS

1B20K10 100 p.i.v. 2 amps., dimensions 1.4 × 1.4 × .6in.	**25/-**
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3FP7 3in. yellow trace, long persistence screen, EHT 2,000V, with P.D.A. (B14A)	**12/-**
3GP1, 3in., green trace, medium persistence, E.H.T. 1,500 V. (B14A)	**50/-**
3WP1, 3in., white trace, flat face, medium persistence, 1,500 V. E.H.T. (B12A)	**120/-**
4EP4, 4in. white trace, flat face, medium persistence, with P.D.A.; 4,000 V. EHT (B12F)	**100/-**
5ADP16, 5in. blue trace, short persistence, flat face, with P.D.A.; 3,000 V. EHT (B14A)	**160/-**
5CP7, 5in. yellow trace, long persistence screen, with P.D.A.; 4,000 V. EHT (B14A)	**100/-**
5UP7, 5in. yellow trace, long persistence screen, MAGNETIC DEFLECTION, electrostatic focussing, 4,000 V. EHT (B14A)	**60/-**
7BP7, 7in. yellow trace, long persistence screen, MAGNETIC DEFLECTION AND FOCUSSING, 7,000 V. EHT	**30/-**
894. 4in. double beam, blue trace, flat face, short persistence, 2,000 V. E.H.T. (special)	**60/-**
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DG7-5, 2¾in. green trace, medium persistence, E.H.T., 800 V. (B9G)	**55/-**
DG13-2, 5in. green trace, medium persistence, P.D.A., max. E.H.T. 4,000 V. (B14A)	**120/-**
DG16-22, 5¼in. × 1¾in., rectangular screen, green trace, medium persistence, E.H.T., 5,000 V. (B14A)	**200/-**
S6d, 6in. green trace, short persistence screen, flat face tube, 4,000 V.E.H.T. (B12D)	**200/-**

WW—152 FOR FURTHER DETAILS.

FEATURE PAGE

CLASSIFIED ADVERTISEMENTS

DISPLAYED: £5 per single col. inch.
LINE advertisements (run-on): 5/6 per line (approx 7 words), minimum two lines.
Where an advertisement includes a box number (count as 2 words) there is an additional charge of 1/-.
SERIES DISCOUNT: 15% is allowed on orders for twelve monthly insertions provided a contract is placed in advance.
BOX NUMBERS: Replies should be addressed to the Box number in the advertisement. c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.
No responsibility accepted for errors.

Advertisements accepted up to MARCH 7 for the APRIL issue. subject to space being available.

SITUATIONS VACANT

COMMERCIAL RADIO STATION (U.K.)

BROADCASTING in medium wave band, requires three high power transmitter engineers with associated audio and line equipment experience; salary up to £1,500 p.a.—Write Personnel Director, Box W.W. 1437, "Wireless World."

PYE CAMBRIDGE WORKS, Ltd., Haig Rd., Cambridge.
- SINGLE sideband equipment.
- VHF radiotelephone equipment.
- HI-FI reproduction equipment.

WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
WE have also limited vacancies for persons of less experience who can be trained for such work.
APPLY to: The Personnel Manager. [131

UNIVERSITY OF OXFORD. Inorganic Chemistry Laboratory.
HEAD of Electronics Section. Qualified electronics Technician required to take charge of section of Research School of the Inorganic Chemistry Laboratory. Some experience with stabilised power supplies, spectrophotometers, oscilloscopes, electron microscopes, etc., would be useful. Salary on Senior or Principal Technician scale according to qualifications and experience. University pension scheme. Good holidays and conditions of work.—Applications to the Secretary, Inorganic Chemistry Laboratory, South Parks Rd., Oxford. [1404

PERMANENT and progressive job for first-class T/V Engineer (bench and field), N.W. area; good salary, transport and subsistence allowance; if you are a top class man—Tel. Field End 0177. [1393

GRAMPIAN REPRODUCERS, Ltd., Hanworth Trading Estate, Feltham, Middlesex, require a senior engineer for development of audio frequency transistorised equipment in public address applications. [1405

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. [149

TEST Service Engineer, adventurous young man required capable of working on own initiative in busy go-ahead atmosphere of small company manufacturing complex control systems, WC1.—Apply Box W.W. 1399, Wireless World.

WEST LONDON AERO CLUB invite A & B licensed engineer with capital and/or necessary equipment to commence radio workshop; alternative propositions may be considered.—Write full details to White Waltham Airfield, near Maidenhead, Berks. [1417

ELECTRONICS, enthusiastic man required for packaging development laboratory, practical electronics and O.N.C. Maths. (Min.), essential, age unimportant, salary according to age and experience.—Tel. Chiswick 6681/2/3 for appointment. [1428

CHIEF Transformer Designer required for a wide range of small transformers; degree or A.M.I.E.E. is preferred and a very attractive salary will be paid. We are part of a public company and operate a pension scheme.—Write: Managing Director, Drake Transformers, Ltd., Kennel Lane, Billericay, Essex. [1436

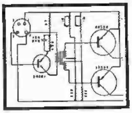
CIVIL AVIATION, Telecommunications.—The Ministry of Aviation has vacancies for Radio Technicians at airports, Air Traffic Control centres, radio stations and other specialised engineering establishments throughout the United Kingdom. The numbers and speed of air traffic today demands a complex, co-ordinated and reliable telecommunications system for airports, en-route navigation and air traffic control in order to ensure the highest standards of safety. The Ministry's radio technicians play a vital role in the installation, maintenance and technical operation of this system; their duties embrace a wide range of equipment, including primary surveillance and approach radars, secondary surveillance radars, radio navigational and landing aids, radio and line communications, electronic data displays, closed circuit TV, digital and analog computers. Applicants should be aged 19 or over, of British nationality and possess a sound basic knowledge of radio/electronics with practical experience in at least one of the main branches of Telecommunications; the possession of formal qualifications would be an advantage. Training on equipments and new techniques is provided at the Ministry's Civil Aviation Signals Training Establishment, Bletchley, Bucks. Radio technicians are encouraged to study for technical and professional qualifications, and generous assistance, including part-time and, in special circumstances, full-time release, is provided. There are good prospects of permanent pensionable posts and promotion to a higher class with a salary ranging from £1,032 per annum to £1,911 per annum. Starting salary varies according to age: from £747 per annum at 19 to £962 per annum for entrants of 25 or over, and rises to £1,104 per annum. Annual leave is 3 weeks and 3 days, plus 9 days for public holidays.—For further details apply to: Mr. J. J. Robinson, M.I.E.R.E., A.M.B.I.M., Ministry of Aviation, Room 754, The Adelphi, London, W.C.2. [1419

Radiomobile

BRITAIN'S CAR RADIO SPECIALISTS
Urgently seek to interview:

RADIO SERVICE ENGINEERS

Due to continued expansion it is now desirable that we should increase our technical staff, and opportunities for advancement are readily available for men with the right experience and ability.



We are able to offer highly competitive rates of pay, with excellent conditions of employment, which include Superannuation and Life Insurance Schemes.

Please apply to the Personnel Manager,
Mr. G. J. Sharkey,
RADIOMOBILE LIMITED,
Goodwood Works, North Circular Road, N.W.2
Telephone GLAdstone 0171 Ext. 129
A SUBSIDIARY OF SMITHS INDUSTRIES LIMITED

SEEKING ALTERNATIVE EMPLOYMENT?

Our dynamic organisation is geared to obtain for you the best job available in the area you require. If you are seeking employment in S.E. England and have at least two years' experience in British industry, contact Electronics Appointments Ltd., who are the foremost source of employment in Great Britain. Write or phone for details of our free and confidential service.

**Electronics Appointments Ltd.,
Norman House, 105-109 Strand,
W.C.2. TEMple Bar 5557-8.**

PYE SYSTEMS TEST ENGINEERS

Pye Telecommunications Limited require Systems Test Engineers for work on custom-built control systems for v.h.f./u.h.f. radio schemes. Knowledge of line and/or radio techniques essential. Experience on carrier equipment or v.f. telegraphy or telephone exchange equipment is desirable.

Apply to: **Personnel Manager,**
Pye Telecommunications Ltd.,
Newmarket Road,
Cambridge. Tel. No.: Teversham 3131.

ASSISTANT TELECOMMUNICATIONS ENGINEERS

Required by the EAST AFRICAN POSTS AND TELECOMMUNICATIONS ADMINISTRATION on contract for one tour of 24 months in the first instance. Commencing salary £1,994 in scale rising to £2,262 a year including allowances. Terminal Gratuity 25% of salary drawn. Generous disturbance allowance. Free passages. Liberal leave on full salary. Accommodation provided at low rental.

Candidates should be aged between 28 and 45 years and possess the relevant City and Guilds Certificates, or equivalent, and have sound experience in one or more of the following fields. (1) Automatic Telephony, (2) Carrier and Telegraph Equipment, (3) H.F. and V.H.F. Radio, (4) External General, (5) Underground Cable Planning.

Apply to **CROWN AGENTS, M. Dept., 4 Millbank, London, S.W.1,** for application form and further particulars, stating name, age, brief details of qualifications and experience, and quoting reference M2T/62721/WF.

MARCONI INSTRUMENTS LIMITED

ST. ALBANS · HERTFORDSHIRE

ARE YOU A SKILLED AND EXPERIENCED ELECTRONICS TECHNICIAN?
HAVE YOU BEEN A WIRELESS OR RADAR FITTER IN THE ARMED FORCES?
CAN YOU DO A PROFESSIONAL REPAIR JOB ON A T.V.?
DO YOU HAVE GOOD TECHNICAL QUALIFICATIONS BUT LACK INDUSTRIAL EXPERIENCE?

If you can answer "YES" to at least one of these questions then we should like to hear from you.

We need new test and calibration engineers to help us increase the output of our very wide range of telecommunication measuring instruments.

The work requires the understanding of the most modern and varied circuit techniques and embraces all frequencies up to U.H.F.

The posts are permanent and pensionable; they offer first class staff conditions in a key export Company of English Electric; they will prove attractive to men who believe strongly that there is a real career for them in production.

Call and talk it over if you live close to us at St. Albans. If you would prefer to 'phone, then ring ST. ALBANS 59292 during the day, or COLNEY HEATH 475 in the evenings, and ask for Mr. Dyson. Alternatively, write to our Personnel Officer, giving details of your training and experience and quoting reference WW2890A.

The Personnel Officer, Marconi Instruments Limited, c/o Directorate of Personnel, English Electric House, Strand, London, W.C.2.

SERVICE Engineer.—Due to continued expansion of our Audio Division, we now require two first-class Service Engineers who are experienced in working with high quality audio and tape recorder equipment.—Applications in writing, giving full details of experience, age and salary required, to J. R. Morris (Director), Truvox, Ltd., Neasden Lane, London, N.W.10. [1407

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff: starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Bromhill Rd., S.W.18. [124

CITY OF GLOUCESTER EDUCATION COMMITTEE.—Laboratory Technician required in the Department of Electrical Engineering. Some knowledge of electrical engineering, electronics or physics desirable. Salary £705 to £805, then on satisfactory report to £890 p.a.—Further particulars from the Principal, Technical College, Brunswick Rd., to whom letters of application should be sent within 10 days of this advertisement. [1431

NORTHERN POLYTECHNIC, Holloway, London, N.7. The Governing Body invites immediate applications for appointment as (a) Senior Lecturer, and (b) Lecturer in the Department of Electronics and Telecommunications. The lecturers will be expected to cover the graduate syllabus of the I.E.R.E. and Part III of the I.E.E. and should hold a degree of a British University or equivalent qualification and/or be Corporate Members of an appropriate professional engineering Institution. Previous teaching and industrial experience an advantage. Salary scales—Senior Lecturer—£2,140×£60×£2,380 plus £70 London Allowance, Lecturer—£1,875×£50 £1,975×£55×£2,140 plus £70 London Allowance.—Apply for further particulars (state post in which interested) and form of application. R. H. Currell, F.C.A., Clerk.

UNIVERSITY of the West Indies, Department of Physics. Electronics Engineer. The University of the West Indies invites applications for the post of Electronics Engineer to help establish an electronic workshop. The workshop will be intended to assist all departments throughout the University and the Teaching Hospital in connection with electronic equipment. The equipment has the widest variety from a mass spectrometer to high powered R.F. transmitters. Applicants should have had a wide experience. The total emoluments for the post will lie between £1,600 p.a. upwards to about £2,100 p.a. Applications should be addressed to Professor R. W. H. Wright, Department of Physics, University of the West Indies, Kingston, Jamaica, and should include details of qualifications and experience with the names of 3 referees. [1412

RADAR Technician required by the Government of Zambia, Meteorological Services, on contract for one tour of 36 months in the first instance. Commencing salary according to experience in scale rising to £1,580 (including overseas addition). Gratuity 25% of total salary drawn. Free passages. Children's education allowances. Quarters at moderate rental Candidates, preferably aged between 25 and 45, must possess Intermediate City and Guilds Certificate or its equivalent and have five years' experience in the installation and maintenance of S— and X— band radar. Familiarity with Plessey (Decca) Weather and Wind-finding equipment would be an advantage. The duties of the post will involve travel to various parts of Zambia.—Apply to Crown Agents, M. Dept., 4, Millbank, London, S.W.1, for application form and further particulars, stating name, age, brief details of qualifications and experience, and quoting reference M2T/62827/WF. [1420

PYE VHF TEST ENGINEERS

CAMBRIDGE WORKS LIMITED have vacancies in their expanding Test Organisation for men with experience of VHF Transmitters and Receivers.

Men with Service training in VHF equipment would be suitable.

Progressive rates of pay and promotion and good facilities for training are offered.

Apply: **Personnel Manager,**
Cambridge Works Limited,
Haig Road, Cambridge.

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Opportunities in the following Product Groups:

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Big things are happening at RBM Electronics. Big break-throughs. In every field RBM technologists are pushing forward the old frontiers, to pave the way for tomorrow. With RBM at Welwyn, research is the key-note. There are immediate opportunities in new and expanding fields for PROJECT LEADERS, DESIGN and SALES ENGINEERS as well as vacancies in other Departments for qualified technicians and graduates in such fields as Test and Installation. In the factory we need a first-class Chief Production Engineer, Estimators and Rate Fixers. This expansion could open the door for you to share in important development growth.
All positions offer genuine promotion prospects as expansion continues. Attractive working conditions too – Welwyn, with its modern buildings and open spaces, is located in pleasant Hertfordshire countryside less than 30 minutes from London. Assistance with housing in certain cases. Participation in all Rank Organisation benefits, including pension and non-contributory life assurance. Make the break-through now: tell us about your career to date, specifying any qualifications you have attained and which division you are interested in,

The Personnel Manager, Rank Bush Murphy Electronics, Welwyn Garden City, Herts. Tel. No. Welwyn Garden 23434

Outside normal working hours, use our telephone answering service. Ring Welwyn Garden 27906. Give your name, address and the type of vacancy that interests you. An application form – and details of our operation and current vacancies – will be in the post to you tomorrow morning.

RANK BUSH MURPHY ELECTRONICS

RADIO DIVISION

STC

TEST METHODS ENGINEERS

We require engineers to specify test methods and design test equipment. Education to H.N.C. standard and two years practical experience are desirable and an interest in automatic test methods would be an advantage.

Starting salary up to £1,225 p.a., Pension Scheme and non-contributory benefits apply to these positions, which offer good prospects for promotion.

For further details write or telephone the:—

Personnel Manager, Radio Division,
Standard Telephones and Cables Limited
Oakleigh Road, New Southgate, N.11.
telephone ENTerprise 1234, ext. 489.

IMPERIAL COLLEGE, South Kensington, S.W.7, Electronics development; we have a new and interesting vacancy in our electronics group concerned with the application of electronics techniques to our chemical engineering and technological research; several years' practical experience and a good knowledge of transistor circuitry are essential; H.N.C. would be an advantage; this is a unique opportunity to enter the department at a time of rapid expansion and re-equipment; there are excellent opportunities for working on instrument design and systems engineering; starting salary will be in the range of £1,000 to £1,200; write in confidence to—Professor G. R. Hall, Department of Chemical Engineering and Chemical Technology, Imperial College, London, S.W.7.

TELECOMMUNICATIONS ENGINEERS

required by the GOVERNMENT OF MALAWI on contract for one tour of 24-36 months in the first instance. Commencing salary according to experience in scale (including overseas addition) rising to £1,905 a year. Gratuity 15% of total salary drawn. Outfit allowance £30. Free passages. Liberal leave on full salary. Generous education allowances. Quarters at low rental.

Candidates, preferably aged 25-45 years, must have at least 5 years experience in one or more of the following branches of telecommunications engineering, after completion of two years approved training: Automatic exchanges and Subscribers Apparatus; carrier and V.H.F. equipment; HF radio; overhead lines or underground cables (construction). They must possess at least one appropriate City and Guilds Certificate. Previous overseas experience and experience in training and supervision of subordinate staff would be advantages. For certain posts the ability to instruct and control large numbers of low graded staff is essential.

Apply to **CROWN AGENTS, M Dept., 4 Millbank, London, S.W.1**, for application form and further particulars, stating name, age, brief details of qualifications and experience, and quoting reference M2T/62648/WF.

NEW TELECOMMUNICATIONS DEVELOPMENTS

involving some of the most advanced equipment in the world, offer careers of outstanding interest, secure and well-paid, to science and engineering graduates. A Royal Signals Officer is trained to command men. He leads a full and satisfying life, much of it out of doors. During his career, he has ample opportunity to obtain professional qualifications and to use them in tackling interesting problems in many different countries. The Royal Corps of Signals is responsible for the Army's modern telecommunications network, and also for a world wide static communications system. It needs graduates as officers, and offers immediate commissions to suitable candidates. *Pay and allowances* now compare very favourably with anything a young graduate could earn in civilian life. *Applicants* should be under 25, and should hold (or be studying for) a degree or a diploma recognised by the National Council for Technological Awards, preferably in: Mathematics, Physics, Applied Science, Natural Science, Electrical Engineering, or a diploma acceptable to the Institution of Electrical Engineers or the Institution of Electronic and Radio Engineers, as giving exemption from these Institutions' examinations. *Service* can be either for a short period (minimum three years, with tax-free gratuity) or as Limited Service Regular Officer (initially for 16 years with a pension and gratuity at the end) or for a full career up to at least 55. *For further details* write stating age and educational qualifications held (or for which studying) to: Lt.-Col. D. L. Pounds, Room 045, Ministry of Defence, Dept. 48, Old War Office Building, Whitehall, S.W.1.

ENGINEERS and Technicians required with Electronic or Physics qualification for research development and maintenance on a wide range of medical and electronic equipment. Current development projects include intestinal pressure measurements. Radiotelemetry and low noise amplifiers. Salary scale £668-£1,061 according to age and experience plus London Allowance.—Application forms from the Secretary (EW), The Hospital for Sick Children Great Ormond Street, London. S.E.1 [1424

UNIVERSITY OF NOTTINGHAM. The Department of Civil Engineering has a vacancy for a Senior Technician with electronics and electrical experience. Duties will include the maintenance and development of data measuring and recording systems, strain bridges and allied equipment. Applicants should be capable of working under the minimum of supervision and a recognised trade apprenticeship with O.N.C. or equivalent will be considered an advantage. Salary within the range £880 to £1,190 according to qualifications and experience. Applications in writing to the Head of Department, Civil Engineering Department, University of Nottingham. [1427

ELECTRONICS Technician required in physiological laboratory, re-equipping with transistorised recording equipment. Work will consist of developing, building and servicing equipment. There are excellent opportunities for co-operative work with the Hospital Department of Physics. The person appointed will be expected to undertake some administrative responsibility in the Dept. Applicants, aged 25-30, should hold an O.N.C. or equivalent qualification. Salary in range £805-£1,025 p.a. plus London Weighting of £45 p.a. with superannuation.—Apply giving details of experience to the Secretary, Guy's Hospital Medical School, London, Bridge, S.E.1. [1426

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a positon that offers :

★ Satisfactory employment
★ Five-day week
★ Good prospects of advancement
★ Staff status
★ Sick pay
★ Generous salary

Apply: Personnel Manager

Multitone Electric Co. Ltd.

12-20 Underwood St., London, N.1

ELECTRONICS Engineer.—We have a vacancy for an experienced electronics engineer for development work on fire detectors and smoke detectors, together with automatic control, signalling and relaying apparatus; applicants should have had some experience in electronics development and should hold H.N.C. in electronics or electrical engineering; promotion prospects and conditions of service are excellent.—Write in confidence to the Personnel Manager, The Pyrene Co., Ltd., Great West Rd., Brentford, Middlesex. Tel. No. Isleworth 4131, quoting ref. PM4033. [1410

COLLEGE OF AIR TRAINING, Hamble.—Simulator engineer required for maintenance of electronic flight simulators involving analogue computation, servo-mechanics, instruments, etc., good technical background and experience of electronic equipment maintenance essential; familiarity with aircraft systems preferred but not essential; salary scale £1,120 by annual increments of £30 to £1,330 per annum; four weeks holiday per year; contributory staff pension and life assurance schemes.—Apply in writing to the Bursar giving details of qualifications and past experience. [1406

CRAFTSMAN required for installation and maintenance work on the board's communication system, experience of v.h.f. and u.h.f. transmitters and receivers essential, knowledge of telephone systems an advantage; salary £835 per annum (£16/0/4 per week) and 10/6 per week productivity bonus; service increments of £20 per annum are payable after 2 and 3 years satisfactory service; N.J.I.C. conditions, holiday and sick pay schemes, optional superannuation scheme.—Apply by letter to Mr. E. C. Watson, Area Manager, Midlands Electricity Board, Spring Gardens, Ditherington, Shrewsbury, Shropshire. [1409

RADIO specialists required by the Government of Zambia for installation and maintenance duties (in the grade of Inspector of Police) on contract for one tour of 36 months in the first instance; salary in scale rising to £1,600 a year according to experience; gratuity at the rate of 25% of total emoluments; liberal leave on full salary or terminal payment in lieu; quarters, with heavy furniture, at low rental; education allowances, outfit allowance, free passages. Candidates, at least 25 years of age, must have had not less than five years' experience in the installation and maintenance of modern low and medium power h.f. equipment, S.S.B. and I.S.B. equipment and of v.h.f. equipment including multiplex links. Knowledge of maintenance of teleprinters, diesel and petrol generators an advantage; duties would involve travelling by road and air.—Apply to Crown Agents, M. Dept., 4, Millbank, London, S.W.1, for application form and further particulars, stating name, age, brief details of qualifications and experience and quoting reference M2T/62715/WF. [1411

WEST RIDING COUNTY COUNCIL. Applications are invited for the post of Language Laboratory Technician to be based at Woolley Hall, nr. Wakefield. Candidates should have qualifications and/or practical experience in recording and working with similar electronic equipment with ability to carry out maintenance work, tape transfers and splicing. The successful candidate will be expected to carry out emergency repairs at Language Laboratories in the neighbourhood of Wakefield. Salary will be payable in accordance with the scale for Laboratory Workshop Technicians in Secondary Schools, £405-£890 with additional payments of up to £50 for approved qualifications, i.e. City & Guilds Science Laboratory Technicians Advanced Certificate. The commencing salary within the scale will depend on previous experience and qualifications.—Application forms available from the Education Officer, County Education Offices, Bond Street, Wakefield, to whom they should be returned not later than 7th March, 1966. [1423

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LIMITED

AN OPPORTUNITY

to work on the world's foremost range of

ELECTRONIC INSTRUMENTATION

To allow for the considerable expansion envisaged over the next few years, our Marketing Division will shortly be moving to new premises in Slough.

A number of

SERVICE ENGINEERS

are required to supplement the existing staff who will be moving with us, and we shall be pleased to hear from suitably qualified, experienced engineers prepared to accept the challenge of working with a range of advanced instruments and systems.

For one position a knowledge of medical electronics and a willingness to travel quite extensively throughout the U.K. will be an advantage.

The conditions of employment are first-class and include attractive salaries, non-contributory pension scheme, bonus scheme and other fringe benefits. Applications giving details of qualifications and experience should be addressed to:—

Personnel Officer,
Hewlett-Packard Limited,
Dallas Road,
BEDFORD

EMI

FIELD ENGINEERS

The Field Division of **E.M.I. Electronics Ltd.,** Feltham, Middlesex, has a number of vacancies for Field Engineers.

The successful candidates will be concerned with trials work involving a range of sophisticated Electronics equipment. Normally, the Field Engineers are based at Feltham and are required to be away from base for periods varying between a few days and several weeks.

Applicants should have a sound basic knowledge of electronics and should preferably have had experience involving both valve and semi-conductors in the communications field. Some familiarity with U.H.F. would be an advantage.

Applicants should apply in writing, quoting reference number PF/1 to:—

P. W. E. Fox,
Personnel Officer,
EMI Electronics Ltd.,
Victoria Road, Feltham, Middx.

Manchester and Great Lancashire Areas

Television Rental Service Managers.

The present Service organisation and procedures are simple and efficient and the quality of engineers is extremely high. These factors have enabled us to meet the requirements of BBC-2 without undue difficulties. The resultant increase in subscribers has created these vacancies.

Applications for these positions should be made to this BOX NO. 5020, c/o "Wireless World", and show evidence of an understanding of all facets of Service Management and of effectiveness in implementing speedy and efficient service. Ability to undertake further responsibility in the future will be welcomed.

Conditions of employment are generous. Removal expenses will be paid if necessary.

PART TIME CONSULTANTS

An expanding new Company wishing to enter electronics field requires services on a part-time basis of men experienced in the field of H.F. circuitry/transformer design. Reply in complete confidence to

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AGENTS REQUIRED FOR PUBLIC ADDRESS AND SOUND-REINFORCEMENT EQUIPMENT

Established Sound Equipment Manufacturer requires experienced Agents for Sales and Service of Public Address equipment in the following areas:

- London and Home Counties
- East Anglia
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- Yorkshire (Leeds)
- North-East (Newcastle)
- North-West (Blackpool)
- Midlands (Birmingham)
- South Coast (Portsmouth/Southampton)

Existing contacts advantageous, but the manufacturer will provide new leads. Generous terms available. Write: Box. No. 5021 c/o "Wireless World."

SYSTEMS DESIGN ENGINEERS

PYE TELECOMMUNICATIONS

require

SYSTEMS ENGINEERS FOR THE DESIGN OF CONTROL SYSTEMS FOR USE WITH RADIO COMMUNICATIONS NETWORKS

Applicants must be experienced in the design and maintenance of telephone switching equipment or multi-channel telephone systems and be familiar with the principles involved.

Experience of the application of such systems to radio bearer circuits is desirable but not essential.

Corporate membership of the I.E.E. is desirable but applicants without such qualifications who can prove wide experience up to a recent date will be considered.

Apply to: **Personnel Manager, Pye Telecommunications Ltd., Newmarket Road, Cambridge.**

ELECTRONICS Technician wanted to aid in design and construction of apparatus for Psychological research.—Application forms from Establishment Officer, University College London, Gower St., W.C.1, quoting Psy/5. [1438

IMPERIAL COLLEGE. Research Assistant required for a space research group centred at Silwood Park, near Ascot, working on rubidium and proton magnetometers for rocket measurements of magnetic fields in the ionosphere, currently concerned with the national Skylark and ESRO rocket programmes. Candidates with 1st or good 2nd class degree in electronics or physics required. Salary in the range £1,110-£1,335 according to qualifications and experience, with F.S.S.U.—Applications to Geophysics Dept., Imperial College, London, S.W.7. [1422

ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM, SWINDON, WILTS. OPPORTUNITY FOR RESEARCH.—Experimental Officer is required for a research project in the field of electromagnetic radiation. Excellent facilities and conditions. Work suitable for publication and submission for higher degrees. Qualifications: Appropriate H.N.C., Pass Degree or equivalent. Experience in electronics generally, and aerial and microwave measurements in particular an advantage. Age: Applicants must be at least 26 years of age. Salary: Within the incremental scale: £1,365×6 annual increments to £1,734 p.a. Accommodation: Temporary single accommodation in the Officers' Mess or the possibility of a married quarter.—Please write for further details in confidence to Professor M. H. N. Potok, Electronics Branch, or for form of application to C.E.P.O., Royal Military College of Science, Shrivenham, Swindon, Wilts. (Please quote reference R.3225/27). [1439

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have vacancies in the

INSTRUMENT DEVELOPMENT DEPARTMENT

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We have vacancies at almost all levels for men or women with enthusiasm. For the Senior posts a degree or equivalent is required and several years design experience on products COMPARABLE with ours.

Please write to Personnel Manager,
Servomex Controls Limited,
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CENTRAL ELECTRICITY GENERATING BOARD

South Eastern Region
North Thames Division

BRADWELL NUCLEAR GENERATING STATION

require

MAINTENANCE CRAFTSMEN (INSTRUMENTS)

Applicants should have had experience in the maintenance of physical instruments, electronics and/or telecommunications equipment.

Gross weekly wage **£20.10.9** for a 40 hour 5 day week on staggered day working plus service increments after 2 and 3 years' service.

Rented housing accommodation may be available to the successful applicants.

Applications quoting Vacancy No. 1057/66 (W.W.) and stating age, present position and previous experience should be sent to the Station Superintendent, Central Electricity Generating Board, Bradwell Generating Station, Southminster, Essex.

RADIO ENGINEERS and COMMUNICATORS

Required by the GOVERNMENT OF ZAMBIA, Department of Civil Aviation, on contract for one tour of 36 months in the first instance. Gratuity at the rate of 25% of total salary drawn. Children's allowances. Free passages. Quarters available at moderate rental.

RADIO ENGINEERS GRADE I—(M2T(62800/WF)

Salary according to experience in scale £1,645 to £1,855 a year. Candidates, aged 32 to 50 years, must have had 12 years' experience following a 5 years' apprenticeship or gaining a Services Trade Certificate or a M.O.A. or I.C.A.O Certificate of Competency (or equivalent). They must have a sound theoretical knowledge of and experience in the maintenance, overhaul and installation of ground terminal radio communication equipment and navigational aids used at Airports and Flight Information Centres.

RADIO ENGINEERS GRADE II—(M2T/62809/WF)

Salary according to experience in scale £945 to £1,580 a year. Candidates aged 21 to 50 years, require qualifications as for Grade I Engineers but less experience is acceptable.

COMMUNICATORS GRADE I—(M2T/62812/WF)

Salary according to experience in scale £945 to £1,580 a year. Candidates, aged 21 to 50 years, must have a 1st Class P.M.G. Certificate, or Air Force, Naval or Marine Communicators Trade Certificate of Competency, together with three years' experience and plain language and code morse speeds of 25 w.p.m. and 20 w.p.m. respectively. Proficiency in radio telephony operation to international standards is required.

Apply to: **CROWN AGENTS, M. Dept., 4 Millbank, London, S.W.1,** for application form and further particulars, stating name, age, brief details of qualifications and experience, and quoting the relevant reference.

English Electric Leo Marconi

Computer servicing

Have you had experience in the Forces in maintaining radio, radar or missile electronics?

If so, there could be a career for you as a computer engineer with English Electric Leo Marconi, Britain's leading company in the field of digital computers.

Salaries, fringe benefits and conditions of employment are all that you might expect from such a successful organisation.

Full time training would be given in our own schools in London or Kidsgrove and vacancies exist in the London Area, the Midlands and South West Lancashire.

To obtain more information about the exciting possibilities that exist for you, write to:—
The Personnel Officer,
Department WW.M.18,
English Electric-Leo-Marconi Computers Ltd.,
24 Minerva Road,
London, N.W.10.

EELM

TEST ENGINEERS

Due to Company expansion, The Decca Navigator Company Limited wishes to recruit the services of Test Engineers for the testing of Radio Navigation and Survey Equipment.

We are world leaders in this field and have an extensive and interesting programme planned for the future.

Applicants with a first class background of T.V. and Radio Servicing or Telecommunication Electronic and Control Circuiting are required.

The salary paid will be commensurate with ability and experience.

Please apply for interview giving brief details of experience, qualifications and present salary to:—

The Personnel Officer,
The Decca Navigator Company Limited,
88 Bushey Road, Raynes Park, London, S.W.20.
Telephone: WIMbledon 8011.

RADIO TECHNICIANS

A number of suitably qualified candidates will be required for training, leading to permanent and pensionable employment, normally at Cheltenham but with opportunities for service abroad or appointment to other UK establishments including London.

Applicants must be 19 or over and be familiar with the use of Test Gear and have had Radio/Electronic Workshop experience. They must offer at least "O" level GCE passes in English language, Mathematics and/or Physics or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g. at 19 **£747**, at 25 **£962** (highest pay on entry) rising by four annual increments to **£1,104**.

Prospects of promotion to grades in salary range **£1,032-£1,691**.

Annual leave allowance of 3 weeks 3 days, rising to 4 weeks 2 days.

Normal Civil Service sick leave regulations apply.

Apply:
Recruitment Officer (ET/3),
Government Communications Headquarters,
Oakley, Priors Road, Cheltenham, Glos

A UNIQUE opportunity occurs for an enthusiastic but capable engineer with wide interests to take charge of the control room for the Theatre and Recording Studios at one of Britain's leading entertainment agencies; must have knowledge of recording, both operating and maintenance, a working knowledge of public address system and mixing panels, some knowledge of lighting, be able to operate 16mm film projection equipment and able to carry out first line maintenance and/or installation; an interesting position for a hard-working person.—Apply, in writing, giving as full details as possible to: The General Manager, West One Entertainments, Ltd., 20, Manchester Square, London, W.1. [1414

ELECTRONIC Technician. Do you enjoy playing around with electronic gadgets? Here is a chance to make a career of your hobby. We offer you interesting and varied work in the field of electronic instrumentation. This small but expanding department is concerned with the design and application of electronic circuits required for the testing of diesel engines and their fuel injection systems. Staff conditions are good and include sickness and contributory pension and life assurance schemes, restaurant facilities, etc. —In the first instance, applicants should write in confidence, giving only brief personal details to: The Personnel Manager, Simms Motor Units, Ltd., Oak Lane, East Finchley, N.2. Fin. 2692. [1421

TEST GEAR ENGINEER

We manufacture and develop Precision Electro-Mechanical Components and Electronic Control and Measuring Instruments. We have a vacancy for a Test Gear Engineer who will be responsible for the analysis of test requirements, the establishment of test methods and the development of test units. The work would include the precision measurement of D.C. and A.C. at low frequency.

Applications are invited from persons with suitable practical experience who need not necessarily have any formal qualifications. The position demands a sense of responsibility, attention to detail and initiative. The starting salary will be in the range £1,000—£1,200 per annum.

Please write or telephone for an application form, quoting reference ARN to the Personnel Manager,

Rank Pullin Controls,
Great West Road,
Brentford, Middlesex.

WANTED:
ENGINEERS WHO WILL TRAVEL

To meet continued expansion the Service & Calibration Department of the Livingston Group has a number of interesting vacancies to fill.

They offer applicants with the right qualifications an opportunity to join a young team with excellent working conditions, three weeks' annual holiday and pension scheme.

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FIELD ENGINEERS with experience in industrial electronic systems, to install and service a wide variety of equipment. Experience with laboratory instrumentation, computers or industrial X-ray equipment desirable, current driving licence essential.

THE Livingston GROUP

Write giving brief details of background, and salary required to:
Mr. R. J. Mundy,
Manager, Service & Calibration Dept.,
Livingston Laboratories Ltd.,
Greycaines Estate, Bushey Mill Lane,
North Watford, Herts.
Telephone: WATFORD 41291

The Civil Service

Professional and Technical Appointments

The Civil Service offers an interesting and full career for professional engineers in government departments ranging from Cadetships which provide professional training for young graduates to Chief Engineer appointments with salaries of over £5,000. A booklet giving further details can be obtained from the Civil Service Commission at the address given below.

Current vacancies include the following:—

EXECUTIVE ENGINEERS POST OFFICE

At least 30 posts in London and Provinces for mechanical, electrical and electronic engineers to develop and design communications systems and postal service equipment.

QUALIFICATIONS: Degree or Dip. Tech. in Mechanical or Electrical Engineering, Physics, or Applied Physics or, exceptionally, very high professional attainment. Final year students may apply.

SALARY (Inner London): £877-£1,806. Salary under review. Promotion prospects.

AGE: At least 21 and normally under 35 on 31.12.66. Some extensions for service in H.M. Forces or Overseas Civil Service. (Reference: S/322.)

ELECTRICAL ENGINEER MINISTRY OF DEFENCE (ARMY DEPARTMENT)

Engineer required at ROYAL ORDNANCE FACTORY, Bishopton, Renfrewshire, for the maintenance and extension of the Electrical Installation of the explosives factory, including 11 KV distribution system, Power Station, and special plant, etc.

QUALIFICATIONS: Applicants should have satisfied the basic training and examination requirements for Corporate Membership of the I.E.E. Knowledge of the Factory Acts and Electrical Safety Regulations including Explosive Electrical Regulations and I.E.E. Wiring Regulations is essential. Opportunities for promotion. Candidates under age 35 may apply immediately for permanent appointment. Older candidates can be considered for a pensionable appointment after nine months' service.

SALARY (interim): £1,068-£1,633.

APPLICATION FORMS from Ministry of Defence, C.E.2(g)2(AD), Northumberland House, Northumberland Avenue, London, W.C.2. Candidates under 35 applying for permanent appointment should obtain forms from the Civil Service Commission, Savile Row, London, W.1, quoting S/85.

ENGINEERING CADETSHIPS

providing training and experience in accordance with the requirements of the major Professional Institutions are open to young engineers (under 26) holding Degrees or Diplomas in Technology with First or Second Class Honours. Graduate Members of the major Institutions will also be considered.

The appointments provide interesting employment and wide experience for Civil, Electrical and Mechanical Engineers ranging from practical shop or site work to design and management duties in Government Departments including opportunities of service overseas.

On completing training Cadets are offered appointments which should provide professional responsibility and experience leading to Corporate Membership of one of the Institutions. Promotion to the Main Grade (maximum salary (under review) £2,227) can be expected after three to six years.

SALARY (Inner London): First Year £996
Second Year £1,055
Third Year £1,119

(Reference: S/565.)

There are also vacancies in the Scientific Civil Service as follows:—

MINISTRY OF DEFENCE (ARMY DEPARTMENT) THE ORDNANCE BOARD LONDON, W.14

EXPERIMENTAL OFFICER required for examining the electrical safety of a wide range of weapon systems to assess their behaviour under various fault conditions as well as when exposed to electromagnetic fields; co-ordination of the organisation for and reporting of trials. Ability to chair meetings essential.

QUALIFICATIONS: Degree, Dip. Tech., H.N.C., or equivalent in appropriate subject. A good knowledge of radio engineering would be an advantage.

SALARY: (minimum age 26) £1,440-£1,819. Prospects of permanent pensionable appointment.

APPLICATIONS: To Ministry of Defence, CE2(f)(AD), London, W.C.2.

EXPERIMENTAL OFFICER CLASS SPRING—1966—RECRUITMENT

Careers in SCIENCE and TECHNOLOGY are offered to men and women with qualifications in MATHEMATICS, PHYSICS, CHEMISTRY, BIOLOGY, METEOROLOGY, ENGINEERING and GEOLOGY as Assistant Experimental Officers and Experimental Officers, in Government Scientific Establishments.

QUALIFICATIONS: University Degree, Dip. Tech., H.N.C., etc., and candidates under age 22 may offer lower qualifications (minimum: G.C.E. "A" level in 2 scientific or mathematical subjects).

SALARY and AGE LIMITS:

Experimental Officer (age 26-30) £1,365-£1,734.

Assistant Experimental Officer (ages 18-27) £568 (at 18)—£1,017 (at 26 or over)—£1,243.

Salaries supplemented in London area. Aid given for further education. Promotion prospects.

Closing date 18th March, 1966. (Reference: S/577-578/66.)
(Further recruitment in Autumn, 1966.)

Except where otherwise stated the above posts are pensionable, and APPLICATION FORMS are obtainable from the Secretary, Civil Service Commission, Savile Row, London, W.1. Please quote appropriate reference.

BP has vacancies in the Cable Branch of its Head Office in London for a **TECHNICAL ASSISTANT** (TELECOMMUNICATIONS) and a **DEPUTY TECHNICAL ASSISTANT** (TELECOMMUNICATIONS). Responsibilities will include the maintenance and servicing of:—

(a) Teleprinters;
(b) Electro-Mechanical Equipment, Power Plant and Test Equipment associated with Tape Relay Systems.

Applicants should have had at least 5 years previous experience in this field and possession of City and Guilds Telegraphy and Telephony Grade I Certificate is desirable. Age range 25-40 years.

Induction and introductory training on new equipment will be given on joining. The Company also offers several other benefits including a Luncheon Club, Non-contributory Pension Scheme, 3 weeks holiday, etc.

Please write giving details of age, and experience to: **P. G. Andrews, Central Staff Department, The British Petroleum Company Limited, BP House, Ropemaker Street, E.C.2,** quoting reference H.7249/WW.

X-RAY manufacturers require field service engineers to be based in South London to service and install the company's products. O.N.C. or similar qualification required; a company car will be provided on completion of training; attractive pay, permanent position, good pension, 5-day week; vacancies also exist for overseas tours in English speaking countries; these positions will be made available after prolonged training to suitable applicants.—Please write to: Watson & Sons (Electro-Medical), Ltd., East Lane, Wembley, Middx. [1408

PATENT Agents require Technical Assistant for preparation Patent specifications and prosecution thereof; mainly in electronics and Applied Physics; minimum qualification 2 A levels or equivalent, one for physics, and ability to write good English; training provided to assist in qualifying as Chartered Patent Agent; starting salary range £800-£1,200, according to qualifications.—Apply in writing to Mr. A. J. Ransford, Carpmaels & Ransford, 24, Southampton Buildings, Chancery Lane, W.C.2. [1435

BOOKS, INSTRUCTIONS, ETC.

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a, Moffat Rd., Thornton Heath, Surrey. [143

ELECTRONIC ENGINEERS

Service Engineers required for London Area and Provincial Offices of well-known Company manufacturing Electronic Desk Calculating Machines. Applicants should possess a sound knowledge of basic electronics with experience in electronics, Radar, Radio and T.V., or similar field. Position is permanent and pensionable. Comprehensive training on full pay will be given to successful applicants. Please send full details of experience to:

Service Manager,
SUMLOCK COMPTOMETER LTD.,
102/108 Clerkenwell Road,
London, E.C.1.

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Temporary CIVILIAN INSTRUCTORS

R. N. Air Electrical School, H.M.S. DAEDALUS—LEE on SOLENT.

Post I: to instruct Naval Personnel in the theory of Aircraft Electrical, Instrument and Flight Control Systems, and to supervise their practical laboratory work connected with maintenance and repair of these equipments.

Post II: to instruct Naval Personnel in the theory of Airborne Radar Equipments and to supervise their practical instruction on the maintenance and repair of these equipments.

O.N.C., City & Guilds Certificate or equivalent qualifications desirable. Selection by interview and if necessary, trade test.

Starting salary £1,082 (at age 26) to £1,243 (at age 30 or over) rising to £1,366.

Prospects of pensionable employment. Write for application form to the **Civilian Administrative Officer, H.M.S. Daedalus, Lee on Solent.**

BOOKS WANTED

MANUALS or instruction books, data, etc., on American or British Army, Navy or Air Force radio or electrical equipment.—H. Harris, 93, Wardour St., London, W.1. [1410

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EDDYSTONE EB35 (1965), faultless and scarcely used, £44.—Box W.W.47, "Wireless World."

GOOD secondhand Ferrographs often available.—Reg. 2745 (Lon.). [110

TWI 500V stabilised power supply 150mA, fully metered, as new; bargain £175.—Wolfendale Electronics, Ltd., 36, Kimberley Rd., Southbourne, Bournemouth. [14

"WIRELESS WORLD" pulse counting F.M. tuner silicon transistor tape recorder; s.a.e. for itemized price lists, including ready-wound coils.—Ajax Electronics, 18a, Rumbold Rd., Fulham, London S.W.6. [35

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CENTRAL ELECTRICITY GENERATING BOARD

South Eastern Region
South Thames Division

DUNGENESS POWER STATION

ASSISTANT INSTRUMENT ENGINEER

Applications are invited for the post of Assistant Instrument Engineer at Dungeness Power Station.

The successful candidate will be responsible to the Instrument Engineer for the direct supervision of a team of technical staff and craftsmen, which deals with the maintenance of a wide range of conventional and nuclear instrumentation.

This covers such plant items as reactor safety circuits, temperature/pressure/flow/and level control systems, automatic data loggers, pulse counting equipment and closed circuit television.

Candidates should be qualified to at least H.N.C. Electrical standard and preferably be corporate members of a senior institution. They should have had a good experience of instrument work including routine maintenance planning and control of staff.

Previous experience of nuclear power station instrument maintenance would be an advantage.

Salary NJB Class F Grade 8 Scale 13/15, £1,650-£2,100 p.a. plus £60 p.a. allowance.

Applications, quoting Vacancy No.120/ST/66, on the standard form available from the Station Superintendent, Dungeness Power Station, Romney Marsh, Kent, should be completed and returned to him to arrive by 24th February, 1966.

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WANTED urgent, R1359 u.h.f. receiver in working order.—Nicholls, 5, Centre Drive, Newmarket, Suffolk. [45

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [140

URGENTLY wanted, new valves, transistors, radios, cameras, binoculars, tape recorder and tapes, watches, any quantity.—S. N. Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [145

ASTATIC voltage relays 50/60c, YB.02565; Transformers YB.02560; Chokes YB.02561; Condensers 1.5mFd, 3.2mFd, 4.3mFd YB.02562/3/4; Mercury switched YB.01456; Variacs 50.B.—Box WW 150, Wireless World.

TAPE RECORDING ETC.

SAVE on cost of hi-fi. See Audio Supply notice (advert No. 111). [109

TAPE to disc transfer using latest feedback disc cutters; EP's from 21/-; s.a.e. leaflet.—Deroy, 52, Hest Bank Lane, Lancaster. [44

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TAPE/DISC/TAPE transfer editing; duplicating; if quality and durability matter (especially with LPs from your precious tapes), consult Britain's oldest transfer service.—Fund raising records published for schools, musical societies (tax free).—Sound News Productions, 10, Clifford St., London, W.1. Reg. 2745. [108

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VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A. Boxmakers, 75a, Godwin St., Bradford, 1. [116

VALVES WANTED

WE buy valves for cash, large or small quantities, old types or the latest; send details, quotations by return.—Waltons Wireless Stores, 15, Church St., Wolverhampton. [134

NEW GRAM AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343, Argyle St., Glasgow, C.2. [120

ELECTRONICS LABORATORY TECHNICIAN

A vacancy exists for a technician with experience in and enthusiasm for electronics. Duties of a non-routine nature, including taking charge of equipment in an electronics teaching laboratory, carrying out repairs and assisting generally in this section of the Physics Department. The post is at Senior Technician level within a salary range of £840 to £1,040 p.a. Excellent working conditions, superannuation scheme, 5-day week. Application forms from the **Staff Officer, College of Advanced Technology, Gosta Green, Birmingham 4,** quoting reference L/166/W

The **GENERAL POST OFFICE** has vacancies for

RADIO OPERATORS II

at its

COAST RADIO STATIONS

Applications are invited from men between 21 and 35 years of age who must hold either the Postmaster-General's First or Second Class Certificate of Competence in Radiotelegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

The posts, which will be temporary in the first instance, carry a salary scale of £674-976, dependent on age at entry, but successful applicants will be eligible to enter the open competitive selection for permanent appointment to be held in the Spring and Autumn of this year.

Applicants should write to: **The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London E.C.1** or telephone London HEAdquarters 5545 for further information.

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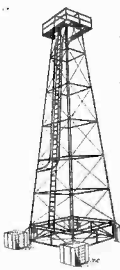

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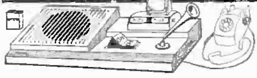

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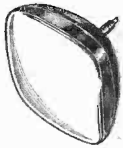

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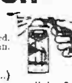

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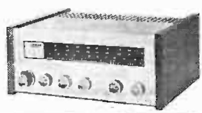

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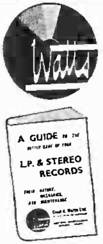

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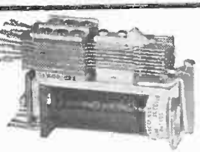

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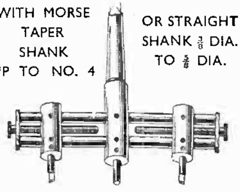

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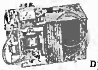

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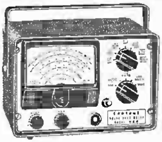

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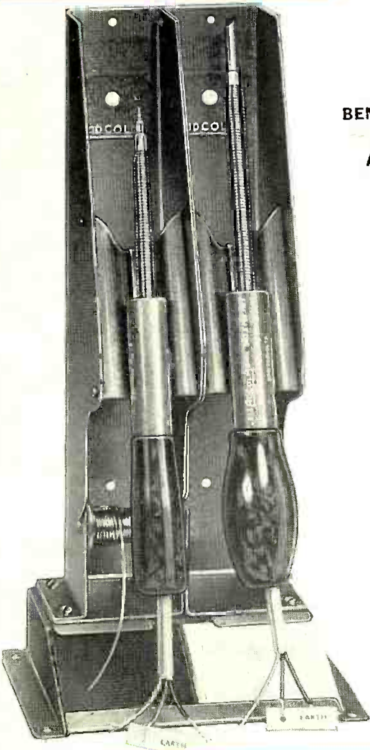

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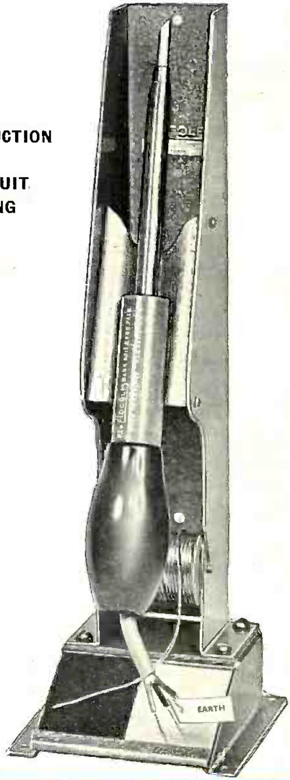

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