Wireless World

January 1969 Three shillings

Digital photographic timer
Better a.g.c.

17 DEC 1968
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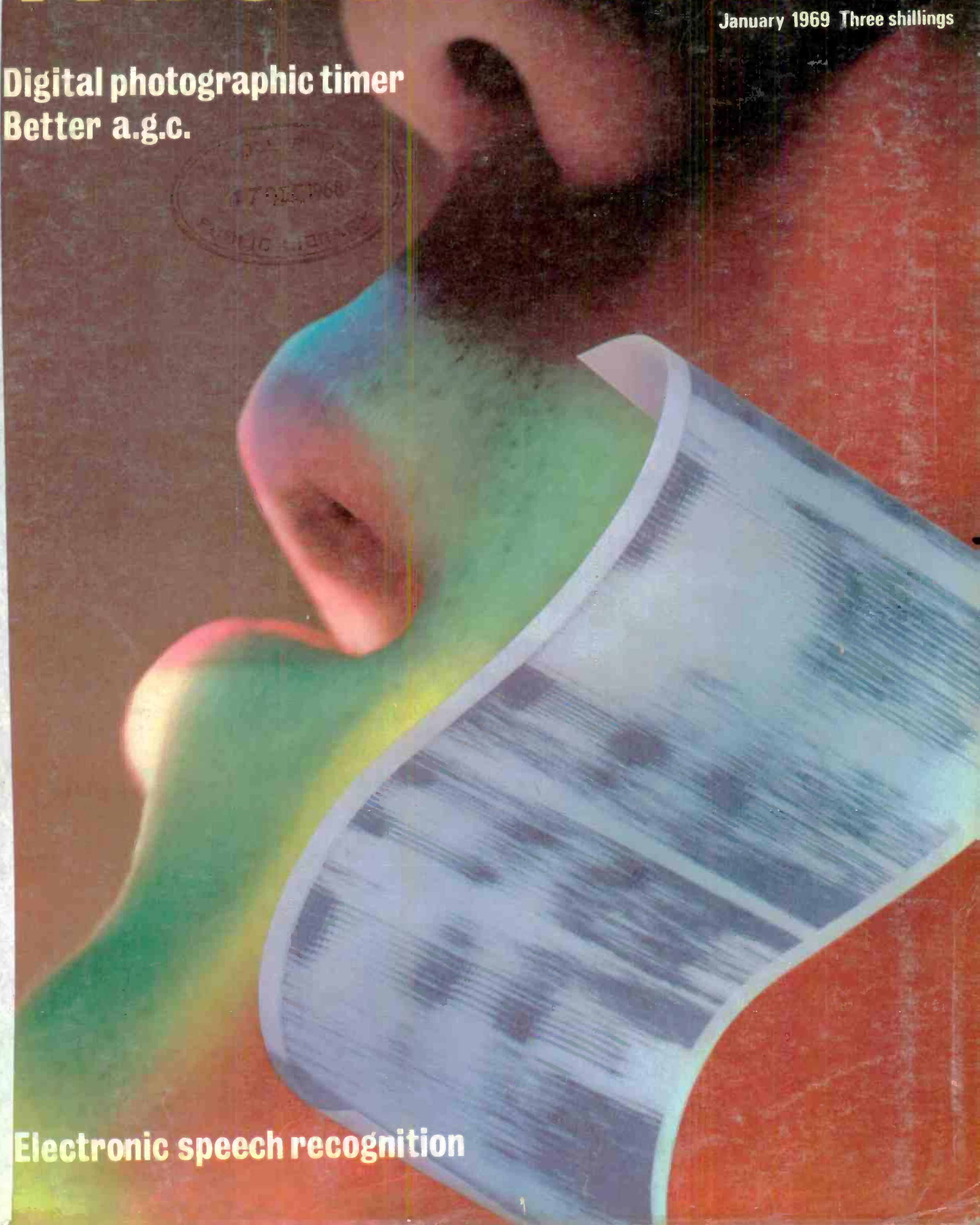

Electronic speech recognition

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NOW 5 BRITISH MIDGETS MAKE & BREAK 1968's BIGGEST RELAYS NEWS

Keyswitch is proud to announce five new miniature relays that cleanly sweep the field. British designed, British developed, and British made, the KMK range features high contact capacity, moulded assembly for high insulation, phosphor bronze contact springs, 99·9% silver or silver cadmium oxide contacts, Swedish iron magnetic circuit, international contact clearance of 4mm, life in excess of 5 million operations, connection by solder or push-on type '110' connectors, open relays mounting in any position, and plug-in relays for international plugability. Unit prices are as low as 9/4d (1,000 rate), substantially less for larger quantities.

These versatile new midgets are available with one, two or three changeover contacts rated up to 10A at 250Vac/6Vdc, and with coils for 6-230Vac/2·5VA and for 6-200Vdc/1W. Contact Keyswitch for complete price and technical details of these exciting new all-British KMK's.

Keyswitch Relays Ltd, Cricklewood Lane, London NW2; telephone: 01-452 3344; telex: 262754.

KEYSWITCH RELAYS

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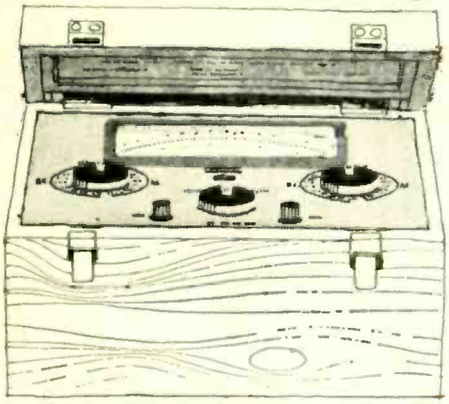
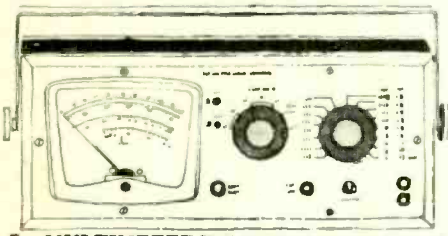
When is an Avo meter not an Avometer?

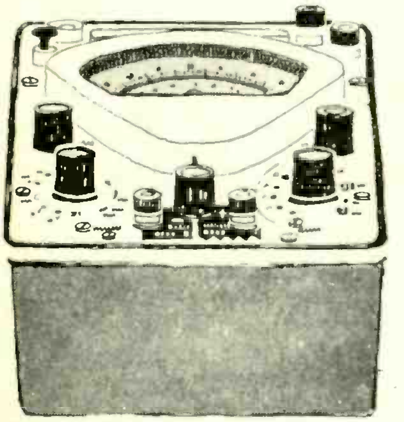
When it gives you (a) ±0.3% accuracy, (b) (c) 100% solid state, (d) (e) (f) semiconductor characteristics data, (g) valve characteristics data, or (h) digital L/C/R measurements.



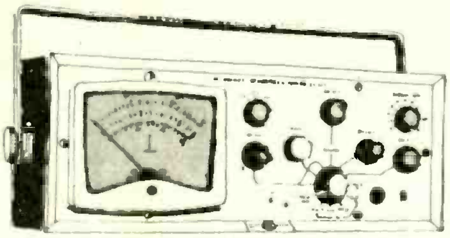
a PRECISION AVOMETER Measures d.c. voltage (1.5-1500V scales, ±0.3% f.s.d.*), d.c. current (1.5mA-15A scales, ±0.5% f.s.d.*), a.c. voltage (3V-1500V scales, ±0.75% f.s.d.), a.c. current (3mA-15A, ±0.75% f.s.d.). *meets B.S.S. 89/1954 for precision-grade instruments.



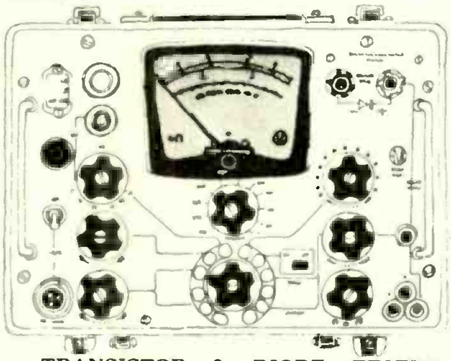
b MULTIMETER HI108 Battery-operated fully-transistorised, measures a.c/d.c. voltage (100mV-1000V scales, ±4%/±3% f.s.d.), a.c./d.c. current (1μA-3A scales, ±4%/±3% f.s.d.), resistance (2kΩ-20MΩ scales), power (-20 to +60db, 9 scales), r.f. voltage (300mV-10V scales, up to 250MHz with external probe available separately).



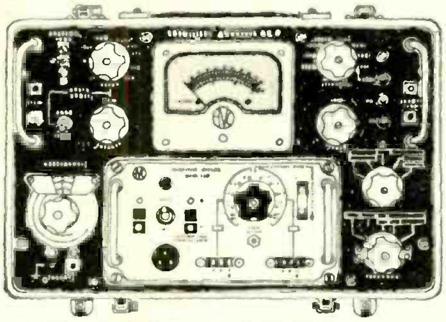
c MULTIMETER CT471A Battery-operated, fully-transistorised, sensitivity 100MΩ/V, measures a.c./d.c. voltage (12mV-1200V scales, ±3%/±2% f.s.d.), a.c./d.c. current (12μA-1.2A scales, ±3%/±2% f.s.d.), resistance (12Ω-120MΩ scales, ±3% m.s.d.), h.f./v.h.f./u.h.f. voltage with multiplier (4V-400V scales up to 50MHz; 40mV-4V up to 1000MHz).



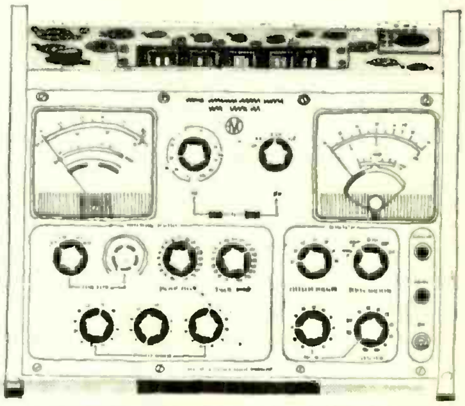
d IN-CIRCUIT TRANSISTOR TESTER TT164 Direct-reading, easy to operate, accurate measurements under static and dynamic conditions. Collector voltage: continuously variable, 0-10V. Collector current: continuously variable 0-10mA, 20mA, 30mA. Measures beta (150-300 scales, ±5%) and leakage current (300nA-1mA scales).



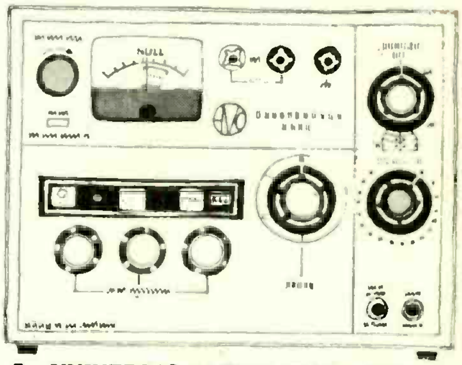
e TRANSISTOR & DIODE TESTER TT537 Measures both transistor and diode characteristics. Collector voltage: continuously variable 0-12V, stabilised. Collector current: 1μA-1A. Base current: 0.1μA-50mA. Measures hfe (50-1500 scales, ±3%), leakage current (50μA-1.5A scales), diode forward voltage drop (1.5-5V scales, 0-500mA forward current) and breakdown voltage (100-1000V scales, 3mA & 200μA currents limited on short circuit to 13mA & 1.3mA).



f TRANSISTOR ANALYSER MK2 Available in both mains-powered and battery-powered versions; provides accurate measurements in grounded-emitter configuration; accommodates high-power and switching types. Collector voltage: 0.05-12V (up to 150V external). Base current: 1-40mA scales. Collector current: to 1A in 5 ranges. Measures leakage current (from 2μA), hfe (25-250 scales), saturation voltage, turn-over voltage and noise factor.



g VALVE CHARACTERISTIC METER VCM163 The most comprehensive instrument of its kind ever offered by Avo. Provision for testing nuvistors, compactrons and other special types with up to 13 pin connections. No need to back off standing anode current before measuring mutual conductance, which is continuously moniored under all conditions. Heater voltage: 0-119.9V in 0.1V steps. Anode and screen voltages: 12.6V-400V. Grid voltage: 0-100V continuous. Measures gm: 6-60mA/V f.s.d. in 3 ranges.



h UNIVERSAL BRIDGE B150 A battery-operated general-purpose bridge with unique automatic digital display of measured component values. No multiplying factors required. Overall accuracy of inductance, capacitance and resistance measurements is ±1%/±1 digit. Residuals 0.2pF, 0.15μH and 2mΩ. Internal 1kHz oscillator &9V battery, provision for external supplies.

Here are eight members of the Avo test equipment range that combine traditional Avo quality with some of the most advanced instrument technology available anywhere. Start your measurements with a standard Avometer, of course, but as your requirements develop and expand, remember the many other ways in which Avo can continue to help you. For full details, contact Avo Ltd, Avocet House, Dover, Kent. Telephone Dover 2626. Telex 96283.

AVO

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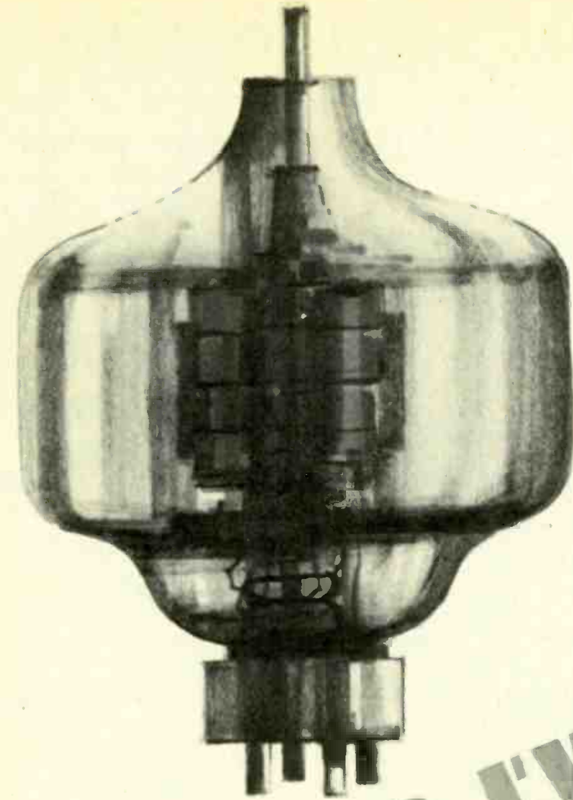

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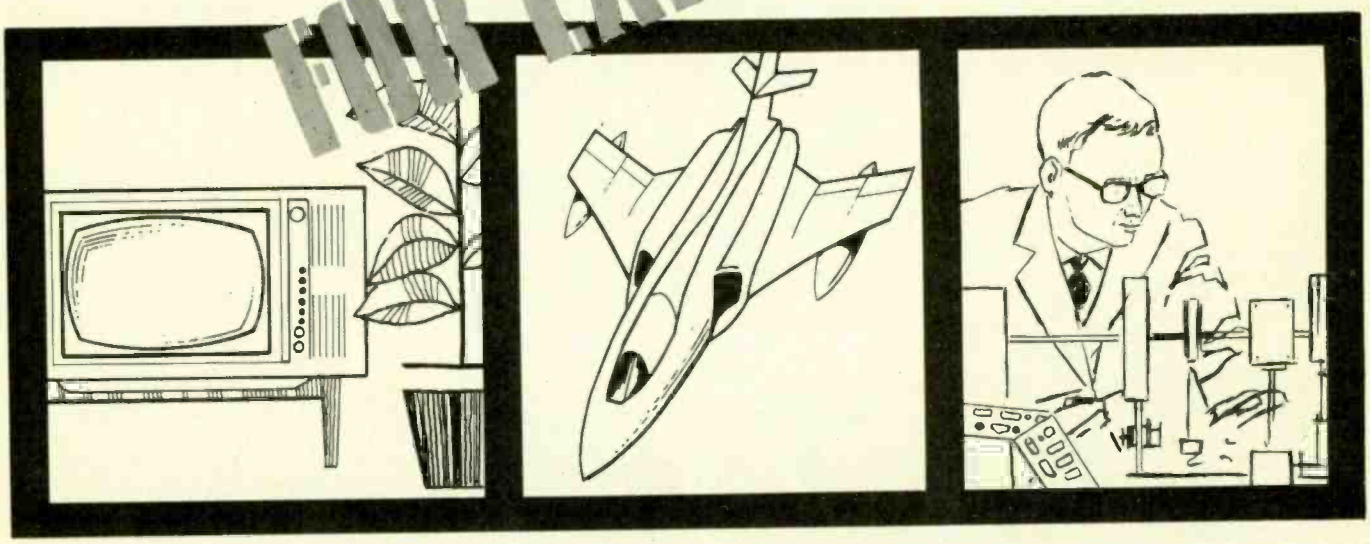

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English Electric Valve has developed cathode ray tubes with a new type of electron gun. Compared with normal tubes, the new gun achieves better resolution and a much sharper, clearer image on the screen. The improvement in resolution is 3:2 compared with normal CRTs.

Main features of the new tubes are:

1 The gun cathode and focusing assembly produce a laminar electron beam with very narrow divergence.

2 The beam has a uniform electron density, rather than the normal Gaussian distribution, and produces a spot with uniform brightness and a very sharp edge.

3 Aberrations are much reduced.

4 The spot size may be varied without defocusing.

5 The narrowness at the point of deflection minimises deflection defocusing.

6 No focusing coils or high-voltage focusing electrodes are needed so there is no danger of voltage breakdown causing damage to components.

7 If users accept a standard of resolution no better than normal CRTs, they may specify the new gun for tubes with shorter overall length or greater deflection angle, or both, with corresponding advantages in equipment design and compression.

8 The new laminar beam gun may be specified for any EEV CRT but is not for sale as a separate component.

Experimental samples of the new CRTs are available to users for assessment trials. Full technical data and advice about individual applications are available on request.

See the difference...

EEV's new electron gun makes to CRT resolution

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ENGLISH ELECTRIC VALVE COMPANY LIMITED

CHELMSFORD, ESSEX. TELEPHONE: 61777 TELEX: 99103 GRAMS: ENELECTICO, CHELMSFORD

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another clever switch by

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the current slicers

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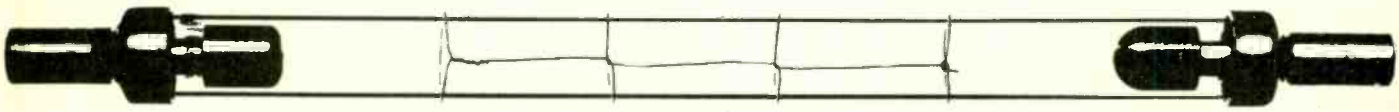
Don't take our word for it—test EEV flash tubes against the equivalents you're now using and learn why other users think so highly of those made by EEV. Incorporating extra heavy duty electrodes, EEV flash tubes are renowned for their reliability, long life (up to 10^6 flashes) and high conversion efficiency. EEV liquid-cooled and air-cooled xenon flash tubes for pumping laser rods offer a wide range of input energy levels and they are capable of operation at high repetition rates.

Full details of the range are available on request—but if your application calls for a flash tube that is not in the present range, tell us your requirement because we can probably make it for you.

Outstanding in quality, reliability and performance



EEV flash tubes

Type	Energy input per flash max. (J)	Arc length (mm)	Bore diameter (mm)	Typical operating conditions: Voltage (kV)	Series inductance (uH)	Flash rate	Trigger voltage (kV)
XL615/7/3	600	76	7.0	2.5	400	1 per 15 sec.	12–16
XL615/9/4	1500	102	9.0	2.5	400	1 per 30 sec.	12–16
XL615/10/5.5	3500	140	10.0	2.5	400	1 per 30 sec.	16–20
XL615/10/6.5	5000	165	10.0	2.5	800	1 per 2 min.	20–25
XL615/13/6.5	10 000	165	13.0	2.5	800	1 per 2 min.	25

1968
THE QUEEN'S AWARD TO INDUSTRY 1966

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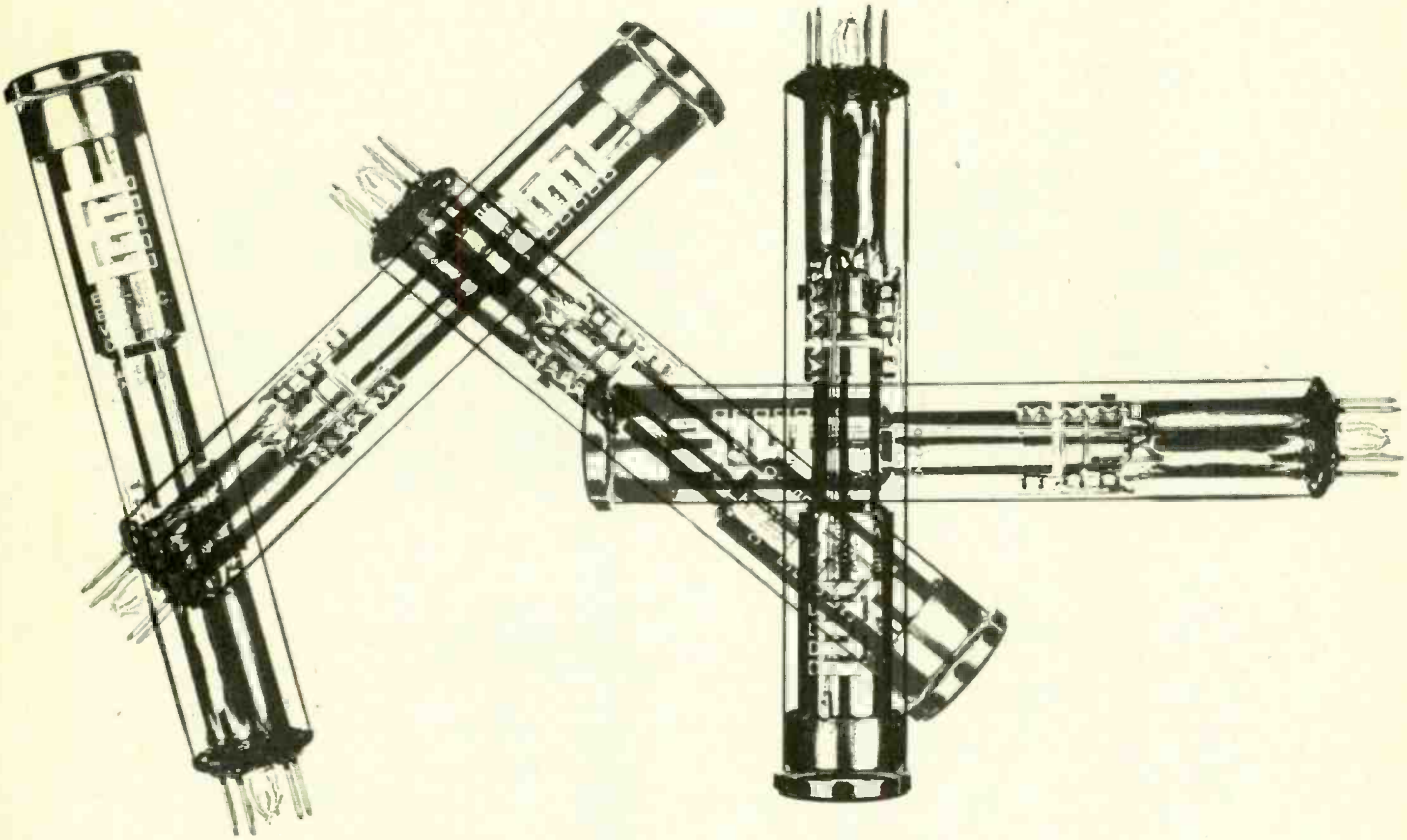
'Spot on the target' is a dirty saying at EEV's vidicon plant because if minute particles of dust or dirt are left in vidicons during manufacture they can settle on the target and ruin the picture. Camera angles were restricted because it was risky to use vidicons upside down. To beat this problem EEV has invested many thousands of pounds in building the largest and most modern clean room in Europe so that EEV vidicons, made in these ideal conditions, are the cleanest on the market today. Because EEV vidicons can now be used upside down, CCTV cameras can be used pointing straight downwards—an obvious advantage in many monitoring applications. This scrupulous cleanliness is characteristic of all EEV vidicons and is one reason why users know that the EEV range will meet practically all requirements. EEV make vidicons with separate mesh and with integral mesh, with magnetic focusing and with electrostatic focusing, and some are made so rugged that they can be used in the nose cones of rockets. EEV also offers a choice of photosurfaces with its vidicons. Full details of the wide standard range are available in the EEV brochure. If your application is so special that none of the many vidicons we make will meet your requirements, we can probably make one specially for you.

Send for your free copy today.

EEV vidicons work in any position



even upside down

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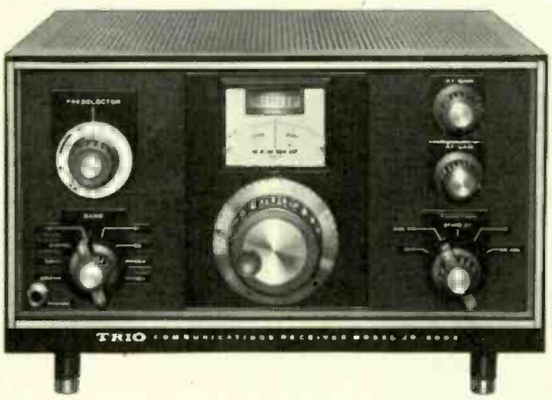

Model JR-500SE

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* Superior stability performance is obtained by the use of a crystal controlled first local oscillator and also, a VFO type 2nd oscillator.
* Frequency Range: 3.5 MHz—29.7 MHz (7 Bands)
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* Dimensions: Width 13", Height 7", Depth 10".

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BUILT IN MECHANICAL FILTER 8 TUBES COMMUNICATION RECEIVER

* Continuous coverage from 550 KHz to 30 MHz and direct reading dial on amateur bands.
* A mechanical filter enabling superb selectivity with ordinary IF transformers.
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* Dimensions: Width 15", Height 7", Depth 10".

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English Electric now has a new TV camera tube, called an isocon, which can virtually see in the dark. The isocon operates on the principle of disregarding the specularly reflected beam of the image orthicon and using the beam scattered by the target. The magnitude of this beam increases with light level and, at low light level, gives a much better signal-to-noise ratio than that of an image orthicon. The dynamic range of the tube is also much greater, and noise in the darker parts of the picture is virtually eliminated.

Two experimental types are at present available – the 4½" P850 tube for viewing low intensity X-ray fluoroscopic screens and the 3" P880 for low scene illumination in TV where good results are obtained when the photocathode illumination is only 10^{-4} foot candles. The P850 will, moreover, produce acceptable pictures even where the photocathode illumination falls as low as 10^{-6} foot candles.

Apart from its obvious applications for TV generally – both colour and black-and-white – the isocon can be applied to a whole range of specialist applications. The P850 for instance, when designed into an X-ray image amplifier, makes it possible to reduce the X-ray dosage to a fraction of that formerly used. In night surveillance and reconnaissance systems the P850 isocon has shown it will provide good pictures at incident light levels well below 10^{-4} foot candles which is the level of starlight illumination. Its application in astronomy is also extremely promising. It will enable medium sized telescopes to participate in deep space and cosmological programmes and it offers impressive results when used with much larger telescopes.

Further detailed information on the isocon is available on request. EEV also provides a complete technical service which includes assistance with the design or redesign of camera equipment.

EEV image isocon
The tube that can see in the dark

1968

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A nose for reliability
Newmarket make a wide range of components with CV approval and sell them through selected distributors: that way service and product are equally reliable.

An ear for urgent calls
with all standard components off-the-shelf and quantities of hundreds within 24 hours (thousands take a little longer).

Teeth to match
Newmarket equivalents of competitors' components are often less costly, more reliable.
All you need is the nerve to change.
Ask for a Newmarket equivalent list.

You're not dealing with a far-flung post of a mighty electronics empire when you talk to a Newmarket distributor. He's a member of the team. Experienced, resourceful, fully-informed and fully-stocked. Try him. Your business is tomorrow and your Newmarket distributor is in tune with it.

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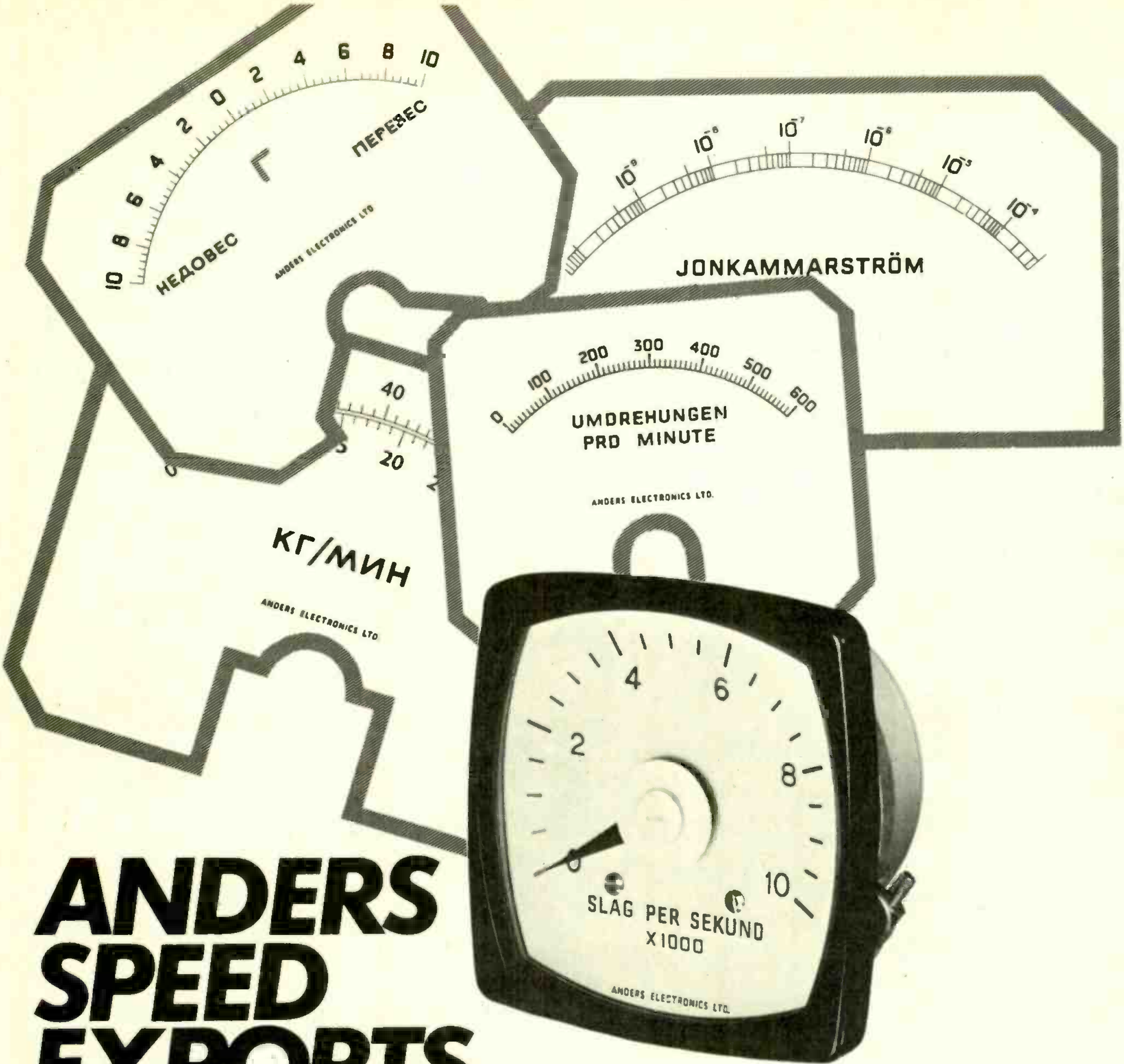

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Ferrograph Series 7 - the simple recorder with thirty recording facilities

The Ferrograph Series 7 Tape Recorder is many instruments in one: If you just want to record without going into technicalities, it is the *simplest* instrument, handled by setting one or two basic controls. If, however, you need a recorder for hard, professional work, the Ferrograph will do it for you 24 hours a day, year in year out (that's why important communications centres specify it). If you need your recorder to produce the most complex effects, the Ferrograph recorder gives you a greater range of facilities than any other.

Available in Mono, and in Stereo with and without end amplifiers, embodying a unique range of recording facilities, including:

- **All silicon solid-state electronics with FET input stages and wide input overload margins.**
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- **Unit construction: The 3 individual units i.e. tape deck, power unit and amplifier complex are mounted on a single frame easily removable from cabinet for service or installation in other cabinets or racks.**
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- **Tape/original switching through to output stages.**
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- **Meters switchable to read 100 kHz bias and erase supply with accessible preset adjustment.**
- **Three outputs per channel i.e. (1) line out—level response. (2) line out—after tone controls. (3) power output—8-15 ohms.**
- **Power output 10W per channel.**
- **Independent tone controls giving full lift and cut to both bass and treble each channel.**
- **Retractable carrying handle permitting carrying by one or two persons.**

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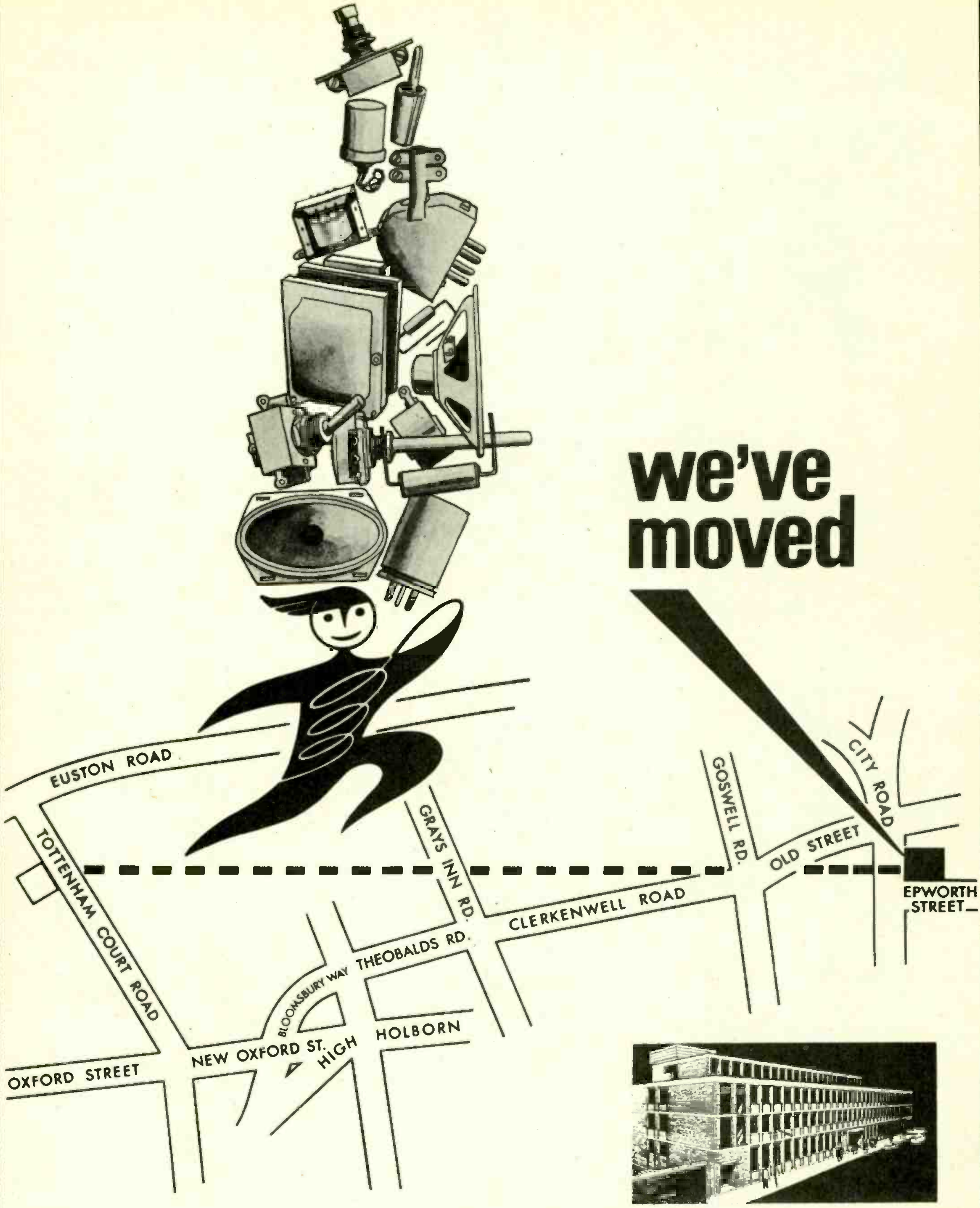

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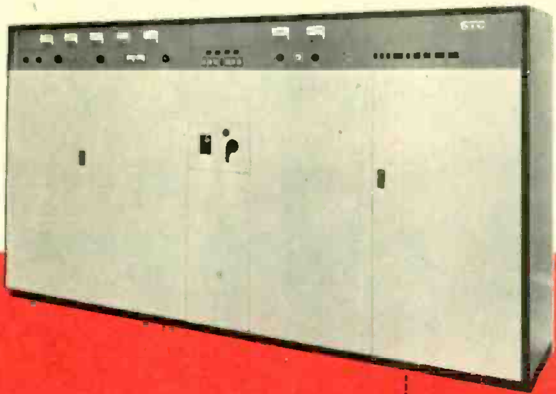

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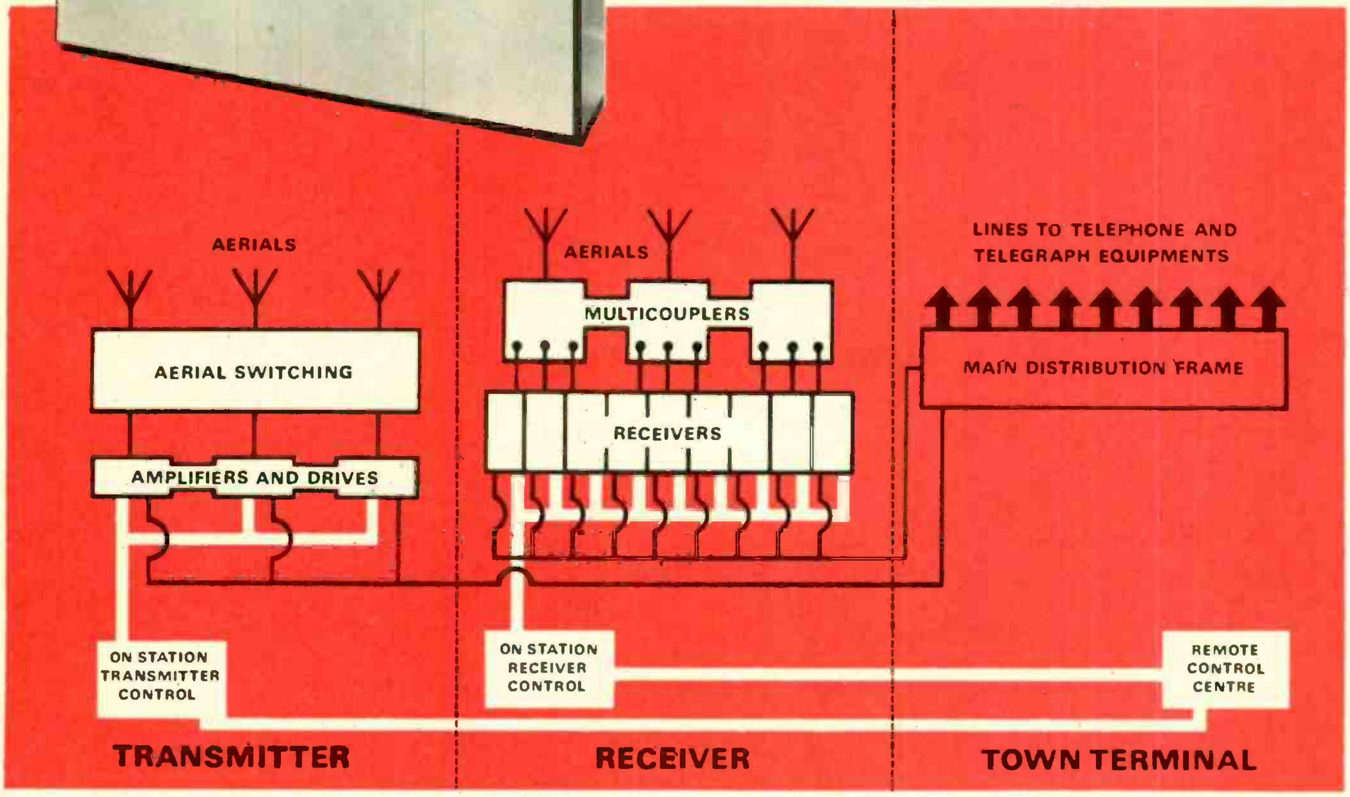
This self-tuning linear amplifier—for i.s.b. and d.s.b. telephony, and for single or multi-channel telegraphy—covers the frequency range 4-28MHz and accepts a low level modulated signal at final frequency produced by external drive equipment.



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Here's how

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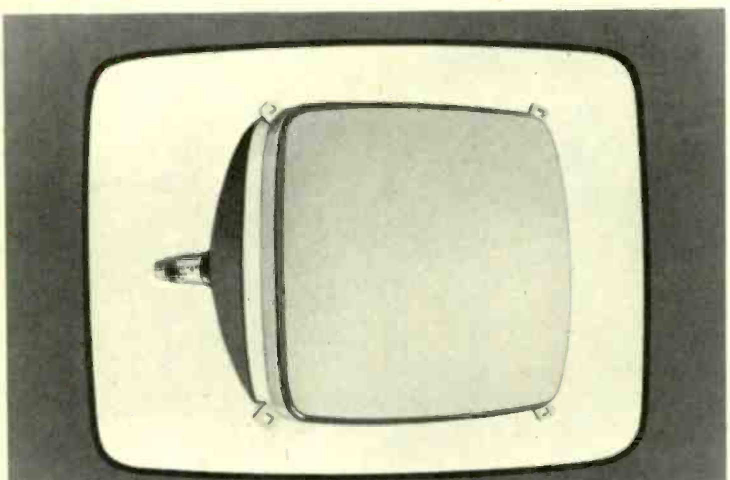
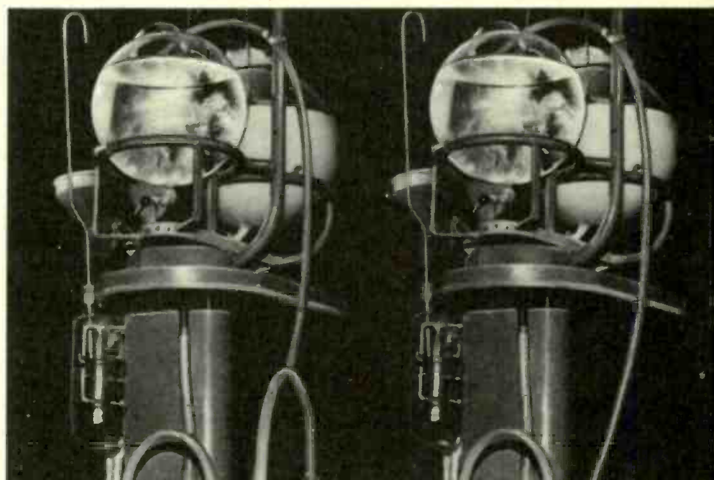


Versatile Presentation
Integral protection. Push-through capability. And with the latest slim-line SUPERSQUARE tubes, a flatter faceplate, squarer corners and larger picture area.



Uniform Brightness
Consistent brightness of the whole screen area is the result of the Mullard formulated high efficiency phosphors and the TEMOS process. These ensure optimum settling conditions controlling the particle shape, size and coating density.

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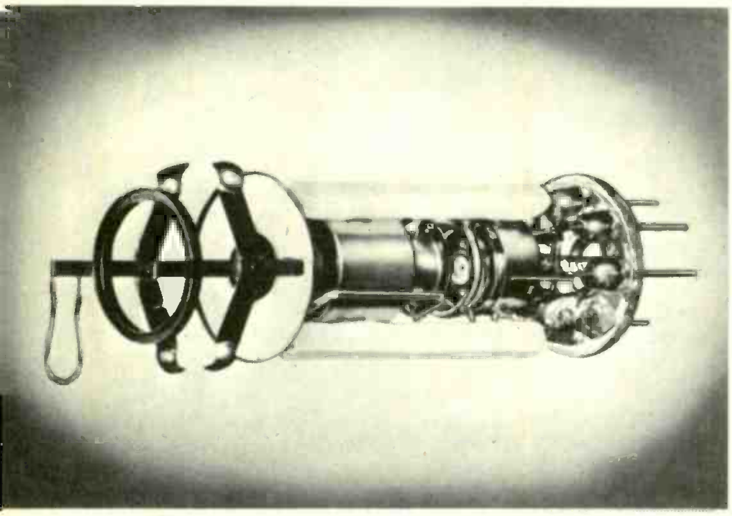

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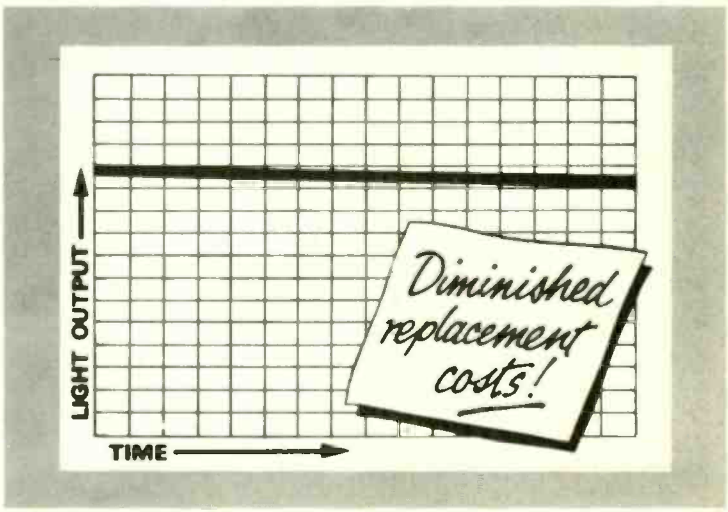
The advanced assembly jigging techniques used by Mullard provide precision alignment of the gun components, minimize haze and ensure sharper focus.



Longer Life
The Mullard developed cathode nickel N441 coupled with the automated activation process and the most stringent raw material inspection ensure longer and consistent emission life.

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CED66

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Like all 800 Series instruments, the 801R, the latest in the line, is custom-designed for specific function, combining excellent sensitivity with high input impedance and exceptional stability. Gate times of 10 mS to 10 seconds and the RACAL patent dynamic readout give operational flexibility—instant follow for fast tuning or resolution of 0.1 Hz. Remote control and BCD output are options of particular value to the Production Engineer. Measuring to 500 MHz (resolving to 1 Hz in just over one second) the 801/802 combination at £1076*is value engineering at its best, true RACAL performance.

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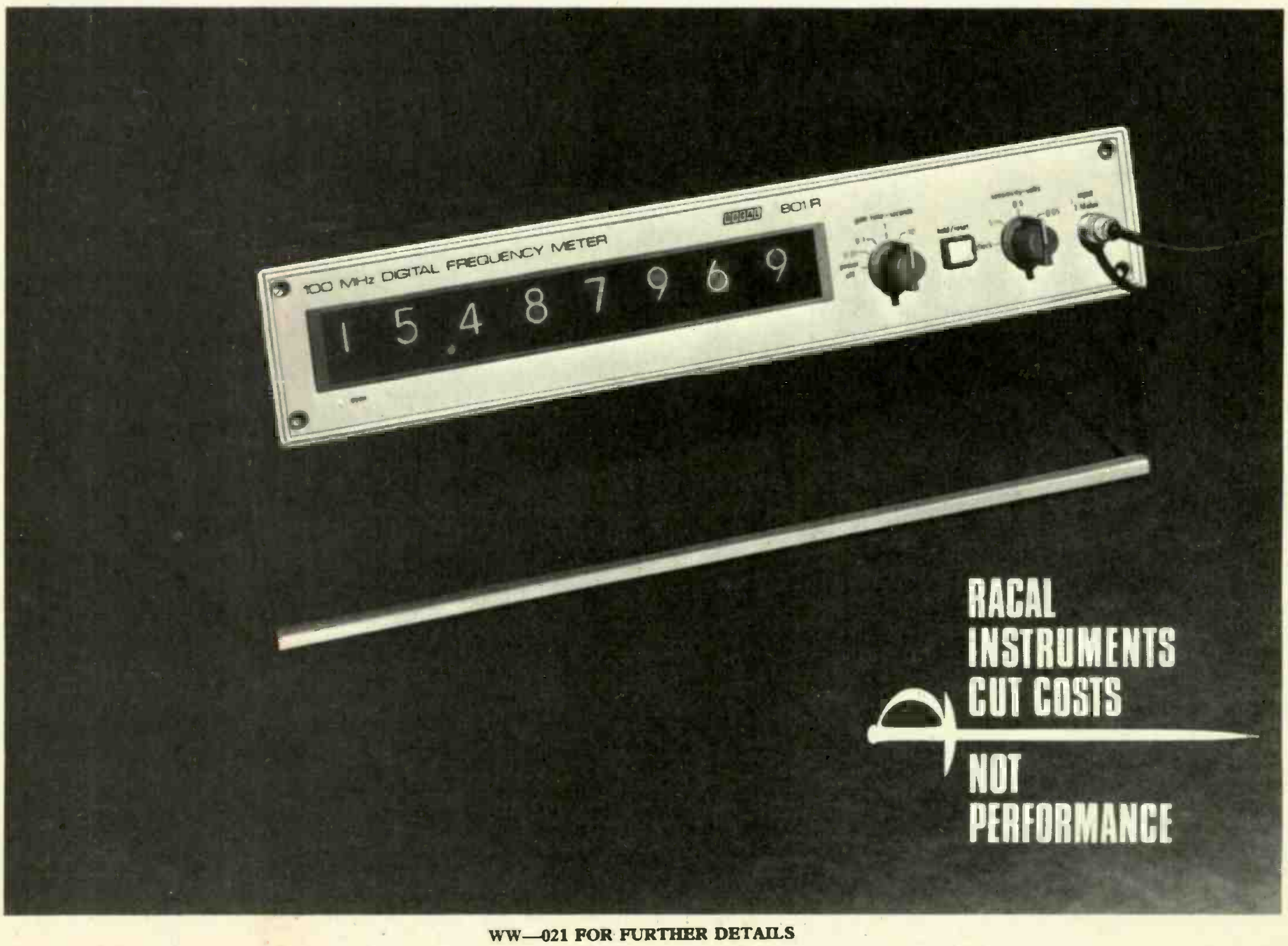

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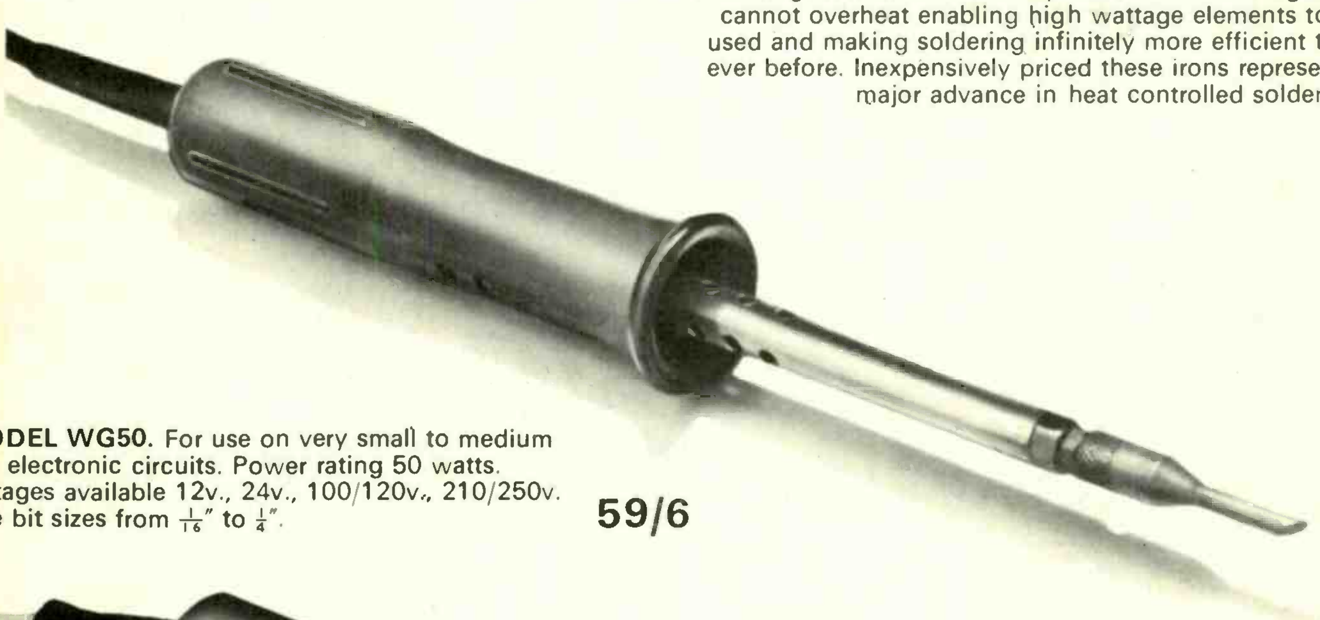
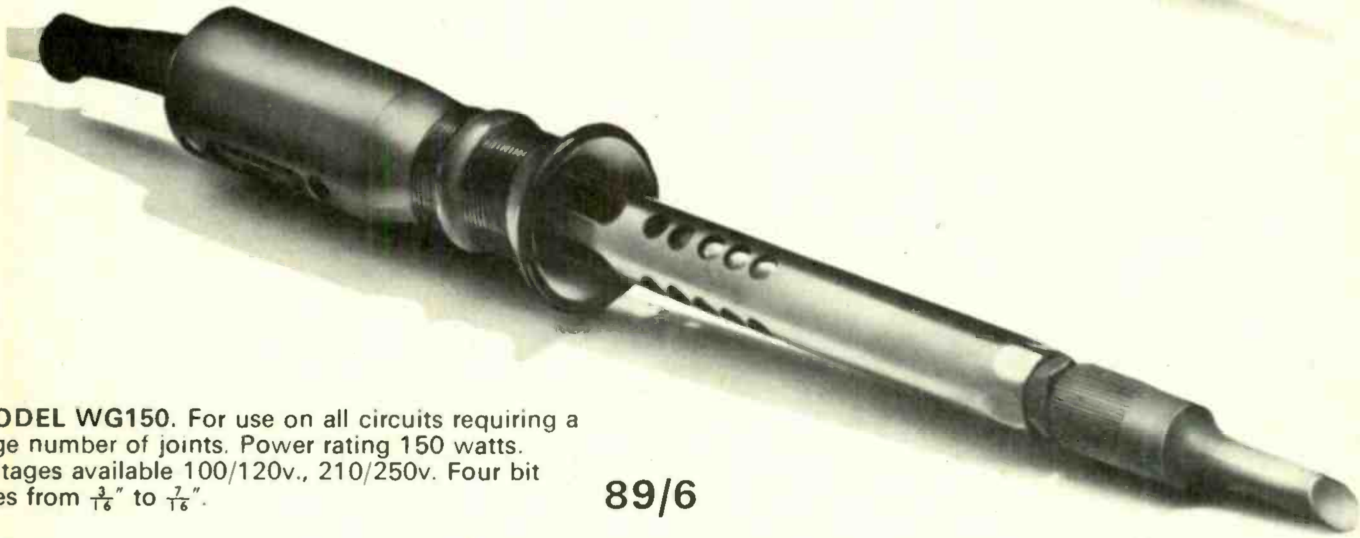
Two new and unique thermostatic soldering irons with closely controlled bit temperatures to suit all types of soldering. WG thermostatically controlled soldering irons cannot overheat enabling high wattage elements to be used and making soldering infinitely more efficient than ever before. Inexpensively priced these irons represent a major advance in heat controlled soldering.



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

59/6



MODEL WG150. For use on all circuits requiring a large number of joints. Power rating 150 watts. Voltages available 100/120v., 210/250v. Four bit sizes from $\frac{3}{16}$" to $\frac{7}{16}$".

89/6

W. GREENWOOD ELECTRONIC LTD.

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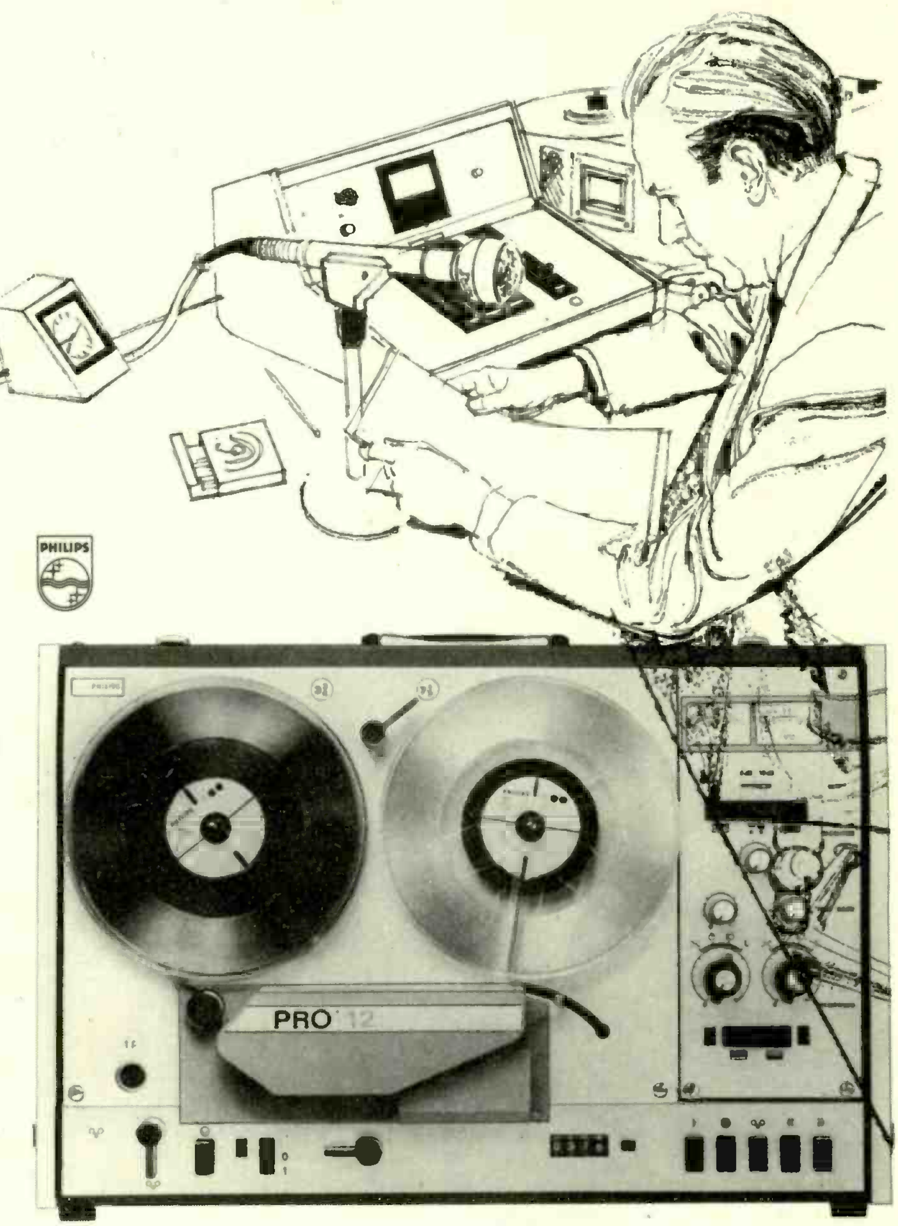

Here's a professional tape recorder that you can use in the studio and in outside broadcast vans.
Philips Pro'12 meets a long standing requirement of studio sound engineers. This portable two-channel recorder is designed to meet the high standards of sound quality and versatility expected of professional equipment, yet it is small and competitively priced.
Recording and playback quality of the Pro'12 is of a very high standard. Tapes prepared on a Pro'12 are suitable for immediate broadcasting. Even at the lowest tape speed of 3 3/4 in/s, the sound quality is at least equal to the DIN 45511 studio equipment specification.
It features: • Twin-track stereo, twin-track mono and dual-track mono operation on 6.25 mm (1/4 in) wide tape (standard version). • Extra quarter-track stereo (special version). • Tape speeds of 9.5 and 19 cm/s (3 3/4 and 7 1/2 in/s). • Unique "constant load" tape transport. • Microphone, diode and line inputs for each channel. • Facilities for mixing input signals of both channels. • Multiplay, sound on sound and echo effect. • Fade in and out and dubbing facilities. • Cueing and pause keys. • Line and monitoring outputs for each channel. • Monitoring with stereo headset or built-in loudspeaker, before or after tape. • VU-control of either channel. • End-of-tape switch. • Remote control connection. • Horizontal or vertical operation.

Technical data
Tape speeds
3 3/4 and 7 1/2 in/s (9.5 and 19 cm/s)
Tape
longplay (1800 ft — 540 m) or doubleplay (2400 ft — 720 m)
Reels
Ciné type, max. 7 in (180 mm)
Playing time
for longplay tape on 7-inch reel:
at 7 1/2 in/s: 45 min
for doubleplay tape on 7-inch reel:
at 7 1/2 in/s: 60 min
Deviation on absolute tape speed
less than 0.8%
Wow and flutter
measured acc. to DIN 45507 with EMT 420,
at 7 1/2 in/s: 0.08%
at 3 3/4 in/s: 0.1%
Frequency response
acc. to DIN 45511, playback
at 7 1/2 in/s: 60 . . . 12000 Hz, 0-1.5 dB
at 7 1/2 in/s: 40 . . . 18000 Hz, 0-2.5 dB
at 3 3/4 in/s: 60 . . . 10000 Hz, 0-1.5 dB
at 3 3/4 in/s: 40 . . . 15000 Hz, 0-2.5 dB
overall at 7 1/2 in/s:
60 . . . 12000 Hz, 0-3 dB
overall at 7 1/2 in/s:
40 . . . 18000 Hz, 0-5 dB
overall at 3 3/4 in/s:
60 . . . 10000 Hz, 0-3 dB
overall at 3 3/4 in/s:
40 . . . 15000 Hz, 0-5 dB
Signal-to-noise ratio
acc. to DIN 45405, weighted,
at 7 1/2 in/s: — 56 dB
at 3 3/4 in/s: — 52 dB
Inputs
a. line: 100 mV, 100 kΩ
b. microphone: ≤ 1 mV (unbalanced), suitable for microphones from 50 to 2000 Ω
c. diode: 2-40 mV, 20 kΩ
Other inputs are available optionally
Outputs
a. line:
nom. 0.775 V, max. 4 V, 10 000 Ω
b. monitor (stereo):
nom. 0.775 V, max. 4 V, 10 000 Ω
c. diode: 0.5 — 2 V, 100 k Ω
Other outputs available optionally.
Power supply
110-117-127-220-245 V, 50 or 60 Hz
Power consumption: 80 W
Dimensions and weight
52 x 34 x 24 cm
(20 5/8 x 13 3/4 x 9 3/8 in);
23 kg (50.6 lb)

For detailed information please write for our 8 page Pro'12 brochure.

Electro-acoustics Division of
Philips Industries,
N.V. Philips' Gloeilampenfabrieken,
Eindhoven, the Netherlands

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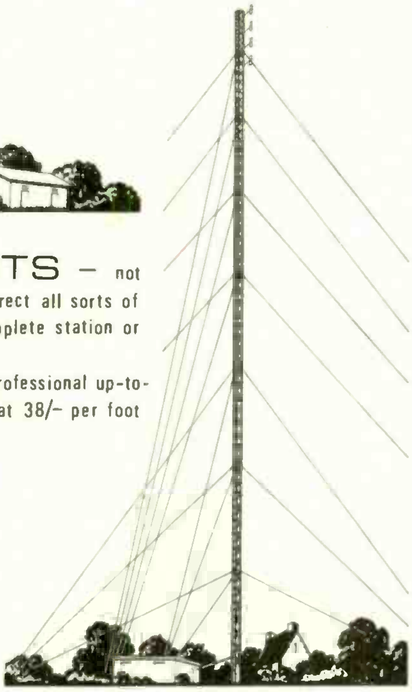
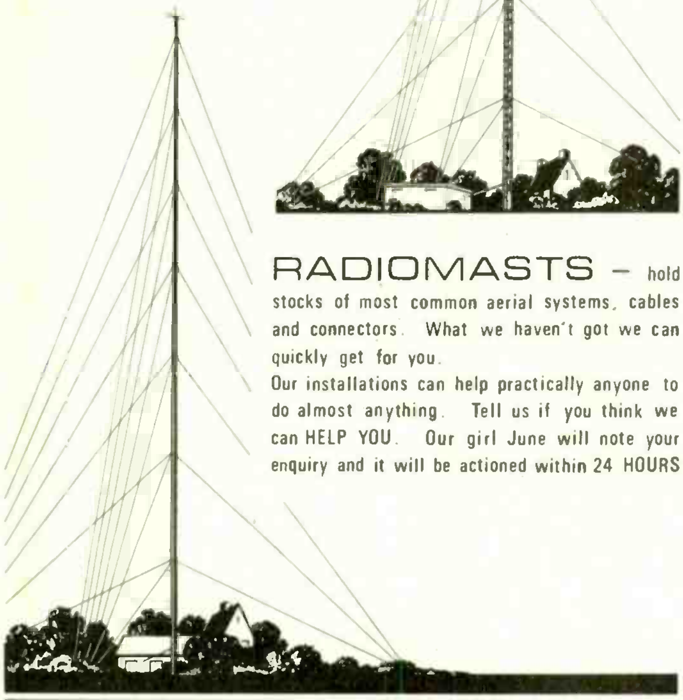
TOWERS.. above all others

RADIOMASTS – can offer you a tower for almost any purpose.
Not only for VHF, UHF or SHF radio systems, but for floodlighting, CCTV – or anything which requires a lot of height in a little space.



RADIOMASTS – not only design, manufacture and erect all sorts of towers – we can plan a complete station or scheme for you.
We also make the cheapest professional up-to-120-foot mast in the World – at 38/– per foot including fitting your aerials.



RADIOMASTS – hold stocks of most common aerial systems, cables and connectors. What we haven't got we can quickly get for you.
Our installations can help practically anyone to do almost anything. Tell us if you think we can HELP YOU. Our girl June will note your enquiry and it will be actioned within 24 HOURS

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NEW IMPROVED SOLDER REMOVER

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- Re-positioned Release Button for better handling of tool.

Instantly removes unwanted solder from printed circuits and all other solder joints without damage to unit or component. Saves valuable time resulting in increased production.

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Armstrong

the high fidelity sound

NEW

Series 500 Amplifiers & Tuners

521 Stereo Amplifier (top photograph)

A superb new transistor amplifier from Armstrong with a performance that is second to none. It is based in circuitry and internal layout on the highly successful 421 amplifier which it supersedes. Its got 25 watts power output per channel (continuous sine wave), a total of 50 watts, and all the facilities you could wish for in a top class amplifier. Inputs for magnetic and ceramic pickups, tape playback and radio, rumble filter, two treble filters, loudness control, tape monitor and headphone listening. Stabilised power supply, output transistor protective circuit and plug in modules for easy servicing.

523 AM-FM Tuner (lower photograph)
524 FM Tuner

Two alternative tuners to match the 521 amplifier in looks and performance. Both tuners provide high sensitivity and top quality on the FM band and, with the optional M4 Stereo Decoder added, give wonderful results on stereo radio.

For all those who want AM radio as part of their sound system, the 523 gives excellent coverage of the medium and long wavebands.

Each Series 500 model comes complete with high quality teak case, for which there is no extra charge.

The full Armstrong range of high fidelity products recommended retail prices

521	Stereo Amplifier	£52 0 0
523	AM-FM Tuner	£51 10 0
524	FM Tuner	£39 10 0
425	FM Tuner-amplifier	£78 5 9
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127	AM-FM Tuner-amplifier	£42 17 9
M5	Stereo Decoder (for 127)	£14 10 0

Have you read the review of the 426 Tuner-amplifier in the October Hi Fi News? If not we will gladly send you a copy. For full details and technical specifications of all models, plus stockists list, post coupon or write mentioning 1WW69

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Muriel has a new trimmer figure

(·75,84,86)

New ·75″ Cermet Trimming Potentiometers in two models:– Models 84 and 86 with a power rating of 0.33W at 70°C.
Ask Muriel to send you samples for evaluation and it'll be no sooner said than done!
While you're about it, ask for samples from the complete Morganite range. It's a full range; not only does it have versions to MIL-R-22097C, but it includes a *second* series of ohmic values from the E6 range.
Morganite Resistors Limited is the only British company to offer you this choice.
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The GEC type RCX dry reed capsule will switch a 5W resistive load several million times and is suitable for fast low level applications where reliability and long life are required. It is hermetically sealed and has a contact resistance of not greater than 150 milliohms. A fully automated production unit has been set up to produce high quality reeds to an extremely severe Post Office telephone exchange specification, and the same modern techniques are being used on this industrial version which is offered at 6d in bulk quantities. Small quantities cost a penny or two more.

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it's sensitive

but you won't hurt its feelings

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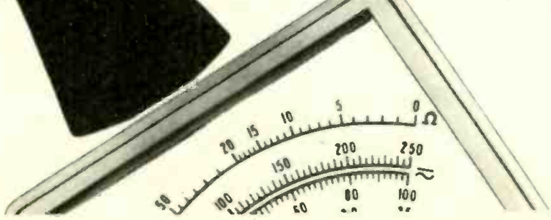

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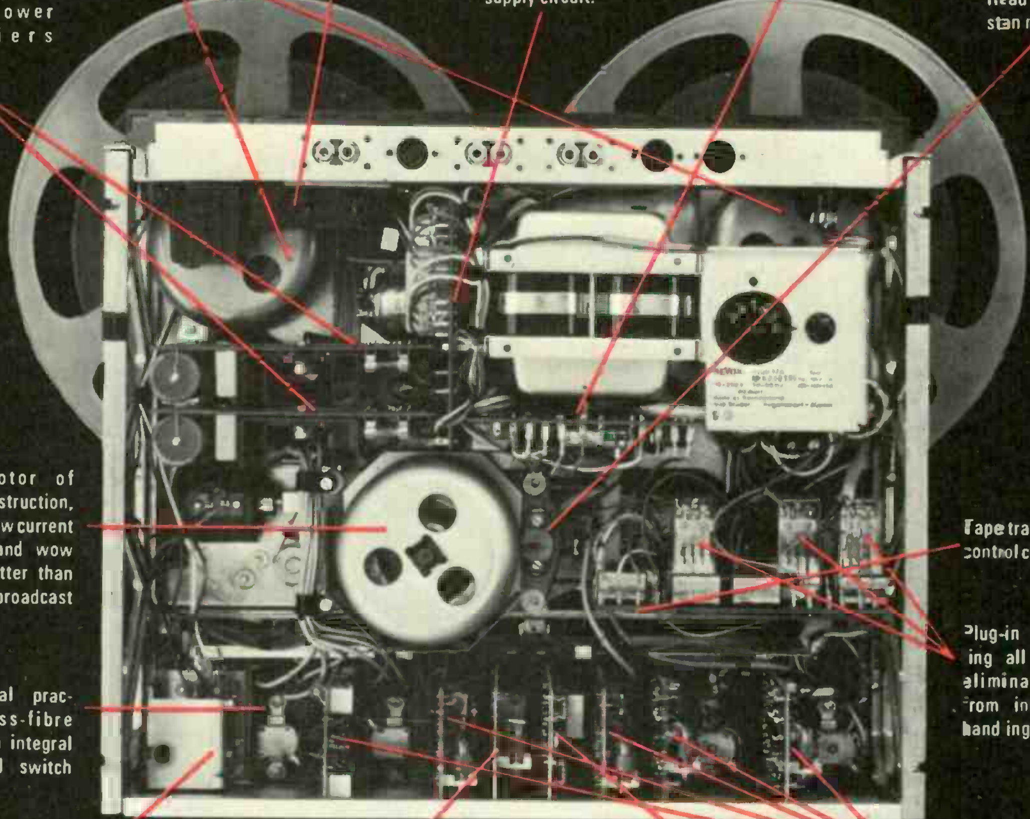
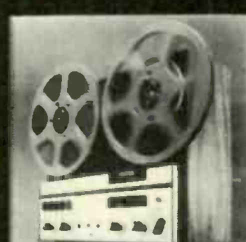


New from the Willi Studer Factory comes the revolutionary Model 77 incorporating design developments based on experience gained in the broadcast field with the 37 and 62 Series Studer machines. The 77 is a studio quality machine compactly presented and offering features unique in this price class including total indifference to fluctuations in mains supply periodicity. With a wow and flutter level below broadcast standard requirements plus a linear response from 20-20,000 Hz at 7½ ips. (±2 db) and an ultra low noise level, this new Revox will fulfill virtually every scientific and industrial requirement in the sonic band.



NAB version priced from £149. 10. 0. Tax Free.

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The Microphone with a Message

EV 635A

... a simple message. If you're looking for professional results, use a professional microphone.

Radio and TV media, film units and recording studios throughout the world demand the best and get it – in an EV 635A Omnidirectional dynamic microphone. It can be used on a stand, hand-held or as a lavalier and is practically indestructible under normal conditions of use. An internal shock absorber greatly reduces the pick-up of cable or other noises generated by external contact, and the steel casing provides excellent magnetic shielding. Used outdoors, the 635A withstands the effects of high humidity and temperature extremes, salt air and severe mechanical shocks. A four-stage pop and dust filter eliminates the need for an external windscreen.

Specifications

Element:	Dynamic
Frequency response:	80-13,000 Hz
Polar Pattern:	Omnidirectional
Impedance:	Low (150 ohms)
Output level:	55 dB (0 dB = 1 mw/10 dynes/cm^2)
EIA sensitivity rating:	149 dB
Diaphram:	EV Acoustalloy
Case material:	Steel
Dimensions:	6" x 1⅞" dia.
Finish:	Non-reflecting matt satin nickel
Net weight:	6 ounces without cable
Cable connector:	Cannon XLR-3-12 complete with 18' 2-conductor shielded broadcast type cable
Accessories:	Lavalier neck cord assembly and model 310 clamp

For more information about the EV 635A, write the sole U.K. distributors:

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PHILIPS

Every aspect of microphone manufacture is covered by the makers of ten million of them—Philips. Presentation and directivity are made to suit requirements. In fact, whatever your needs, there's one in ten million for you. Please ask for full information.

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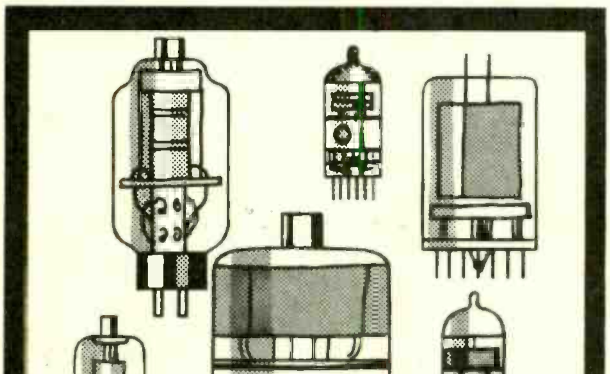

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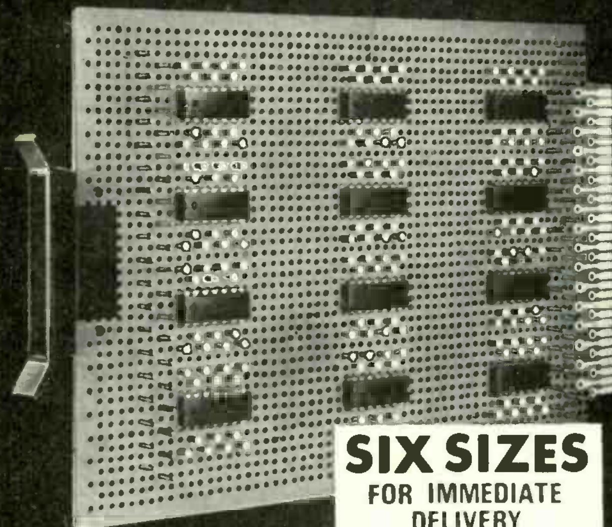
AND DISCRETE COMPONENTS



Made of plain XXXP base, these circuit cards are pre-pierced with .052" dia. holes on a square 0.1" x 0.1" hole matrix and are provided with a row of gold-plated copper contact fingers at one end for use with standard 0.1" pitch connectors. Rapid circuit assembly on these ready-to-use cards can be accomplished with point-to-point wiring either side using Vero terminal pins. Ideal for mounting TO 5 or Dual-in-line integrated circuits as well as discrete components.

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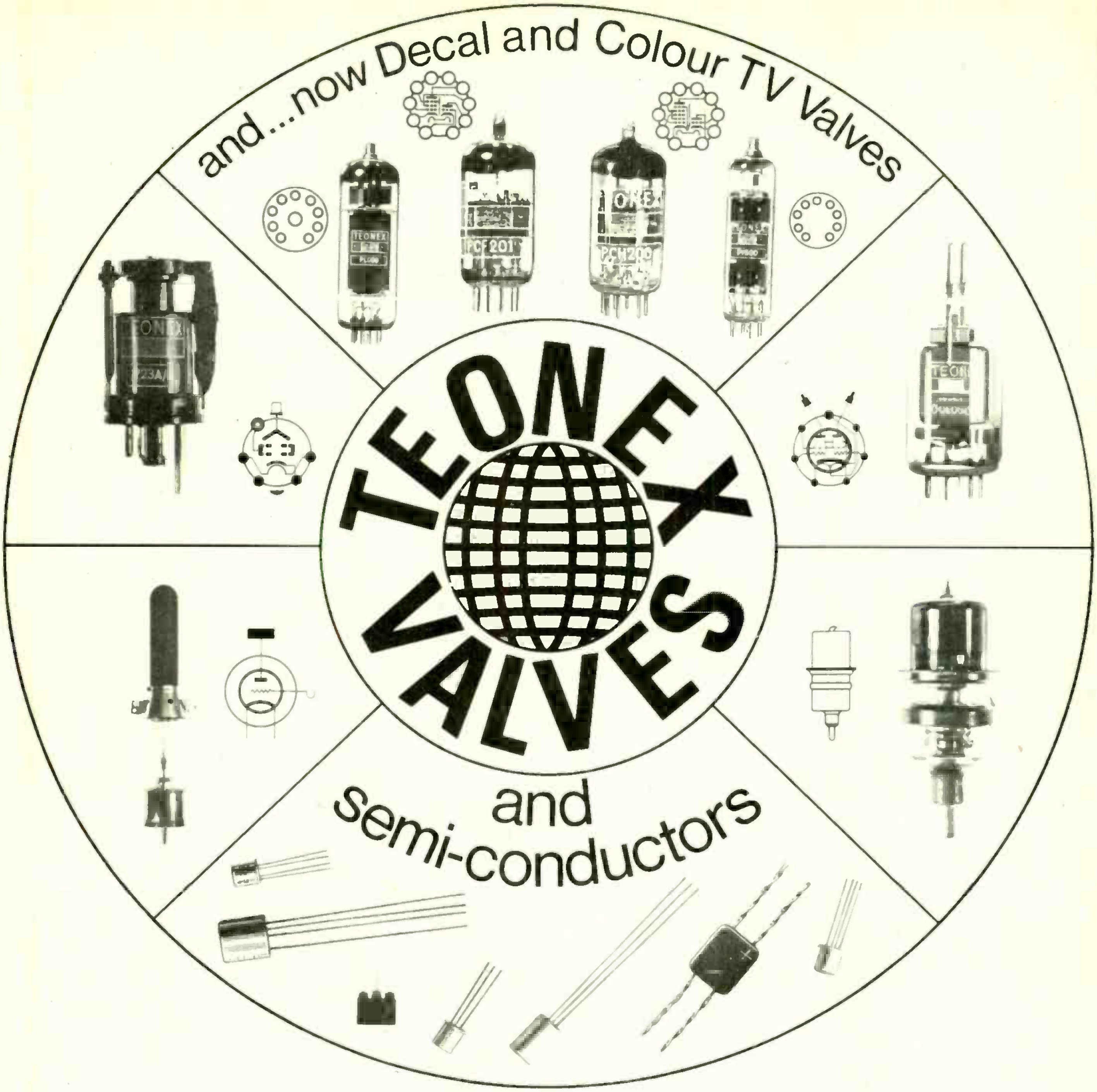

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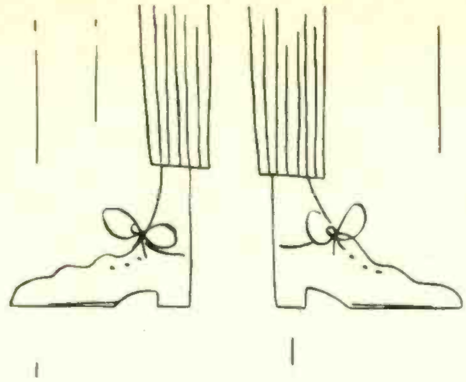

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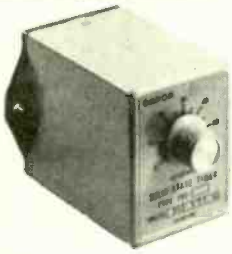
TIMERS MICRO SWITCHES

IMMEDIATE DESPATCH

NEW

Solid State Process Timer type TDS



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30 sec and 60 sec Linear dials
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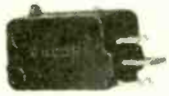
- COMPACT

Temperature ranges up to 280°C
Output contacts .4 amp
Repeat Accuracy 3% full scale
Complete with Thermistor
Approximately £15 dependent on quantity

VV-15-1A



★ 15/10 AMPS. c/o
★ 100,000 ops.

1/11 each per 1,000
Single Throw 1/6 each

FLOATLESS LIQUID LEVEL CONTROL

★ 5 amp. OUTPUT CONTROL CONTACTS
★ Solid State
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STP Sub-Mini Process Timer SYNCHRONOUS MOTOR & CLUTCH

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Automatic re-set.
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★ Senses ferrous objects.
★ Needs no mechanical force or pressure to operate.
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remote from 240v AC Power Pack which

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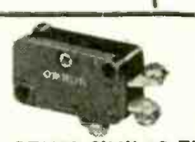

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★ 10 amp. c/o.
★ COMPARE OUR SPEC. & OUR PRICES WITH OTHER SIMILAR TYPES.

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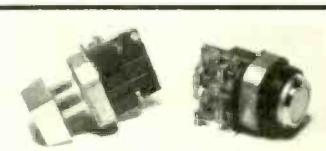

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	Auxiliary. Mic. 8mV at 50Kohms.
	Gram. 150mV at 1Mohm.
	Tape 80mV at 100Kohms.
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Volume Controls	Each channel and overall master gain control.

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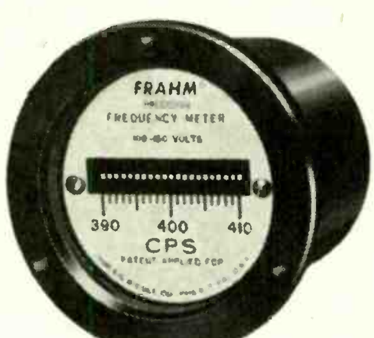
FRAHM vibrating reed FREQUENCY METERS



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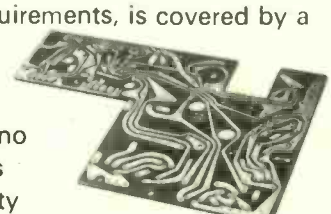

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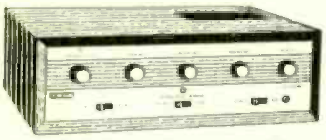

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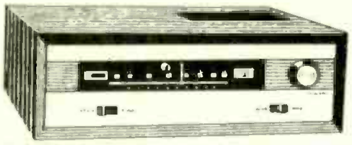

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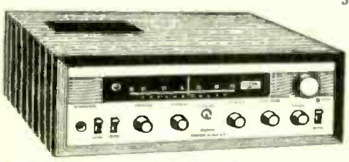

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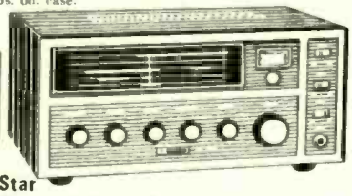

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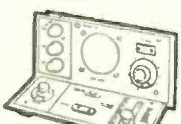

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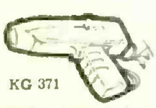

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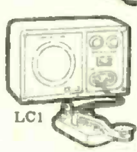

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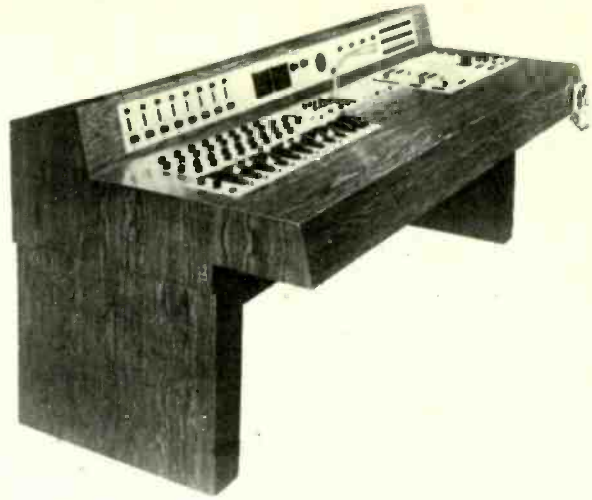

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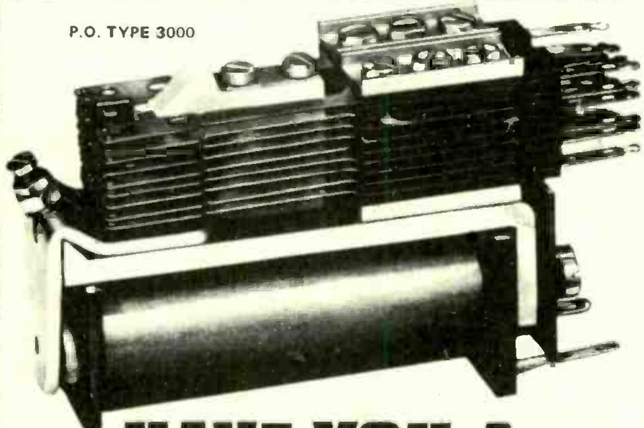
P.O. TYPE 3000



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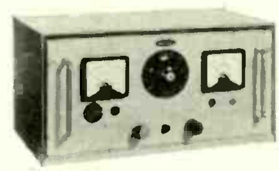

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VALRADIO LTD., DEPT. PU16, BROWELLS LANE, FELTHAM, MIDDLESEX, ENGLAND. Tel. 01-890 4242.

Export enquiries invited. Demandes concernant l'exportation solicités. Se invitan consultas sobre exportación. Exportanfragen erbeten.

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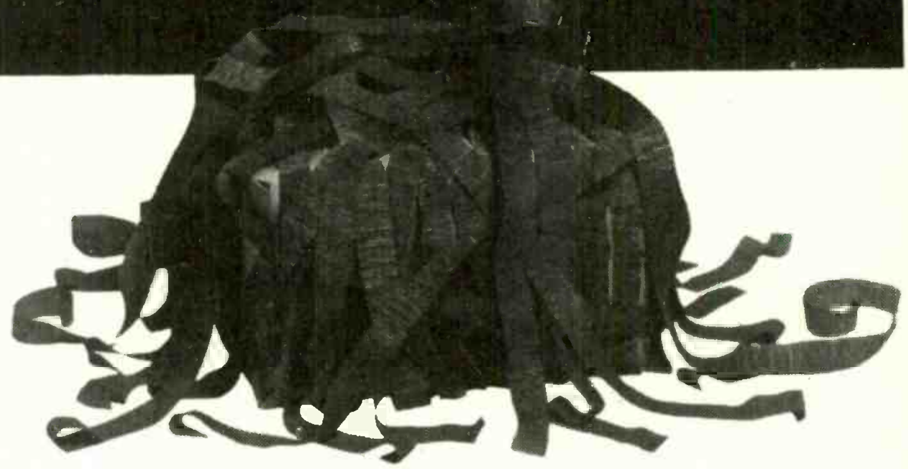
Has red tape been complicating your procurement of electronic components from the U.S.A.?



Let us help you cut through it!

Procurement of American-made electronic components used to be thought of as a complex, time-consuming procedure with a myriad of red tape details and problems. Not anymore—now you can join the growing list of companies that rely on the technical skills and services of Milo International, world-wide distributors of electronic components. Our team of experienced specialists will process your order with speed and efficiency from start to finish—immediate price and availability quotations, product information, application data, import certificates, export licenses, declarations, export packaging, delivery expediting, etc. And this all-inclusive service is provided for each order, no matter how small or large.

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If you have designs on printed circuit boards you need Ferranti IC Sockets

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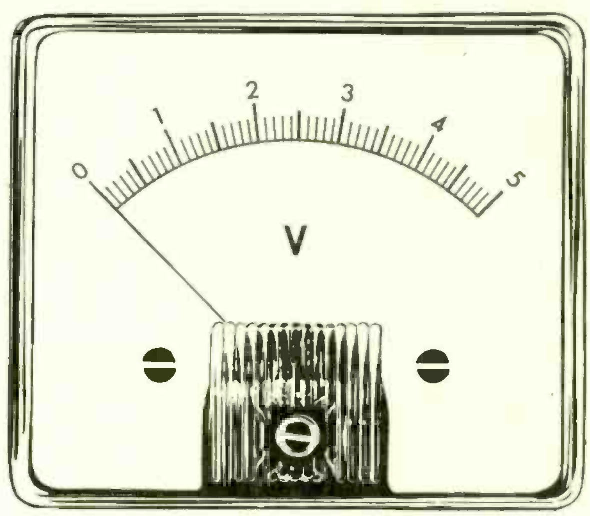

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MODEL 2000

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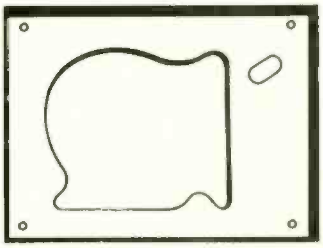
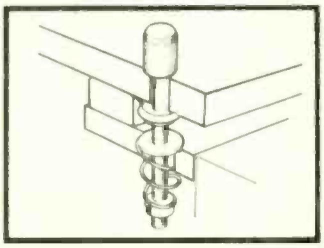
Designed to house SME precision pick-up arms in combination with leading makes of turntable, the Model 2000 Plinth System combines high-quality workmanship with ease of assembly. The basic unit is finished in selected veneers of teak, straight grained walnut, or rosewood. A one-piece lid in heavy acrylic is reinforced with a polished stainless steel trim.



Motor boards in matching veneers are ready cut and drilled for screw-driver assembly with the appropriate pick-up arm and turntable. The range, which will be added to from time to time, includes a blank board which can be cut to special order.



Four-point spring suspension adjustable for height and damping protects the motor board from acoustic feedback and external vibration.

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Full technical details of these new era cartridges from Desk HF, Goldring Manufacturing Co. (Great Britain) Ltd., 486-488 High Road, Leytonstone, London, E.11, or from your nearest dealer.

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Frequency response to 5000 Hz.
Sensitivity at 1000 Hz = -78db re 1 V/μ bar.
Load = 2000 ohms.
Impedance at 1000 Hz = 2500 ohms.
D.C. resistance = 360 ohms.

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Impedances available = 15, 60, 120, 250, 500, 1000, 2000 and 4000 ohms.
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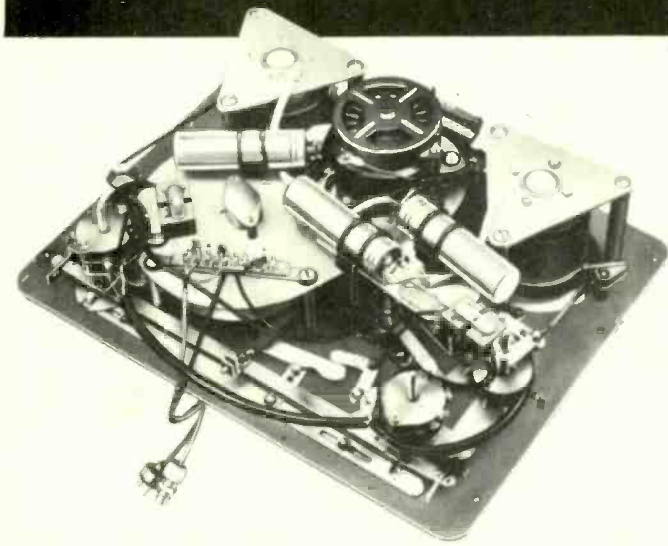

Mk 5 Series 3 for spool sizes up to 8¼" dia.
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Head assemblies to customer's specification

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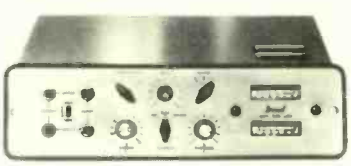

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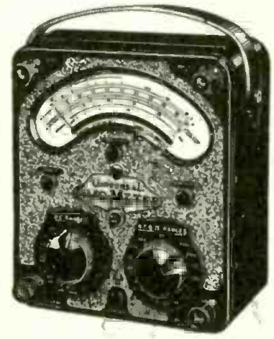

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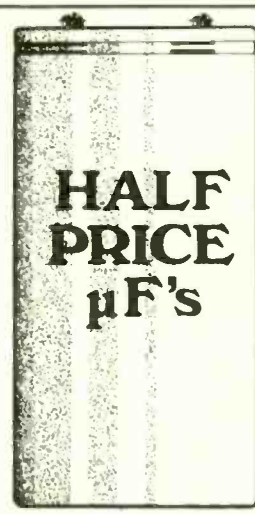

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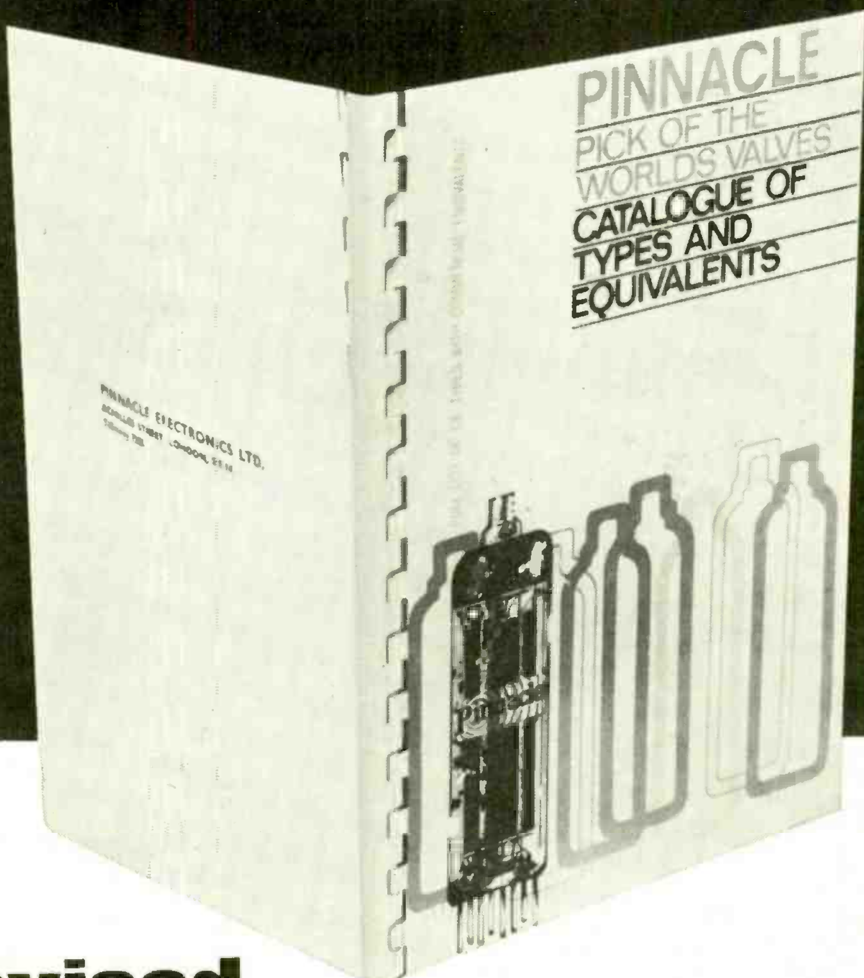

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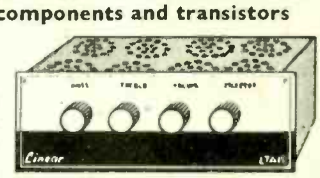

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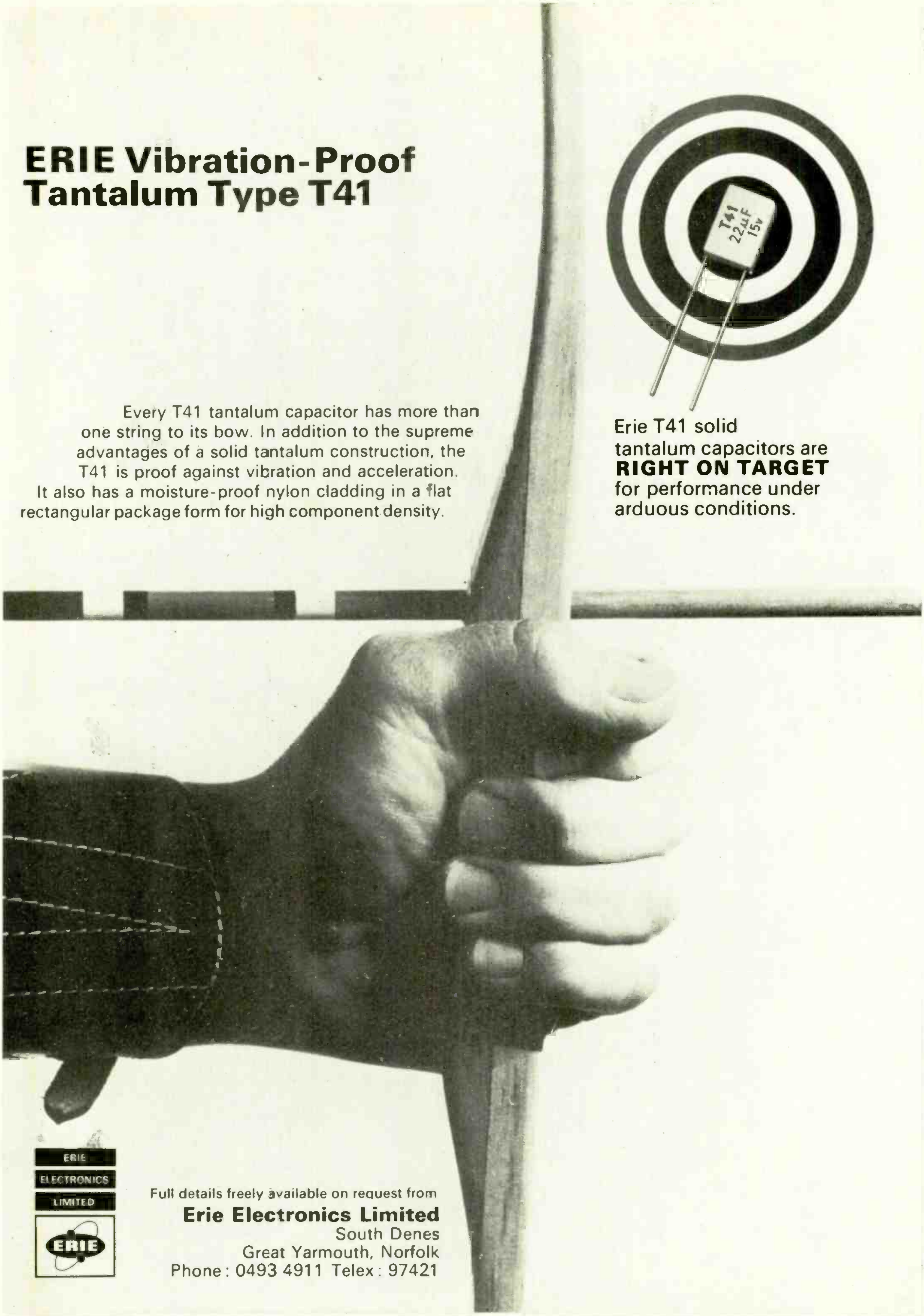

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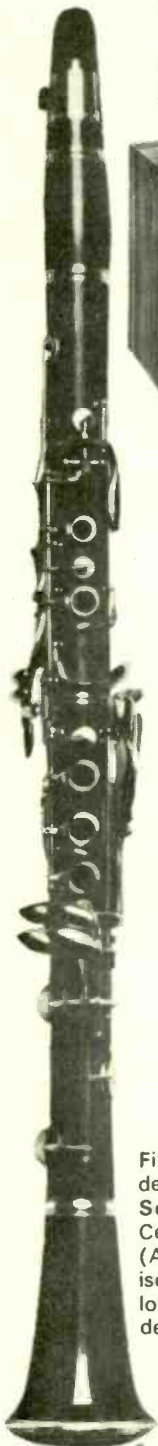

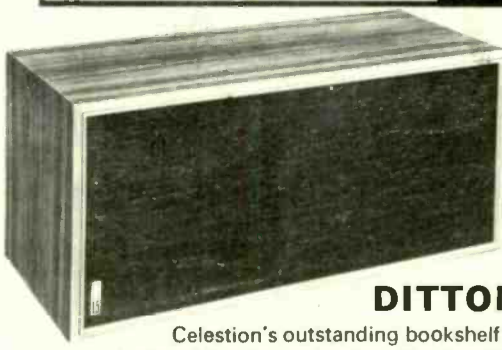

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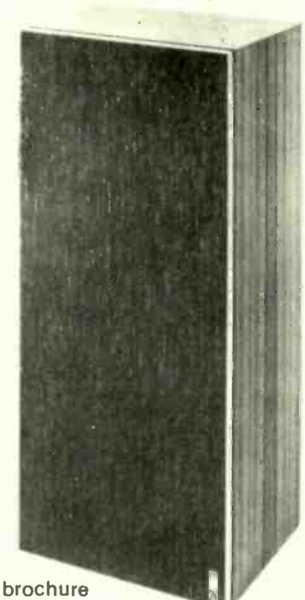

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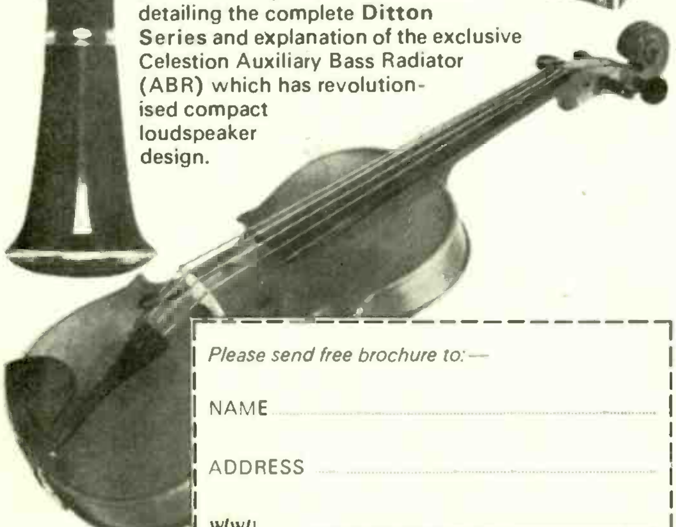

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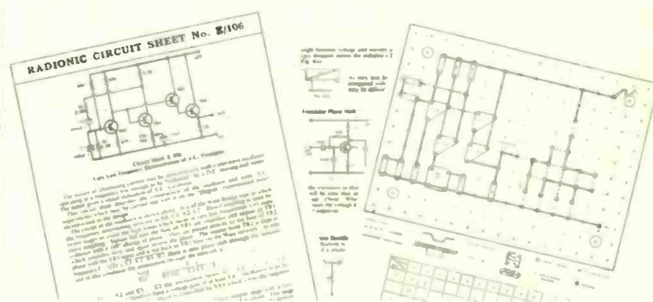

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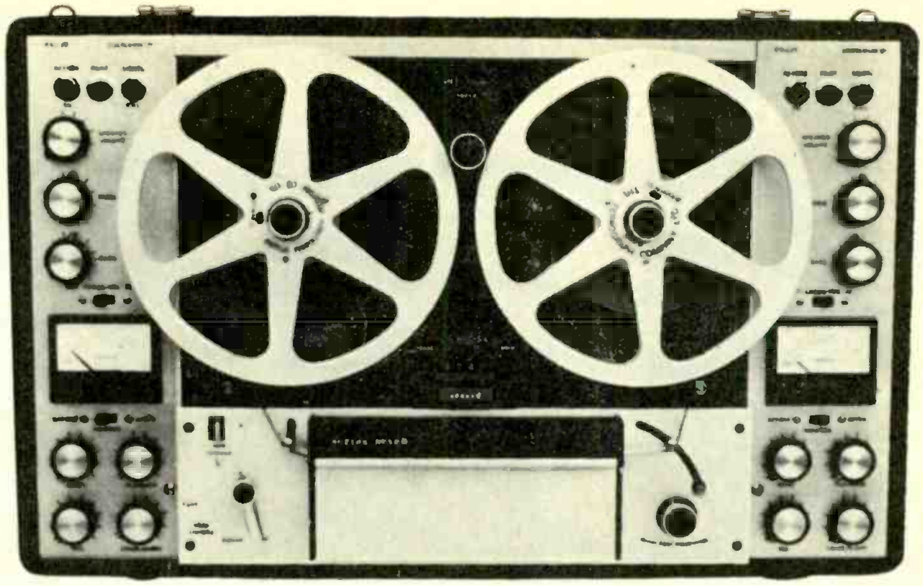
VORTEXION



The CBL/7T solid state Tape Recorder uses 8 low noise Field Effects Transistors on its twin channel Mic., P.U. and Playback inputs to give low intermodulation distortion, and the 10 watts sine wave 15 watt speech and music amplifiers each have less than 0.05% harmonic distortion and less than 0.1% intermodulation distortion at 10 watts output. "Before and After" monitoring on phones and by internal or external speakers is catered for, and separate power amplifier volume controls allow the speakers to be independently controlled from the headphones. 30/50 ohms balanced line Microphone and P.U. inputs can be mixed with the other channel via crossmix and an echo control.

All the facilities of the valve model C.B.L. are provided plus a few extras . . . The series 7 deck has variable speed wind in either direction, solenoid operation, provision for an external switch for remote run or voice operated accessory, and still lower wow and flutter figures. Mono versions also available.

Speeds $1\frac{7}{8}/3\frac{3}{4}/7\frac{1}{2}$ *i.p.s. or* $3\frac{3}{4}/7\frac{1}{2}/15$ *i.p.s.* *Weight* 52 *lb.* *Dimensions* $13\frac{1}{2}'' \times 22'' \times 9\frac{3}{4}''$.

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

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

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

CP50 AMPLIFIER. An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 ohms-15 ohms and 100 volt line. Bass and treble controls fitted.

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(Heathkit models available Ready-to-use, as well as in easy-to-build kit form)

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KIT K/IM-25 **£48.10.0** P.P. 10/6
Ready-to-use A/IM-25 **£59.0.0** P.P. 10/6

Latest Solid - State High - Impedance Volt - Ohm Milliammeter . . . IM-25

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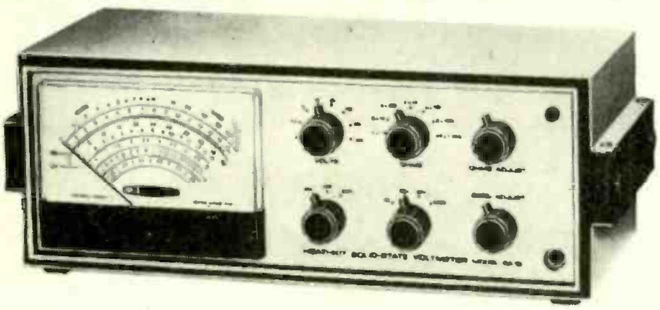

KIT K/IM-16 **£28.8.0** P.P. 10/6
Ready-to-use A/IM-16 **£35.8.0** P.P. 10/6

Latest Solid-State Volt-Ohm Meter, IM-16

• 8 A.C. and 8 D.C. ranges from 0.5 volts to 1500 volts full scale • 7 ohm-meter ranges with 10 ohms at centre scale and multipliers of ×1, ×10, ×100, ×1k, ×10k, ×100k, and ×1 megohm • 11 megohm input on D.C. ranges, 1 megohm on A.C. ranges • Operates on either built-in battery power or 120/240 volt A.C., 50 Hz • Circuit-board construction.

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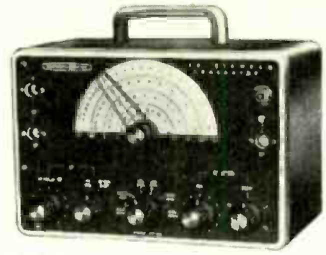
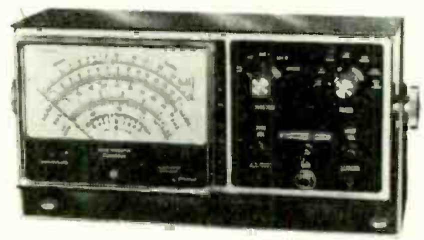
10-12U SCOPE



RF-1U GEN.



VVM IM-13U

3" Portable General-Purpose Service Oscilloscope OS-2

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Vertical amplifier: Frequency response: ± 3 dB, 2 Hz to 3 MHz. **Sensitivity:** 100 mV r.m.s. per cm. at 1 kHz. **Input Impedance:** 3.3 megohm shunted by 20 pF. **Horizontal amplifier: Frequency response:** ± 3 dB, 2 Hz to 300 kHz. **Sensitivity:** 100 mV r.m.s. per cm. at 1 kHz. **Input impedance:** 10 megohm shunted by 20pF. **Time base generator:** Range 20 Hz to 200 Hz. Automatic lock-in sync; Retrace blanking **Voltage calibrator:** 1 volt, peak-to-peak, 50 Hz. **Controls:** Brilliance and on/off switch, Focus, Astigmatism, Time base range switch and Fine Frequency, Vertical and Horizontal Gain, Vertical and Horizontal Position.

5" Wide-band General-Purpose Oscilloscope 10-12u

KIT **£36.18.0** Ready-to-use **£46.16.0** P.P. 10/6

Vertical sensitivity: 10 mV r.m.s. per cm at 1 kHz. **Frequency response (referred to 1 kHz):** ± 1 dB, 8 Hz to 2.5 MHz; ± 3 dB, 3 c/s to 4.5 MHz; -5 dB at 5 MHz. **Rise time:** 0.08 microseconds or less. **Input Impedance:** (at 1kHz) 2.7 Megohms at X1; 3.3 Megohms at X10 and X100. **Horizontal sensitivity:** 50 mV r.m.s. per cm at 1 kHz. **Frequency response:** ± 1 dB, 1 Hz to 200 kHz; ± 3 dB, 1 Hz to 400 kHz. **Input impedance:** 30 Megohms at 1 kHz. **Time base generator:** Range, 10 Hz to 500 kHz in 5 steps, variable, plus 2 switch-selected pre-set sweep frequencies range. **Synchronising:** automatic lock-in circuit.

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Frequency range covers 100 kHz to 200 MHz in six bands. Band A, 100 kHz to 300 kHz; Band B, 300 kHz to 1 MHz; Band C, 1 MHz to 3.1 MHz; Band D, 3.1 MHz to 10 MHz; Band E, 10 MHz to 30 MHz; Band F, 30 MHz to 100 MHz. **Calibrated harmonics:** 100 MHz to 200 MHz. **Accuracy:** 2%. Large accurately calibrated disc scales. Factory wired and aligned coil and band switch assembly. Modulated or unmodulated RF output. **Output:** Impedance, 75 ohms; Voltage, 100 mV. **Modulation:** Internal, 400 Hz; 30% depth; External, approx. 3 V across 50 Kohms for 30%. **Audio Output:** Approx. 4V. **Valve complement:** 1-12AT7, 1-ECF80.

6" Valve Voltmeter, IM-13u

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Range D.C.: 7 Ranges: 0-1.5, 5, 15, 50, 150, 500, 1500 volts full scale. Input Resistance: 11 megohms. Sensitivity: 7, 333, 333 ohms per volt on 1.5 volt range. Circuit: Balanced bridge (push-pull) using twin triode. Accuracy: ± 3% full scale. **Range A.C.:** 7 R.M.S. Ranges: 0-1.5, 5, 15, 50, 150, 500, 1500 r.m.s. full scale. Freg. Response (5v. range): ± 1 db 25 Hz to 1 MHz. Accuracy: ±5% full scale. Input Resistance Capacitance: 1 MΩ. **Ohmmeter:** 7 Ranges: × 1, × 10, × 100, × 1,000, × 10K, × 100K, × 1MEG. Measures 0.1 ohms to 1000 megohms with internal battery. Meter: 6" 200μA movement.

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Portable Solid-State Volt-Ohm Meter IM-17

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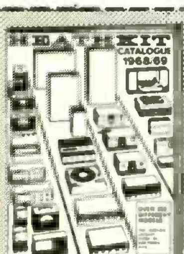

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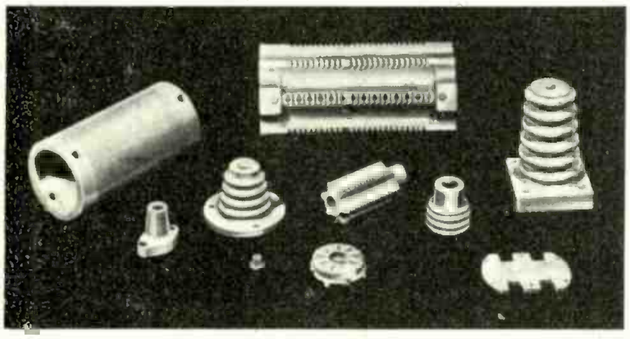
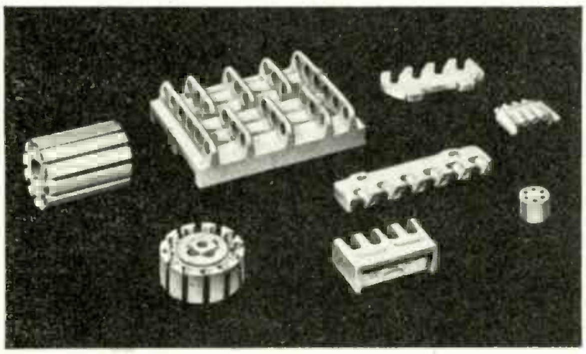

Frequelex—for high-frequency insulation.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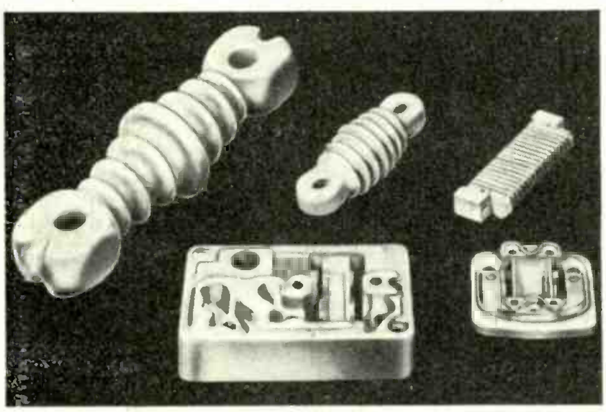
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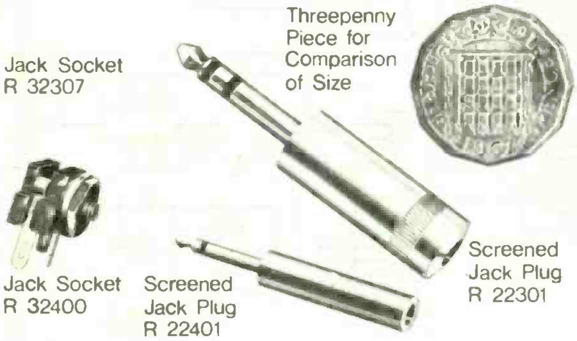

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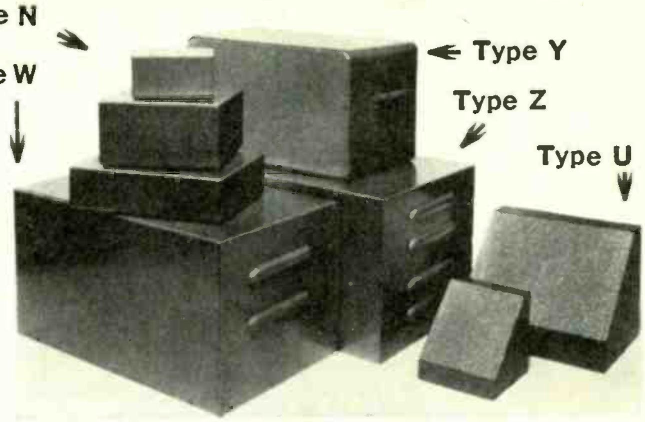

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FLANGES (¼in., ⅜in.), **6d.** per bend.

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SOLID STATE (AC/DC operation)

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Specification

Power supply:	AC mains (50Hz/60Hz) DC 12 volts (12 volts battery)
Power consumption:	AC: 20VA at non-signal 110VA at rated output 140VA at max. output DC: 0.7A at non-signal 4.7A at rated output 7.0A at max. output
Output power:	Rated 30 watts Max. 45 watts
Distortion:	3% at 30 watts
Output impedance:	Low 4Ω, 8Ω, 16Ω High (Balanced type) 165Ω (70 volts line), 330Ω (100 volts line)
Input gain:	MIC-1 (50KΩ) and 30Ω balanced 3mV MIC-2 (50KΩ) and 30Ω balanced 3mV MIC-3 (50KΩ) and 30Ω balanced 3mV MAG-PHONO (50KΩw/equalizer) 6mV } changeable AUX (500K Ω) 250mV
Frequency response:	20Hz 20.000Hz. ±6dB
Tone control:	Bass: −12dB at 50Hz Treble: −12dB at 10KHz
S/N ratio:	65dB
Transistors & diode:	2SC–694 .... 4 2SC–536 .... 5 2SC–615 .... 1 2SB–471 .... 2 4H2B–10R 1
Dimensions:	106H × 396W × 271D mm
Weight:	6.1 kg

Model **TA-267** (60 watts R.M.S.) £85.14.3 retail

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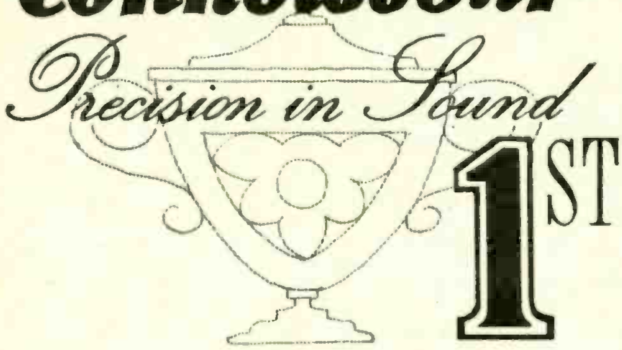

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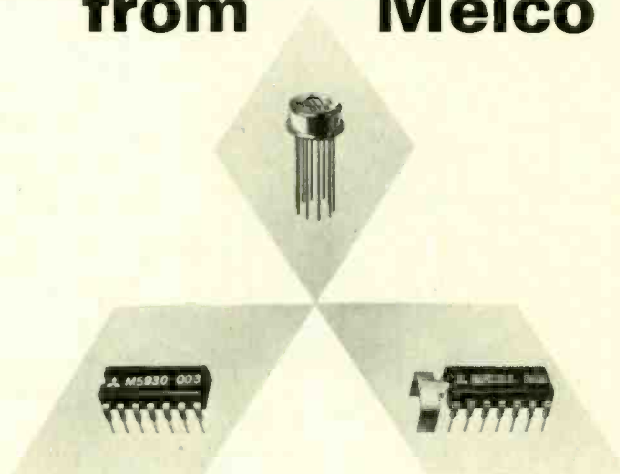

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M5933P	Dual 4-Input Expander
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M5945P	Single R-S/J-K Clocked Flip Flop
M5946P	Quadruple 2-Input NAND Gate
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M5948P	Fast single R-S/J-K Clocked Flip Flop
M5949P	Fast Quadruple 2-Input NAND Gate
M5961P	Fast Dual 4-Input Expandable NAND Gate
M5963P	Fast triple 3-Input NAND Gate
M5952P	Dual J-K Clocked Flip Flop (Common $\overline{T}$, $\overline{R_D}$)
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M5310P	Single 8-Input NAND Gate
M5320P	Dual 4-Input NAND Gate
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M5113T	Wide-Band Amplifier-Discriminators
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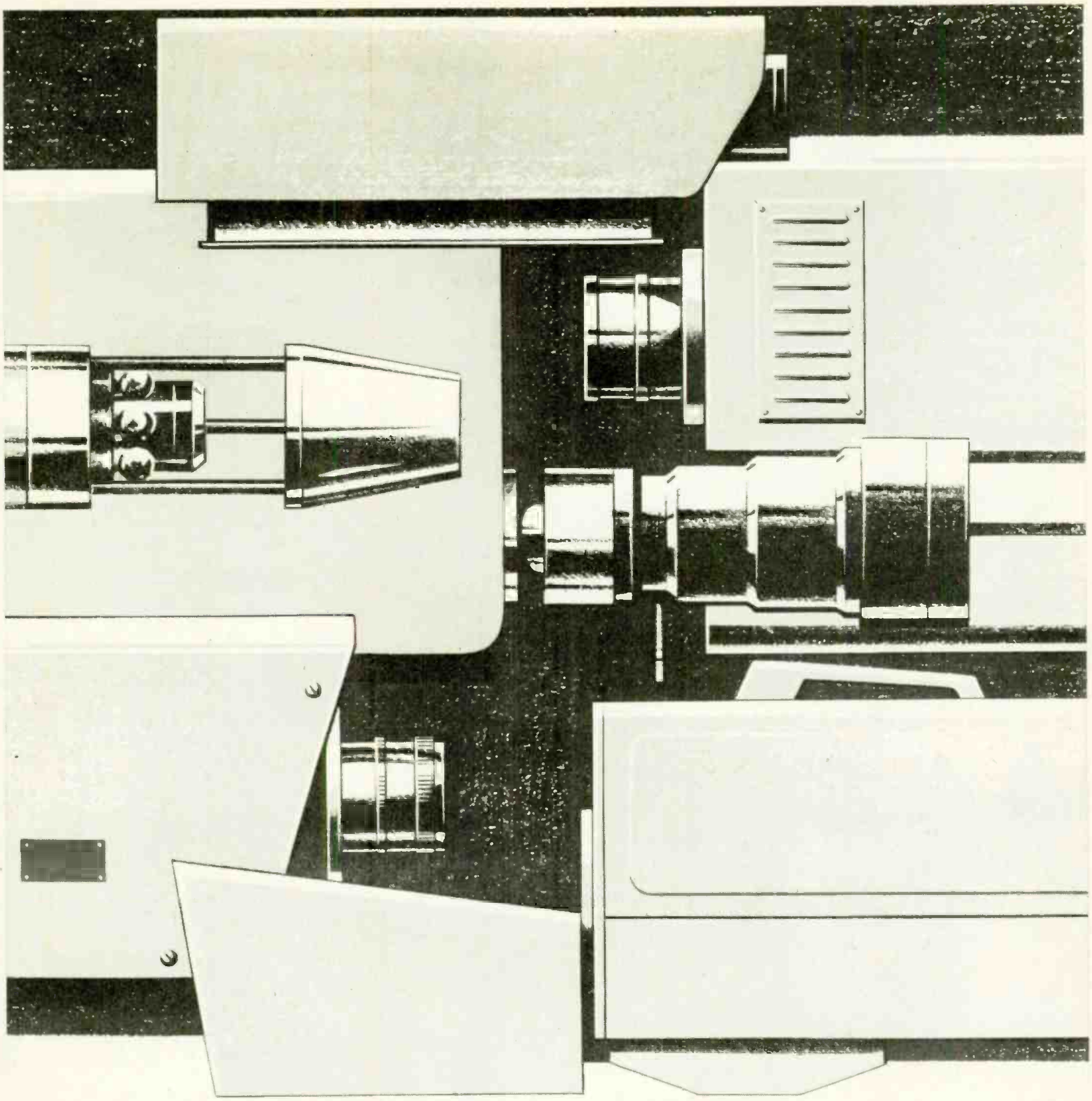
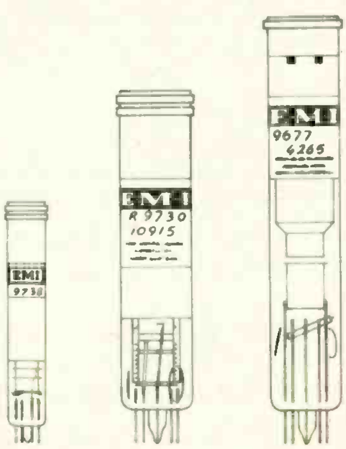


Cameras a plenty... but how quickly can you find the right low cost tube?



There is a growing range of closed-circuit equipment available, ranging from the simple black and white camera to sophisticated full-colour facilities. The time inevitably arrives when a replacement vidicon tube is needed quickly. This is the service **EMI** sets out to provide. Our vidicon range provides a type for virtually every camera, where reliability, good resolution and high sensitivity are required. Send for the **EMI** Vidicon replacement chart. Then, when you need a tube, simply contact your distributor or **EMI**.

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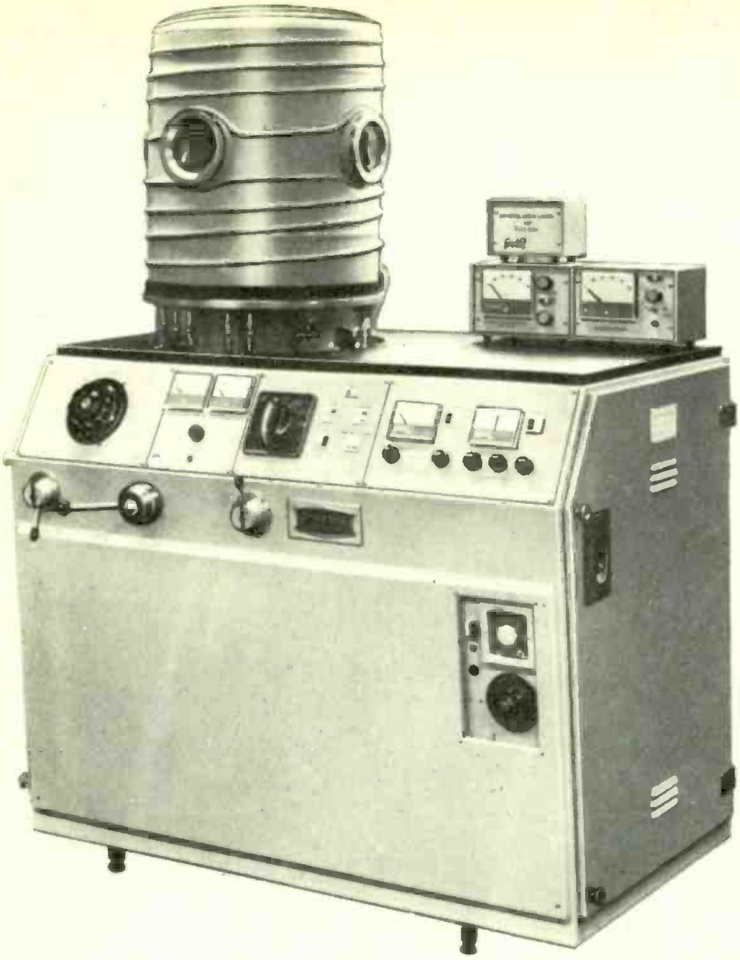

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New A301 price: £560 f.o.b. London
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- 150 KHz to 220 MHz—all on fundamentals.
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Includes all the versatile advanced features of the Standard Model 29-S

AND

Integral Crystal Oscillator providing calibration check points throughout all ranges, for adjustment of scale accuracy to ±0.02%. The crystal marker signal is available at R.F. socket for use externally.

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SPIN WHEEL TUNING
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PRODUCTION RELEASE—FEBRUARY 1969

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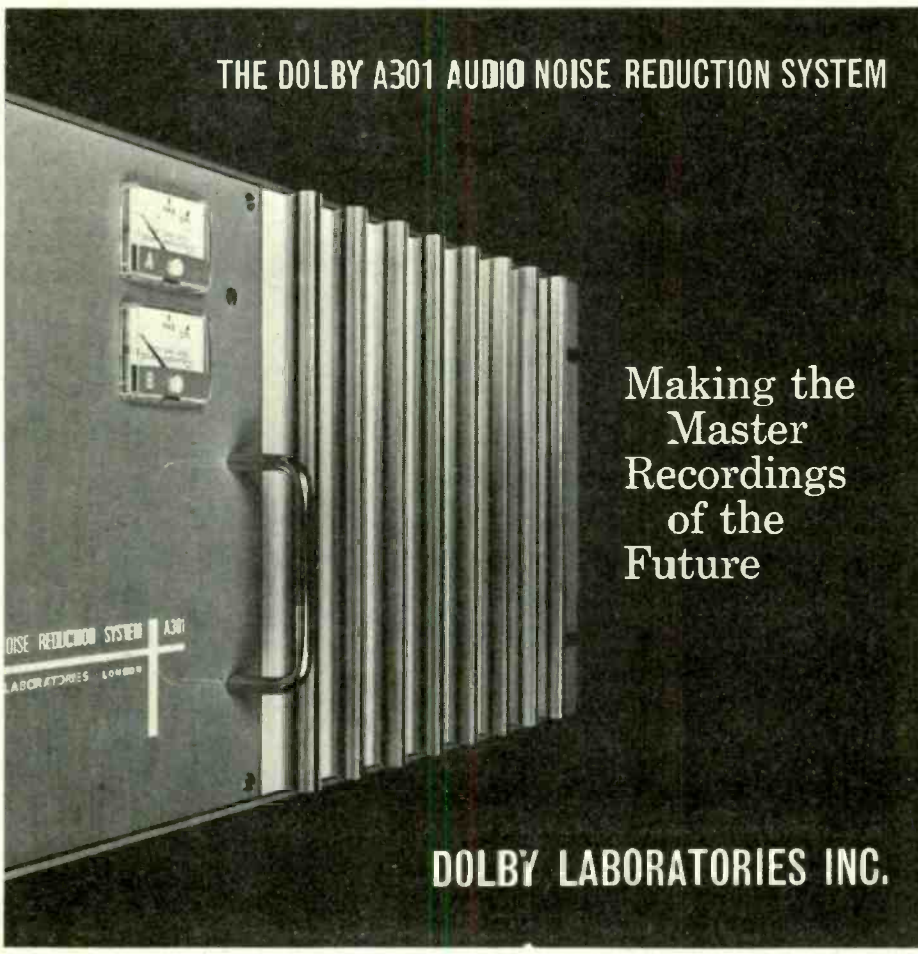

Already in use in eighteen countries, the Dolby system is making master recordings which will withstand the test of time.

The system provides a full 10 dB reduction of print-through and a 10–15 dB reduction of hiss. These improvements, of breakthrough magnitude, are yalid at any time—even after years of tape storage. This is why record companies with an eye to the future are now adopting this new revolutionary recording technique.

A301 features: Easy, plug-in installation · solid state circuitry · modular, printed circuit construction · high reliability, hands-off operation. Performance parameters such as distortion, frequency response, transient response, and noise level meet highest quality professional standards.

NEW Remote Changeover option cuts costs, enables one A301 unit to do the work of two.

NEW NAB and DIN level setting meters simplify recorder gain calibration.

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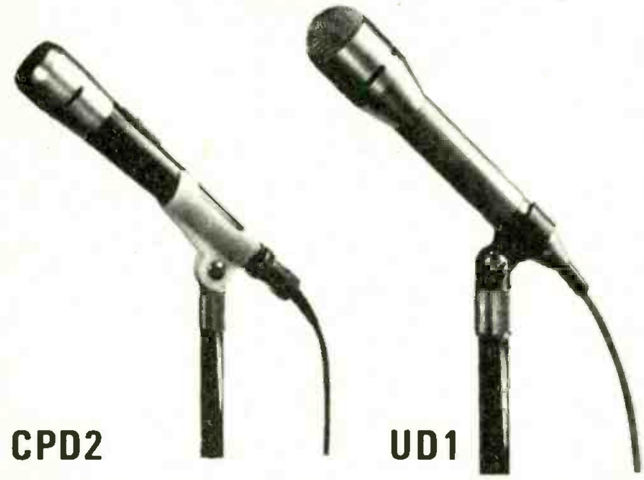
RESLOSOUND microphones

Precision engineered give the sensitive acoustical performance required today



CPD2

Cardioid Pencil Dynamic Microphone *improved* version of the well known Reslo CPD microphone. Most suitable for:
High Quality Music Recording.
General Sound Reinforcement.
Loud close singing or speaking if used with an amplifier incorporating reasonable bass cut.
Frequency response is smooth over the range 70 c/s to 16 Kc/s.
Rear response better than 20dB below the front from 100 c/s to 1 Kc/s and over 14dB from 1 Kc/s to 16 Kc/s dropping to 30dB at upper presence frequencies.
Impedance values: CPD2/L—30/50 ohms of 600 ohms.
Supplied with 18' of dual impedance cable £17.15.0.
CPD2/M—200 to 300 ohms. £17.10.0.
CPD2/H—30/50 ohms or Hi—Z. £17.15.0.
Appropriate cable set to order.

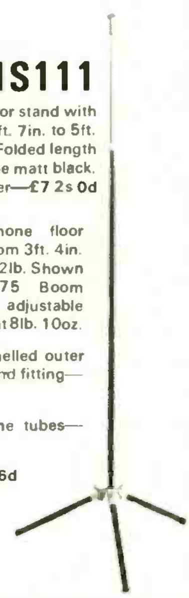
UD1

An improved uni-directional (super cardioid) high output hand or stand microphone, incorporating an internal anti-pop filter. Supplied in a black presentation case with 18ft. of directly connected screened cable. Available in low, medium and high impedances.

Recommended Retail Price:

UD1/L (50 or 600 ohms) £19 10s. 0d
UD1/M (200-300 phms) £19 5s 0d
UD1/H (High impedance only) £19 10s 0d

floor stands



MS111

Lightweight microphone floor stand with folding legs. Adjustable from 3ft. 7in. to 5ft. Weight 4½lb. Feet spacing 18in. Folded length 37½in. Finish: Legs and outer tube matt black, inner tube satin silver—£7 2s 0d

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Solid leg microphone floor stand. Adjustable from 3ft. 4in. to 5ft. 2in. Weight 12lb. Shown fitted with MS175 Boom attachment fully adjustable (length from fulcrum) 2ft. 8in. to 4ft. Weight 8lb. 10oz.

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Type MS110A with all polished chrome tubes—£8 6s 0d

Type MS175 Boom attachment—£7 14s 6d

■ In addition to their World famous series of bi-directional and cardioid Ribbon Microphone Reslo manufacture a complete range of public address amplifiers and loudspeakers—line source and reflex horns.

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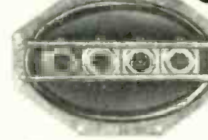

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EMI are famous throughout the world for High Quality sound reproduction. Now our audio design engineers have developed loudspeaker systems suitable for home use.

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The Regulac® range of hundreds of models includes ganged assemblies for parallel and three-phase operation, dual-cutput, portable and oil-immersed models plus many high-frequency and special types, for manual operation or with motor drive.

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CL65

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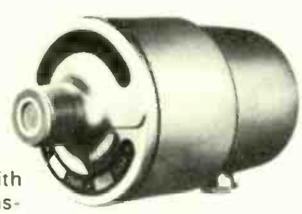
Celestion PA

Loudspeakers for all Public Address Systems

Re-entrant Horns

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

Driver Units



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

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

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  Range of 8 interchangeable bits, from $\frac{3}{64}$in. (.047in.) to $\frac{3}{16}$in., including new non-wearing PERMATIPS.

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  Heating time 90 secs. Max. bit temp. 390°C. Loading 15 watts—equals normal 30/40-watt iron.

- **ALL VOLTAGES**

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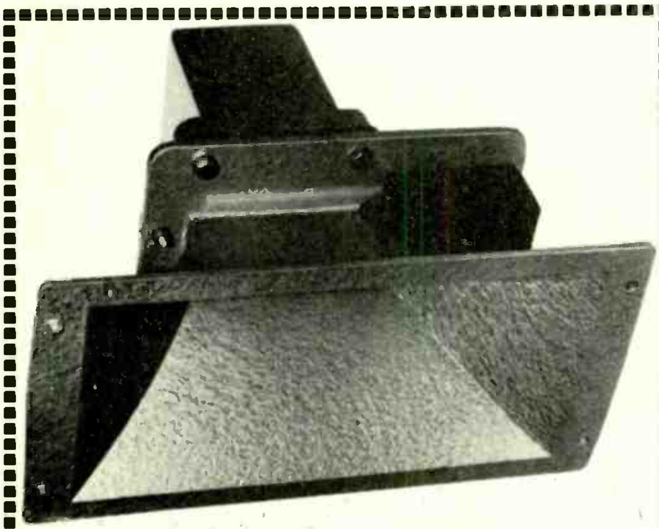
DECCA SPECIAL PRODUCTS

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



The Decca DK 30 Ribbon Speaker

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

Please send me details of the DK 30 speaker.

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ADDRESS ....

.... WW1.69

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

DECCA

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RADFORD

In an article in the Journal of the Audio Engineering Society for July 1967, Bart N. Locanthi, Vice-President, J. B. Lansing Sound Inc. describes the development of an ultra low distortion direct current audio amplifier. In it he says "... to get the highest accuracy possible, an English made RADFORD Low Distortion Oscillator was used which has less than 0.01% harmonic distortion at 20kHz."

LOW DISTORTION OSCILLATOR (Series 2)

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Specification

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Output Voltage:	10 Volts r.m.s. max.
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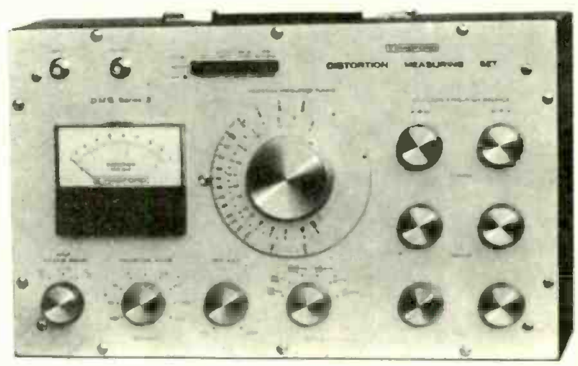
Sine Wave Distortion:	0.005% from 200 Hz to 20 kHz increasing to 0.015% at 10 Hz and 100 kHz.
Square Wave Rise Time:	Less than 0.1 microseconds.
Monitor Output Meter:	Scaled 0-3, 0-10, and dBm.
Mains Input:	100 V.-250 V. 50/60 Hz.
Size:	17¼ × 11 × 8in.
Weight:	25 lb.
Price:	£150.



DISTORTION MEASURING SET (Series 2)

A sensitive instrument for the measurement of total harmonic distortion, designed for speedy and accurate use. Capable of measuring distortion products as low as 0.002%. Direct reading from calibrated meter scale.

Specification

Frequency Range:	20 Hz-20 kHz (6 ranges).
Distortion Range:	0.01%-100% f.s.d. (9 ranges).
Sensitivity:	100 mV.-100 V. (3 ranges).
Meter:	Square law r.m.s. reading.
Input Resistance:	100 kOhms.
High Pass Filter:	3 dB down at 350 Hz. 30 dB down at 45 Hz.
Frequency Response:	±1 dB from second harmonic of rejection frequency to 250 kHz.
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Size:	17¼ × 11 × 8in.
Weight:	15½lb.
Price:	£120.

Descriptive technical leaflets are available on request.

RADFORD LABORATORY INSTRUMENTS LTD.
ASHTON VALE ROAD, BRISTOL 3
Telephone: 662301/3

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Wireless World

Electronics, Television, Radio, Audio

Fifty-eighth year of publication **January 1969** **Volume 75 Number 1399**

This month's cover symbolizes the analysis of speech sounds into the phonemic components required for electronic speech recognition, as described in W. D. Gilmour's article. The chart is a speech spectrogram, provided by the speech recognition group at the National Physical Laboratory, and contains time, frequency and intensity information.

Contents

1 Our Friend and Enemy

2 Watch Your Diode Measurements! *by 'Cathode Ray'*

4 Books Received

5 Electronic Speech Recognition—1 *by W. D. Gilmour*

8 Full-screen TV Standards Converter *by R. E. Davies*

11 News of the Month

Old thinking, new methods

Thick film domestic electronic equipment

15 Circuit Ideas

16 High-performance A.G.C. *by L. Nelson-Jones*

19 Letters to the Editor

21 Stabilized Balanced Power Units *by C. F. Ho*

22 Digital Exposure Timer *by G. Coates*

27 H.F. Predictions

28 *Wireless World* Colour Television Receiver—8

34 Codes & Code Converters—2 *by N. M. Morris*

38 B.B.C. Sound-in-Vision System

39 Announcements

40 Personalities

41 Literature Received

42 New Products

47 Test Your Knowledge *questions and answers by L. Ibbotson*

48 1969 Conferences and Exhibitions

49 World of Amateur Radio

50 January Meetings

52 Real and Imaginary *by 'Vector'*

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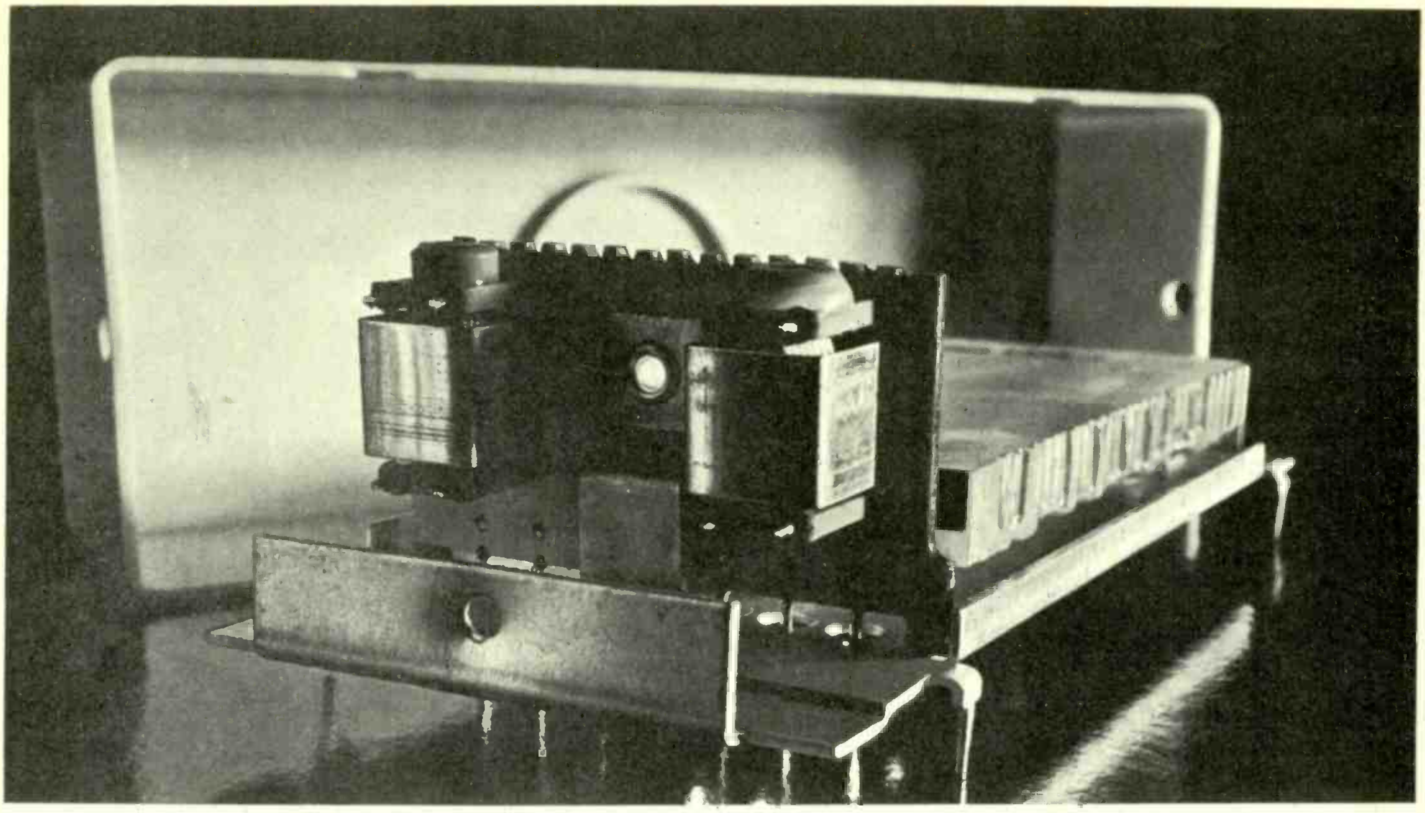

Why we decided to make every part in this PAL delay line

The PAL delay line is a precision item. But it also has to be inexpensive, and therefore mass-produced. The problems involved in getting the delay time of 63·943μS—an adjustment to a few thousandths of a microsecond—for just one, are quite formidable. To achieve it on an assembly line is practically impossible, unless you have everything under your own control.

When the PAL system was being developed, we found ourselves in an excellent position to develop the special glass delay line needed for the chrominance decoder. Delay lines weren't new to us. For the previous five years we'd been producing them for the computer industry. We therefore had considerable experience. Experience which few others in the television industry had and which enabled us to develop our delay line in parallel with the development of colour television itself.

Critical factors. The set designer's demands pose problems in design and in production (remember we're concerned with price too!). Our considerable experience gained in the computing industry made the design problems relatively easy to overcome. But marrying them to mass-production was something quite new. Again we were fortunate in having vast experience in mass producing complex items for other areas of the electronics industry.

Any old glass? The Mullard delay line is made of glass and works on an electromechanical principle.

The glass is specially compounded to ensure consistent behaviour propagation velocities and good stability with changes in temperature. The blocks are cast to ensure complete uniformity and an absence of any internal stressing. One end is ground with two optically flat faces which are at a slight angle to each other and to which two transducers are connected. The electrical television colour signal enters one transducer and is converted into vibrations. These vibrations travel through the glass until they are reflected back from the end face to the second transducer. This converts them back into an electrical signal. In this way we halve the size of the delay line and help save space within the set.

Ground away. The end of the glass block opposite the transducers is then ground away under automatic control until the response is exactly right. We have found that this construction—apart from saving space—greatly simplifies the problem of delay time adjustment to 63·943μS at 4·433619MHz.

Insertion loss. While the glass has some effect on the insertion loss, the major loss is in the transducer and the coupling to the glass. The transducers themselves have been developed from ceramics selected for their long term stability as well as good mechanical properties. We have further reduced insertion loss by developing a new metal deposition technique and adhesives which create an intimate bond. As a result the overall insertion loss is only about 13dB over the bandwidth 3·43 to 5·23MHz.

The final step is the assembly of the delay line on its mounting plate with the associated input and output coils before final testing and inspection.

Worth it? Right from the beginning we've had everything under our control. So we can be sure that the product will give consistent service. And that we're producing it at the best possible price.

Consistently achieving these two aims with all our products has helped us build our reputation. A reputation which stretches across the electronics industry. Before we embark on any new project we can draw on the insight and experience we have gained—sometimes from unusual areas. We can employ our resources to provide the technically excellent products our customers demand.

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components for consumer electronics

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Consumer Electronics Division
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CED 62

Wireless World

Our Friend and Enemy

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The arrival of a new year reminds us of a phenomenon which is widely used in electronics but also greatly misunderstood. *Time* is an essential part of all the eventgraphs in this journal which we call oscillograms or waveform diagrams. Without it they would all be vertical lines, differing only in length. It is a phenomenon which, because we confidently represent it as a spatial dimension (usually a straight horizontal line with the future on the right), we think we have fully understood. How typical of the intellectual arrogance of man that once he has locked up a phenomenon in a concept, once he has labelled and categorized it and drawn a picture of it, he considers that he has mentally disposed of it! Perhaps it is just as well we are arrogant. How else would electronics engineers have the nerve to tackle such formidable operations in the time domain as those required in the advanced television standards converter described in this issue? If they stopped to consider, for example, whether they are really measuring this quantity which they think they are measuring—having assumed it *is* a measurable quantity—they would not have the courage to continue.

Doubtless some eyebrows will be raised at the suggestion that time may not be measurable. But is it? Clocks, c.r.o. timebases, power alternators, atomic frequency standards are really only oscillators, working away on their own. They are self-maintaining repetitive devices, modelled by man on the natural mechanism by which he attempts to measure time, the rotation of the earth. In order to measure something it is usually necessary to apply the measuring instrument to the quantity to be measured—the ruler to the line drawn on paper, the voltmeter to the battery. It is difficult to see how a clock, whether mechanical or electronic, can be "applied to" or still less "connected to" time. It is just an enclosed system, sensitive to nothing but the internal parameters which govern its repetitive behaviour. The best it can be said to do is to set up a human definition of time. The only measurement we can really be sure a clock performs is to count and scale the oscillations it itself produces.

Another assumption which engineers can be forgiven for making is that time passes with a certain velocity—either it passes us or we are travelling along a time dimension laid out like a railway track. We assume that the velocity is constant and that the displacement of the point "now" relative to the time dimension is continuous and linear, like the electrical ramp function used in a c.r.o. timebase. But for all we know time may really be proceeding in an erratic manner, continually speeding up and slowing down. (Everyone's experience suggests that it may well do so!) If this were so, and our clocks are assumed to be independent mechanisms, it might be thought that the clock oscillations would show a corresponding erratic variation of frequency. On the other hand, since everything would be affected by this time behaviour, including our perception of the clock frequency, we would not be aware of any change in that frequency. To find out the truth of the matter one would, of course, need some external reference against which one could observe the behaviour of time—a fifth dimension if one considers time as being the fourth. . . . At which point we will not venture to say more except to wish our readers A Happy New Cycle!

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Watch Your Diode Measurements!

by 'Cathode Ray'

So you thought I was permanently earthed? No; just getting on with something else. And in the course of it I found that there still seems to be a lack of adequate warning about the possibilities of error in measuring voltages with the simple diode rectifier, two versions of which are shown in Fig. 1.

The books tell you that provided *CR* (in megohm-microfarads) is large enough compared with the time period (in seconds) of each cycle of the a.v. input, the average d.v. output (V_d) is very nearly equal to the peak value of the a.v. ($V_{a(peak)}$). That is because *C* charges up to the peak voltage through the diode *D*, and hasn't time to discharge noticeably before the next peak comes. A few of the books are sufficiently forthcoming to go on to tell you about the input impedance of this kind of rectifier. For (a), supposing the diode to be perfect, it is equal to $R/2$. Even fewer books tell you that for (b), which is the more likely one to be used, it is $R/3$, and at least one of them (failing to see that *R* is now continuously across V_a so draws a.c. as well as d.c.) lets you think that it too is $R/2$.

Apart from the mistake just mentioned, this is all right so far as it goes. The trouble is that it doesn't go nearly far enough, even for basic requirements. And a search in the I.E.E. Library for necessary information on the subject in books dealing with electrical measurements drew a complete blank. I am not counting "Radio & Electronic Laboratory Handbook" by M. G. Scroggie, because he writes what I tell him. (If there are any others that escaped my search will the authors please let me know so that I can give them due credit.) The said Scroggie wrote about it at great length in the *Wireless World* issues of March 1952 and June and July 1954, and mathematically in *Wireless Engineer* of February 1955, but as some of you may then have hardly been out of the playpen I am moved to deal with the subject now, at much less length.

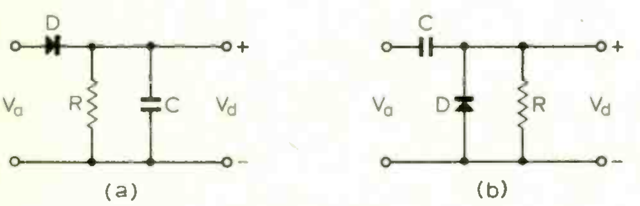

Fig. 1. Two forms of the single-diode peak rectifier. Type (a) cannot be used if the source of V_a includes a d.v. component or a series capacitor, so (b) is more often adopted.

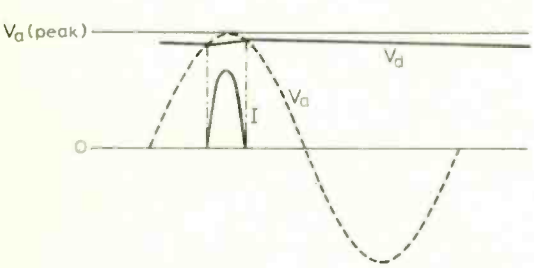

Fig. 2. Input and output voltages and input current for the Fig. 1(a) circuit.

There are two ways in which either of these rectifier circuits can be used for measuring alternating voltages. One is simply to connect a microammeter in series with resistor *R*. Then, if *R* is the resistance of this resistor in megohms, each microamp signifies *R* volts of V_d, and so (approximately) of $V_{a(peak)}$. If the instrument is to disturb the voltage being measured any less than your ordinary voltmeter does, *R* must be large and the microammeter consequently a low-reading and therefore expensive and fragile one. The other method is to use a stable type of amplifier to energize a more robust meter.

If *R* is very large, you are liable to run into trouble with diode reverse current (leakage); remember, the diode is assumed to be perfect, which means alternately zero and infinite resistance. So 1MΩ is likely to be on the high side (it rules out all germanium diodes, for a start). However, for the sake of argument let us suppose it is attainable. Does it give you the impression that it will ensure a very high input resistance compared with your metal-rectifier voltmeter?

We already know that to find the effective input resistance (call it *R'*) we must divide our 1MΩ by at least 2. And unless we are to be confined to measurements between points that are conductively connected—no series capacitors—and have no bias voltages, we must use Fig. 1(b), which means dividing by 3. And because that variety has the full a.v. across *R*, in practice one must filter it out to some extent. That further reduces *R'*, as we shall see later. So if we allow for this, and a bit more for the imperfectness of the diode, *R'* is unlikely to be much above 200kΩ.

That still seems quite a lot compared with an ordinary low-reading a.v. meter, which at best is likely to be only one or two kilohms per volt. But what does it mean?

This is where we have to look more closely at the way the diode peak voltmeter works. Variety *a* is perhaps a little easier to study, though the principle is essentially the same for both. During the first positive half-cycle, *D* conducts and *C* is charged nearly to the peak input voltage. *C* and *R* have both been made large enough to hold nearly all this charge until the next positive peak arrives to make up any loss. Fig. 2 shows how a.v., d.v. and current vary during each cycle. The larger the product *CR*, the less *C* discharges and the nearer the average V_d is to $V_{a(peak)}$. If you wonder why people don't leave *R* out altogether in order to make the output *exactly* equal to the peak input and the instrument resistance infinite, the answer is that the backward resistance of the diode is more or less in parallel with *R* (via the source of V_a) so would have to be infinite too; and, if it *were* infinite, *C* could never discharge, so the meter could only be used to measure voltages higher than the last one!

The point to notice in Fig. 2 is that the more nearly V_d comes up

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to $V_{a(peak)}$ the shorter the time available for charging and the sharper the pulse of current that has to be supplied by the voltage being measured. So the meter, which (if R in Fig. 1(a) is 1MΩ) has an effective resistance R' of 0·5MΩ, is not at all like a 0·5-MΩ resistor. Most of the time it is (except for diode leakage) an infinite resistance, but during the remainder of the cycle its resistance is quite low; in fact, if the impedance of C can be neglected, it is only the *forward* resistance of the diode. This has two very undesirable results when measuring the voltage of a high-impedance source—which presumably is what an "electronic" voltmeter is expected to do better than other types. The heavy current load at the input voltage peak cuts that peak and causes a corresponding error in the reading. And the waveform is distorted, so even if the diode meter were being used only to show relative audio level it would have a disastrous effect on fidelity.

On the other hand, if it was used to measure the voltage across a resonant circuit it really would behave towards it like a resistor of value R', because such a circuit stores enough energy to meet a fluctuating load, just like the oscillating flywheel in a watch or clock.

If you get an electronic voltmeter beginning with a diode, the input resistance specified by its maker will probably be R', which is valid only for tuned circuits. It is quite misleading for measurements on resistive circuits. For a 1% source-resistance error, a Fig. 1(a) diode voltmeter with R even as high as 1MΩ is actually worse, on ranges above 30V, than an ordinary 1,000Ω/V a.c. voltmeter!

As the cited articles show, this error can be calculated from one thing—the ratio between the source resistance and R. Conveniently, it is the same for both of the circuits in Fig. 1, in spite of the fact that type (b) has a lower input resistance and consequently has the larger error when measuring across a *resonant* circuit. The aforementioned calculation assumes that the diode has zero forward resistance. But if instead of source resistance in the ratio we use a resistance r, the calculated error holds good for r meaning either source resistance *or* diode forward resistance. Better still, provided that the ratio is less than 1/10 (as it must be if the error is to be less than about 37%!) r can be taken as source resistance *plus* diode forward resistance, $r_s + r_d$, as shown in Fig. 3. "Error" is the percentage by which V_d is less than $E_{(peak)}$, the voltage being measured; to be precise, $100(E_{(peak)} - V_d)/E_{(peak)}$.

Fig. 4(a) is a curve of error against r/R, and (b) is an enlargement of the top part to show small errors more clearly. These curves apply, with gratifying exactness, to both calculated and measured results, so can be accepted with confidence, the more so as no one has shot them down since they were displayed in 1954.

As an example of their use, let us suppose R is 1MΩ and we want to know the highest resistance a source of voltage can have to cause an error not more than 1%. Against 1% in (b) we see r/R is 0·0003. So the r in question is only 300Ω. The diode forward resistance alone may well be as much as that, in which case nothing is left for source resistance.

Two comments can be made on that, one depressing, the other encouraging. The first is that as the voltage drop in the diode is reduced its resistance increases. So the more we try to reduce this error the more we increase its cause. (The "bottom-bend" distortion of the scale at very low readings is due to this.) The second is that we are reckoning error by comparison with an ideal diode having zero r_d. In other words, our "error" is the difference between $E_{(peak)}$ and V_d, which includes the difference shown in Fig. 2 between $V_{a(peak)}$ and V_d. The 1% error in the above example (assuming $r_d = 300Ω$) is wholly of the latter kind, internal, and can be allowed for in the calibration. More, by artificially increasing r_d and allowing for the resulting drop in meter deflection in the calibration, we can make the instrument less sensitive to external or source resistance, r_s.

Fig. 5 shows the extent of this. In our example the allowable source resistance for 1% error compared with the ideal (gross error) was, as we have seen, zero. By absorbing this 1% in the calibration, we make 2% the relevant point in Fig. 4(b), from which we get $r/R = 0·0009$, or $r = 900Ω$. Of this, 300Ω is the diode, so 600Ω is allowable as source resistance for a net error of 1%. This corresponds to $r_d/R = 0·0003$ in Fig. 5, giving 0·0006 for r_s/R, as above.

Suppose now we put 1,700Ω in series with the diode, to bring r_d/R up to 0·002. That allows r_s/R to be 0·001, or $r_s = 1,000Ω$. An incidental advantage is that r_d, being now mostly in the form of a resistor, is more precisely known than the diode forward resistance itself, which varies greatly during the conduction phase. We could of course increase the allowable r_s for 1% error (or reduce the error for a given r_s) by augmenting r_d more, but Fig. 5 shows that the amount needed goes up drastically for even a limited benefit, and the meter deflection for a given voltage is thereby reduced. Worse still, stray capacitances become much more effective in reducing the highest frequency at which accurate measurements can be made.

There is of course also an error at the low-frequency end if the reactance of $C(=1/2\pi fC)$ is not small compared with R. A slight consolation is that when this error is serious the instrument is less affected by source resistance.

I mentioned earlier that the source-resistance error (but not the

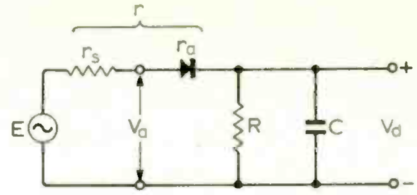

Fig. 3. Showing the Fig. 1(a) rectifier circuit applied to the voltage E to be measured, in series with its equivalent source resistance, r_s. r_d is the resistance of the diode during its conducting phase.

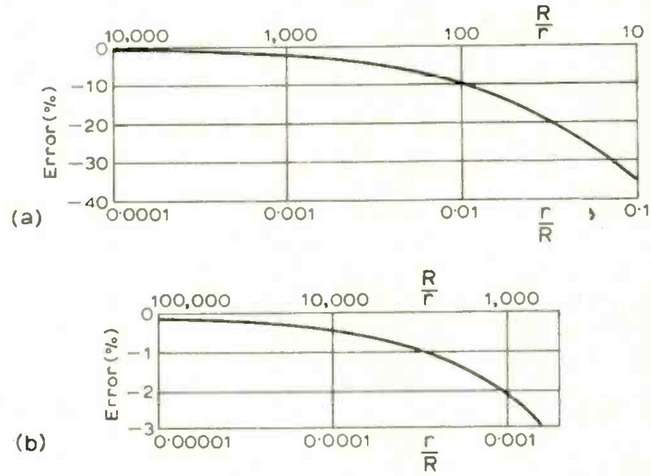

Fig. 4. Percentage by which V_d is less than $E_{(peak)}$ as a function of the ratio r/R. Graph (b) shows the low-error range more clearly. r is nearly or exactly $r_s + r_d$.

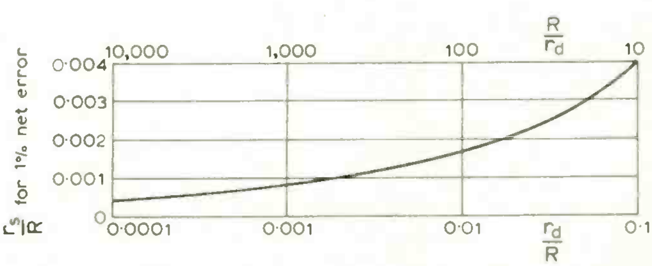

Fig. 5. Ratio r_s/R sufficient to cause 1% net (or true source-resistance) error, as a function of r_d/R.

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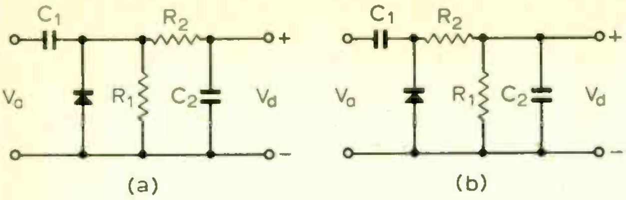

Fig. 6. The Fig. 1(b) rectifier has V_a as well as V_d in its output, so additional components are included for filtering, as in these two simple examples.

equivalent input resistance to resonant circuits, R') for the Fig. 1(b) circuit is practically the same as for (a). And, earlier still, that in practice (b) needs some kind of filter to reduce the a.v. component in the output. Fig. 6(a) and (b) are two such circuits. Note that in (b) R_1 and R_2 act as a potential divider, reducing the d.v. output. These circuits are assumed to work into substantially infinite impedance—a m.o.s.f.e.t., perhaps. Even for these circuits the r error is practically the same as before, up to about 10%, if R is taken as R_1 in Fig. 6(a) and as $R_1 + R_2$ in (b), and R_1/R_2 in either is not large. To complete the story, here is a table of R', approximately. It is useful when working with energy-storing circuits.

Circuit	R'
Fig. 1(a)	$\frac{R}{2}$
Fig. 1(b)	$\frac{R}{3}$
Fig. 6(a)	$\frac{R_1R_2}{R_1 + 3R_2}$
Fig. 6(b)	$\frac{(R_1 + R_2)R_2}{R_1 + 3R_2}$

For assumptions and derivations, see the *Wireless Engineer* paper cited.

The whole of the foregoing article can perhaps be put with devastating clarity and brevity into the statement that the single-diode peak voltmeter is not a very good one. So next month we take a look at a two-diode circuit.

Books Received

Systematic Electronic Fault Diagnosis by T. H. Wingate is an intriguing book. It is a programmed course of instruction in fault finding to be applied to electronic equipment in general. The examples used in the programme are mainly to do with the superhet receiver in valve and transistor forms. However, these examples are only used to illustrate the programme and fault diagnosis on any electronic equipment is claimed to improve by the use of this programme. The minimum knowledge required for entry to the programme is that of the operation of a superhet receiver. Experience with multimeters, oscilloscopes and signal generators is an advantage to the student, and so is a knowledge of the theory of measurements. The text is scrambled so the reading sequence is not the printed sequence. Numbered frames of information and questions lead, by the answers given, to other numbered frames. If you make a mistake you are told so and referred back to the frame containing the original question. The direct teaching sections of the book have the headings—symptom analysis, equipment inspection, signal injection and signal tracking, voltage and resistance measurements, repair and replacement, and performance checks. Then follow three valve problems, a section on transistor techniques, and three transistor problems. Sectional tests are given, and a short but succinct reading list precedes a revision flow chart and valve and transistor superhet receiver circuits. Frames 383. Price 17s 6d. Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London W.C.2.

Transistorized Amateur Radio Projects, by Charles Caringella, W6NJV, is a thoroughly practical book of twenty do-it-yourself circuits. Many of the projects are accompanied by suggested printed circuit board layouts, for which there are thin-paper negatives included at the back of the book. These negatives can be cut out and used directly in etching a printed-circuit board. The projects vary in complexity but are grouped according to function—converters, transmitters, power supplies, test equipment, and accessories. Complete circuit descriptions are given in every case, along with full constructional details, photographs and complete parts lists. Cheap silicon planar transistors are used extensively in the projects, which include an electronic c.w. keyer, a code practice oscillator, a transistor tester, a field strength meter, a speech compressor, low and high-powered regulated power supplies, an 80- and a 40-metre novice c.w. transmitter, 2- and 6-metre voice transmitters, and low noise 2-, 6-, 10-, 15- and 20-metre converters. Pp. 128. Price 25s. W. Foulsham & Co. Ltd., Slough, Bucks, England.

Radio, by David Gibson, is a teach yourself book suitable for any intelligent child from about 9 years onwards. Absolutely no knowledge of electricity or electronics is assumed in the reader, the essential physics being lucidly covered in the first chapter on radio components. The real purpose of the book is as a guide to the construction of three types of receiver—crystal set, t.r.f., and a four-transistor superhet—and a two-transistor amplifier. The layout of components is lavishly illustrated with excellent colour photographs. (For attractive presentation the book could hardly be bettered.) The book ends with a recommendation on aerials, and a brief but interesting introduction to short-wave listening. Pp. 87 (plus a single page index); price 12s 6d. Brockhampton Press Ltd., Salisbury Road, Leicester, LE1 7QS.

Low-Noise Microwave Amplifiers, by H. N. Daglish, J. G. Armstrong, J. C. Walling and C. A. P. Foxell, is a review of the various types of low-noise microwave amplifiers available. The importance of such amplifiers lies in their use as low-noise microwave receivers, which, as the authors note in the introduction, could have been an alternative title for the book. After an introduction discussing the problem of noise and its various natural sources, seven chapters are devoted to discussing the categories of low-noise amplifiers for microwave frequencies. The chapter titles are: travelling-wave tubes; other low-noise electron-beam devices; solid-state masers; varactor-diode parametric amplifiers; microwave-mixer and detector diodes; tunnel-diode amplifiers; and microwave low-noise transistor amplifiers. There are nine pages of references and a concise index. Pp. 167. Price 45s. The book is published, in association with the I.E.E., by Cambridge University Press, Bentley House, 200 Euston Road, London N.W.1.

Colour Television: A Background to Colour Tube Adjustments for the Service Engineer, by a Mullard publication. It is divided into two parts. Part 1 gives a short account of a shadowmask colour picture tube, an explanation of colour purity and convergence, and description of what factors govern picture quality. Part 2 gives simple step-by-step setting-up procedure. The picture tube and controlling assemblies are well illustrated by figures and circuit diagrams. Colour plates and diagrams show the effects of the various controls. Pp. 48. Price 17s 6d plus postage and packing from Mullard Ltd., Distributor Sales Division, Mullard House, Torrington Place, London W.C.1.

The Promise of Space, by Arthur C. Clarke. The author, well-known for his science fiction writing, relates man's achievements in space over the past 20 years to what he sees as the possibilities in space technology in the 1970s and beyond. The book is essentially concerned with space craft, their orbits and means of propulsion, but inevitably communication and telemetry techniques are discussed. It was, of course, Arthur Clarke in his article "Extra-terrestrial relays" in the October 1945 issue of *Wireless World* who first outlined the principles of synchronous communication satellites—an idea which he put forward in a letter published in *W.W.* the previous February. Pp. 345. Price 70s. Hodder and Stoughton Ltd., Warwick Lane, London E.C.4.

Covering, as it does, the years 1918-1939 Vol. 2 of Leslie Baily's **B.B.C. Scrapbooks** inevitably includes many references to the beginning of broadcasting and television. John Logie Baird's advertisement appealing for "someone who will assist (not financially) in making working model" for "seeing by wireless", which appeared in the personal column of *The Times* is reproduced. In the section "Television Begins" Baily, who was at the time wireless correspondent of the *Yorkshire Evening News* writes "it is astonishing to know that his [Baird's] knowledge of radio techniques . . . was so limited that he went to . . . *The Wireless World* for help over the design of amplifiers." Pp. 208. Price 60s. George Allen & Unwin Ltd., Park Lane, Hemel Hempstead, Herts.

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Electronic Speech Recognition

A two-part article on the phonemic elements of speech and circuit techniques employed in their identification. This month: basic principles

by W. D. Gilmour, B.A., M.I.E.E.

The automatic recognition of a spoken language (in this article English only is considered) can serve many obvious or not so obvious purposes. Thus commands could be spoken into a computer, or mechanisms controlled by voice inputs. Telephone numbers could also be requested verbally from a suitably equipped exchange. However, all existing recognising machines are not completely accurate, the best giving overall accuracies of not more than 90-95%, so that some form of storage of the whole message is required before it is entered into the controlled machine itself. The ultimate usefulness of the method in practical applications will thus depend on the characteristics of the system as a whole. As a simple example, 'voice dialling' of telephone calls in a simple step-by-step Strowger system would not be economic, because of the requirement for storage of the whole number for verification before transmission; however, with a computer-controlled exchange, the additional storage could easily be provided, and the elimination of the errors due to incorrect dialling, combined with the elimination of the dial and its associated apparatus, could prove economically viable, especially since some form of central processor, which could serve all lines on a time-sharing basis, would be already available.

At present some use of the automatic recognition of spoken digits is being attempted for tasks such as the sorting of parcels and stocktaking, where it is convenient for the operator's hands to be free for other tasks, but it is believed that no more complicated applications are yet in use.

The remainder of Part 1 of this article will deal with the basic characteristics of speech. Part 2 will describe the types of circuit which form the basis of practical special purpose recognition machines and will consider how these basic circuits can be built up into a complete mechanism.

Speech recognition is, of course, one specialised form of pattern recognition, and a general purpose pattern recognising automation could recognise speech.[1] On the other hand the variability of the input is greater than in many other pattern recognising applications, in that nominally identical utterances spoken by different speakers, or by the same speaker at a different time, are widely different; but conversely the total number of patterns to be distinguished is seldom more than about fifty, and the time sequence of the components of these patterns is invariant for any master pattern. For reasons such as these, there is still a considerable future for special purpose apparatus in this field at least as a pre-coder for a more generalised piece of equipment, and the use of general purpose pattern recognition equipment will not be considered further in this article.

The basic characteristics of speech

Full descriptions of the production and characteristics of speech are available.[2,3] In this article abnormal forms of speech, such as whispering and singing will not be considered, and the basic speech forming mechanism can be considered to be the set of resonant cavities formed in the nose and mouth by suitable placing of the tongue, teeth and other articulators. These cavities are excited by a pressure wave periodically released by the opening of the vocal chords in voiced utterances, or for unvoiced utterances by a white noise source formed by a constriction in the system.

In men the chopping frequency set by the vocal chords generally lies between 100 and 150 Hz, and for women at about double this frequency range. Phoneticians discriminate definitely between voiced and unvoiced utterances, but in reality the discrimination is often not at all well marked, and either the characteristic changes during the utterance or else the white noise and vocal chord contributions to the driving waveform are approximately of equal energy. In broad outline the method of forming speech sounds is shown in Figure 1, which shows the state of affairs for a voiced continuing sound. The vocal chords produce a line spectrum as shown in (a). The resonant cavities have a transfer function as shown in (b), thus giving the combined output (c). The concentration of energy at the resonant frequencies of the cavities leads to the concept of formants and formant frequencies. Formants are defined as the peaks of acoustic energy created as described above. It is found experimentally that most voiced utterances have three formants: the first in the range 200-750 Hz; the second between 750 and 2200 Hz; and the third generally above 2200 Hz. In unvoiced utterances the first formant is generally seldom observed, but well marked second and third formants can be seen in spectrograms.[4] One such spectrogram is to be seen on the front cover of this issue.

It is convenient to split speech sounds into phonemes, which may be defined as the shortest segments of a language, which, if substituted one for another, convert one word into another. Many workers doubt the validity of the concept of phonemes, at any rate as far as machine analysis is concerned, finding less differentiation between some nominally distinct phonemes than between nominally identical phonemes spoken in different contexts or by different voices. To some extent this criticism is valid, but by a judicious use of differing parameters it becomes possible to differentiate many phonemes, which may not necessarily be those used by phoneticians, under most contectual restraints and for the majority of voices. In doing so, the large amount of decoding necessary if the alternative syllabic approach is adopted is avoided.

As an example of these effects the words 'kill' and 'col', which in the simplest phonetic notation differ in the vowel only, can be considered. If these words are spoken it will be found that the positions of the articulators for both the 'k' and the 'l' sounds will differ considerably, and these differences show up instrumentally. On the other hand both 'k's will have the same lag from the initial release of pressure to the start of the subsequent voicing, and for all voices this pause will be very much longer than that for a 'p', with which 'k' could be confused on the basis of a simple frequency analysis. At the other end of the frequency scale for 'k', allowing for the effects of context, confusion could occur with 't', but here separation could be achieved by the higher energy content and longer pause for 'k'.

Similarly, the terminal 'l', which might instrumentally be confused with the final sound of the diphthong 'ou', can be separated therefrom by a higher second formant frequency.

Thus, by using all the available clues: energy, frequency analysis, and timing, it is possible to draw up a set of descriptors capable of separating most phonemes, or at least of grouping them into larger groups, from which unambiguous words can be formed.

Voices vary from each other, quite apart from differences due to dialect, in a number of ways:

In amplitude. However, a given speaker under quiet ambient conditions tends to hold his level to within ± 6 dB for quite long periods. Shouting can increase the level by 20 dB or more.

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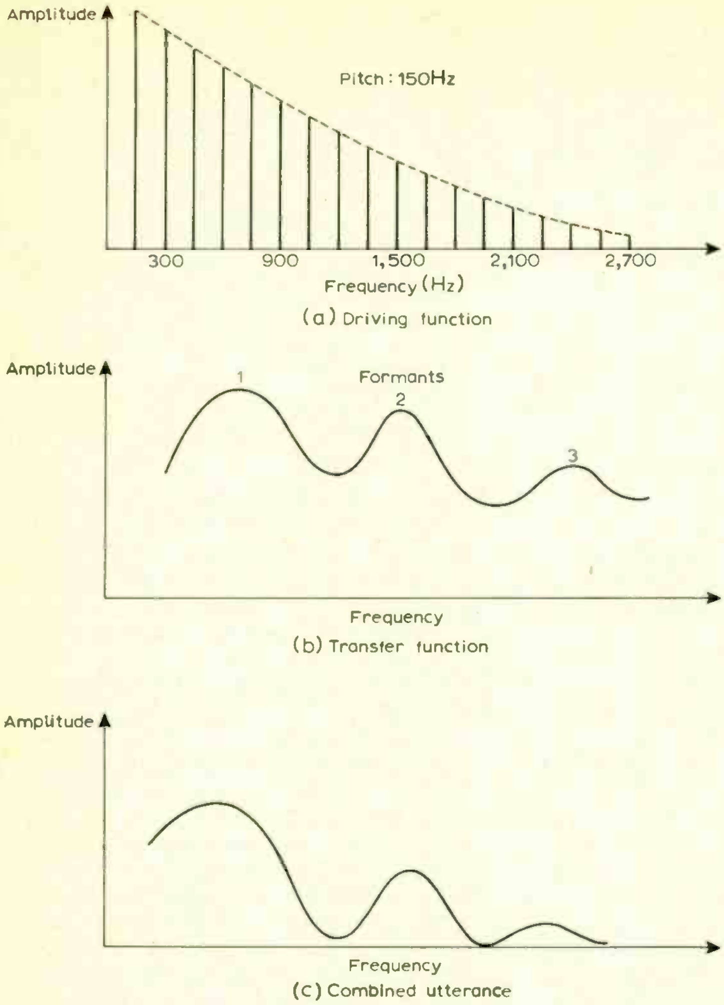

Fig. 1. General formation of a voiced utterance.

In resonance. As shown in Fig. 1, the peaks in the driving spectrum do not necessarily coincide with the formant resonance, but if they do the formant will naturally be enhanced. Some speakers tend to adjust their pitch to obtain this effect, others do not. In addition some speakers seem to have abnormally low and others abnormally high damping of their cavities.

In speed and manner of talking. Speed can be controlled to a certain extent in experimental work by using a metronome, but it is much more difficult for a speaker to regularize his division of time on the different syllables within a word. Some vowels, such as 'oo' (zoo) are naturally stretched, whereas others such as 'a' (bat) are naturally cut short. Some speakers accentuate such differences, others minimize them, and a machine cannot be expected to receive much help from any attempt to standardize these features.

In the proportion of high frequency energy present. Some speakers produce very high amplitudes of high frequency components on fricative sounds, even to the extent of almost whistling their 'f's and 's's. A simple machine would class such speakers as 'abnormal' and refuse to respond to their utterances. A more complex machine could invoke the statistical features of speech to insert suitable audio weighting circuits to obtain a statistically normal specimen of speech from the abnormal input.

In testing any mechanical recognition system, therefore, a large number of voices should be used. However, a single voice shows considerable variation from day to day, and if a satisfactory performance can be obtained on one voice over a protracted period of testing, it is to be expected that the performance on other voices might be adequate. On the other hand, as a machine learns its master's voice, so does the master learn the best way to present phonemes to the machine, subconsciously aiding it by his diction, so that the only final valid test is to present a number of untrained voices to the machine. Because of the day-to-day variability of voices, the use of recorded material is to be deprecated, unless each sample is used for a few runs only. It is also illuminating to watch the machine make mistakes, which are seldom likely to be identical on nominally identical samples.

It is well known that speech remains intelligible to man when it is severely distorted in amplitude. Thus the intelligibility of 100% clipped speech is only slightly degraded. The effect of phase distortion on speech is also slight, but not entirely negligible as simple experiments with a tape recorder running backwards will confirm.

On the other hand it is known that intelligibility suffers at once if the frequency content is distorted, particularly if harmonic relationships are upset. Thus speech doubled overall in frequency (e.g. the 'Chipmunks') is barely intelligible, although smaller shifts can be tolerated. However, a single sideband signal with a misplaced carrier becomes unintelligible if the error in the carrier frequency is no more than a few tens of hertz. Similar problems occur with divers breathing a helium/oxygen mixture. It thus appears, *prima facie*, that the frequency content of speech is its most important characteristic for human intelligibility. Further experiments using low and high pass filters show that much of the information content is contained in the second and third formants.

In man, the mechanism by which sound energy is applied to the inner ear is straightforward, but much less is known about the processing of the energy within the inner ear and in the brain. The cochlea is believed to act as a lossy transmission line[5], so that high frequencies are attenuated close to the input (the stapes), whereas lower frequencies can propagate further inwards. Receptor organs are provided down the whole length of the cochlea, and it can be shown that relatively simple groupings of the outputs from these organs will enable local maxima and minima in the frequency-time pattern; positive and negative slopes; and local transitions in any of these quantities to be determined locally before the composite signal is applied to the brain[6].

A machine of feasible complexity is unlikely to possess man's great adaptability to differing voices, dialects, and speeds and manners of talking. Nearly all machines so far built are much better at recognising their master's voice than the voices of strangers. In addition no speaker fails to elide certain phonemes and in connected speech the gaps between words are often very difficult to observe, and are nearly always less pronounced than pauses before unvoiced stops such as 'K'. At present therefore all machines attempting to identify phonemes rather than, say, words, require that the speech input should be spoken slowly and clearly, with interword gaps accentuated.

Phonetic alphabets are necessary in speech work because there are some 40 basic phonemes in spoken English. Any degree of phonetic complexity can be allowed for in an alphabet, but for non-specialists an alphabet with as many symbols as possible corresponding to normal English usage is preferable. Such an alphabet is the Initial Teaching Alphabet[7], now used in some primary schools, and the phonetic values of these symbols are given in Table 1.

Classification of phonemes

In this section the phonemes are classified by those features which have been found most reliable for machine recognition. These features may not be those used by the ear. Thus most voiced utterances are best classified for machine recognition by the period of the first formant, timed from the voicing instant; the ear, however, does not seem to make much use of this feature. The instrumentation of the measurements in a typical system will be described in Part 2 of this article, but to avoid repeating Table 1, codings which will be referred to later are given now. Briefly, the A coding refers to the period of the first formant, the B coding refers to the frequency of the second formant with B1 high, and the C coding similarly refers to the frequency of the third formant. G refers to the level of sound pressure, with G7 representing a high level and G0 silence.

The major groups of phonemes used will

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Table 1: The Initial Teaching Alphabet and coded values

Character	Example	Group	Codings A	B	C	G	Notes
a	cat	VC–V	1	1	–	7	
ɑ	art	VC–V	1	3	–	7	B3 held for 50 ms. min.
o	hot	VC–V	1	4	–	7	
u	hut	VC–V	1	3	–	7	
e	head	VC–V	2	1	–	7	
er	herd	VC–V	2	2	–	7	
au	for	VC–V	2	4	–	7	
i	hid	VC–V	3	1	–	7	
ω	hood	VC–V	3	4	–	7	
ee	heed	VC–V	5	–	2	5	some special coding
ω	zoo	VC–V	5	–	4	7	
ou	how	VC–D	1/3	–	–/4	7	
ie	hide	VC–D	1/3	–	–/2	7/–	
æ	hay	VC–D	2/3	2	–	7	
œ	hoe	VC–D	2/3	4	–/4	7	
oi	toy	VC–D	2/3	4/–	–/2	7	
ue	hue	VC–D	5	–	2/4	5/–	
uer	your	VC–R	5/2	–	–/3	–	
ωr	moor	VC–R	3/2	4/–	–/3	7	
ir	ear	VC–R	3/2	1/–	–/3	7	
aer	air	VC–R	2/1	1	–/3	7	
ier	tyre	VC–R	2/1	1/2	–/3	7	
our	our	VC–R	2/1	–	4/3	7	
r	roar	VC–L	3	1	3	5-7	special circuit
l	loll	VC–L	3Δ5	4	3	5-7	special circuit
w	wow	VC–L	5	4	4	5-7	special circuit
y	yell	VC–L	5	4	2	4-6	special circuit
n	none	VC–N	6	3	–	4-6	
m	mime	VC–N	6	2	–	4-6	
ŋ	sing	VC–N	6	–/1	–	4-6	
v	vine	VC–F	–	3	3	5-7	
th	then	VC–F	–	4	3	5-7	
z	rose	VC–F	–	4	1	5-7	
ʒ	measure	VC–F	–	1	2	5-7	
f	fife	UC–F	–	1	2	3	
th	thin	UC–F	–	2	2	1	
s	sin	UC–F	–	3	1	4	
ʃh	shin	UC–F	–	1	2	7	
b	bib	VS	–	4	4	5	stop timing 1
d	dead	VS	–	3	3	5	stop timing 2-3
g	gig	VS	–	4	4	6-7	stop timing 2-4
p	pip	US	–	4	4	3	stop timing 1-4
k	kick	US	–	3	3	6	stop timing 6-9
t	tit	US	–	1	3	3	stop timing 4-7
h	house	variable					special circuit

Legend: Δ = OR. – = immaterial. / separates start and finish values. – (between digits) = range.

now be defined and are also listed in Table 1.

Voiced continuants (VC). Phonemes in this group can be uttered in isolation and the utterance sustained indefinitely, or for diphthongs sustained indefinitely at any point. The first subdivision is the *pure vowel* group (VC-V), which are uttered with a relatively unrestricted vocal tract, and therefore have high energy and a well defined harmonic structure and a relatively lightly damped output waveform.

Diphthongs (VC-D) consist of a combination of two or more vowel-like elements with a relatively slow and smooth transition between them. As such in normal phonetic terminology they consist of two or more phonemes, but if this approach is adopted on a machine great difficulty is found in specifying the boundaries, which are very dependent on context and speed of talking. (Thus in extreme cases 'ou' could end as 'ω', although in normal diction it ends 'ω'.) Consequently for machine identification it is better to treat diphthongs as entities.

Vowel compounds with -r (VC-R) form a large group in spoken English and are best treated as diphthongs. The final sound is far from invariant, but it is always produced with the vocal tract somewhat obstructed, so that energy falls at the end of the utterance.

Liquids or glides (VC-L) are a difficult group to place. They can occur in any context and are approached by a relatively slow transition from the preceding phoneme to a position of the articulators rather more dependent on context than is the case for other groups. The vocal tract is more or less constricted, causing some diminution in energy, and in extreme cases a fricative-like quality to the utterance. Glides can occur between vowels, and it is important to distinguish between glides and diphthongs. For these reasons special circuits are often needed to select this group.

Nasals (VC-N) are produced by blanking off the oral cavity and opening wide the velum, so that most acoustic energy is radiated from the nostrils. With a conventional microphone considerably less energy is received from nasals than from voiced continuants with the oral cavity unobstructed.

Voiced fricatives (VC-F) are produced by forming a constriction in the oral cavity and thus adding high frequency random noise to the voiced sound. It is interesting to note that the peak amplitude often occurs half way between voicing instants with this group. The energy radiated and the amount of high frequency energy present vary very greatly from speaker to speaker and with context, so that the weaker members of this group ('v' and 'th') are among the most difficult phonemes to detect.

Unvoiced continuants (UC). Phonemes in this group can also be uttered in isolation and the utterance sustained indefinitely. However, the vocal chords are not used and the acoustic output is thus noise-like in character. High frequency energy predominates. It should be noted that 'f', 'th', 's', and 'ʃh' are the unvoiced equivalents of 'v', 'th', 'z', and 'ʒ', respectively, although it is difficult to make much use of this fact.

Stops (S). To form a stop, air pressure, from a voiced or unvoiced source, is allowed to build up behind an obstruction in the oral cavity and is then suddenly released. There is thus a period of silence whilst the pressure is building up, followed by a burst of high frequency energy whilst the opening is still constricted. The acoustic energy pattern resulting from these actions depends very much on context, but there are certain invariant characteristics relating the timing of the silent period and the high frequency content of the burst to the phonemic identification. Depending on whether the vocal chords are in use during the building up of pressure and during the subsequent release, stops may be divided into voiced (VS) or unvoiced (US) categories. The unvoiced stops 'p', 't', and 'k' are the equivalents of the voiced stops 'b', 'd', and 'g', respectively.

The aspirate 'h'. This phoneme is so very variable that its machine recognition is difficult. It can occur voiced or unvoiced, with energy distribution greatly affected by context. It also has to be differentiated from the normal wheezes and breath tones which occur in any speech from time to time.

Table 1 shows the phonemes arranged in their groups, but before describing how a simple apparatus can be made to perform separations of phonemes, a few general notes on technique may be useful.

The remarks made above on the inadvisability of using recorded materials should be noted.

To display waveforms in raw or processed forms a storage cathode ray oscillograph is invaluable, as many samples can be compared with such an instrument in a way that would not be economically possible by any other method. The instant availability of the record is also most useful. The Sonagraph type of instrument which displays a complete frequency spectrum of a 2s sample of speech has been found to be of limited value, partly because of the time taken to process the record, and partly because the resolution of the very important first formant region is low. A more fundamental objection is that the analysis is on a frequency basis instead of on a period basis, timed from the voicing transient. A very full record of typical spectrograms of phonemes, alone and in combination, is available[4]. A more useful instrument, although still working in frequency bands, is the Hewlett-Packard Noise Analyser, which has a reasonable resolution in the first formant region and an instantaneous display with freezing facilities.

The microphone used has to meet a number of conflicting requirements:

a) It must be capable of being used close to the lips in order to reduce the effects of ambient noise, yet,
b) It must be insensitive to breath tones.
c) It must be free from resonances.
d) It should have some directional properties, again to reduce outside interference.
e) It should be insensitive to the movement of the user, and should ideally move with his head, thus preserving a constant distance from lips to microphone.

It has been found that a good quality noise-cancelling magnetic microphone, carried on a head-mounted boom so that the active area of the microphone is opposite the point of the chin and separated therefrom by 4cm, proves satisfactory for most subjects. Every effort should be made to minimize all other sources of noise, including echoes of the speaker's voice, for speech recognition is difficult enough without producing a crop of spurious masking noises.

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The simple special purpose phonetic equipment to be described in Part 2 makes use of a combination of analogue and digital circuits. The analogue circuits consist of filters, amplitude selecting circuits, amplifiers with a.g.c., and various inhibiting circuits. Most of the analogue signals are then digitalised using course quantization. Frequency-to-voltage converters are also used.

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Full-screen TV Standards Converter

Changes American to European standards without reducing picture size and allows output to be locked to local sources

by R. E. Davies, M.A.*

Owing to the fact that different television standards have been adopted by various countries, exchanges of programme between them require the use of television standards conversion, unless the exchanges are carried out by means of cine film. Early forms of standards converter[1,2] relied upon the image-transfer principle, in which the picture to be converted is displayed on a suitable cathode-ray tube and is viewed by a camera working on the required standards; this method inevitably introduces significant picture impairments due to the characteristics of the cathode-ray tube and camera-tube used. With the advent of BBC-2 operating on 625-lines, it became necessary to develop a fully satisfactory method of converting signals generated on this system to the 405-line standard. All-electronic "line-store" converters[3], which rely upon identical input and output field frequencies, were evolved and are in wide use today. With the increasing use of video tape recording and communication satellites, the exchange of programmes between countries using the 50 fields-per-second and 60 fields-per-second standards have become an almost daily occurrence; in the past these exchanges have relied upon converters exploiting the image-transfer principle. However, more and more countries are transmitting in colour and a pressing need for high-quality colour conversion has arisen. Image-transfer conversion for colour poses severe problems and, although some success has been recently achieved[4] using such methods, it was considered essential that an all-electronic converter, suitable for exchanges in colour and effecting the necessary change of field frequency, should be developed. In 1964 development of two such all-electronic converters was started in the B.B.C. The converters required sufficient storage to hold one field of a television signal and came to be known as "field-store" converters. The proposals were based on the use of ultrasonic quartz-delays as the storage media since these seemed to offer the best chance of success in a reasonable time.

The first all-electronic converter[5] was completed in 1967 and, on account of its relative simplicity, has two disadvantages. Firstly the size of the converted picture is reduced, and secondly, the output field frequency is rigidly locked to the input field frequency in a 5 to 6 ratio. The European and American colour field frequencies are respectively 50 Hz (exactly) and 59.94005 Hz, with relatively tight tolerances, and thus converted "live" signals are non-standard.

The second, more advanced, converter[6,7] was completed recently. It does not suffer from the above disadvantages and, moreover, has the useful facility that the signal can be locked to local sources, allowing mixing, fading and like processes to be carried out with local signals.

The first major use of the B.B.C. advanced converter was for live coverage in Europe of the Mexico City Olympic Games. The signals were generated on the 525-line standard and were transmitted by satellite to Goonhilly and thence by landline to London. After conversion the 625-line signals were distributed both in the U.K. and to other countries via the Eurovision and O.I.R.T. links; a total of nine broadcasting organizations transmitted the pictures in colour and a further nineteen transmitted them in black-and-white.

Fig. 1. Relative positions of lines on a screen at the 525-line and 625-line standards.

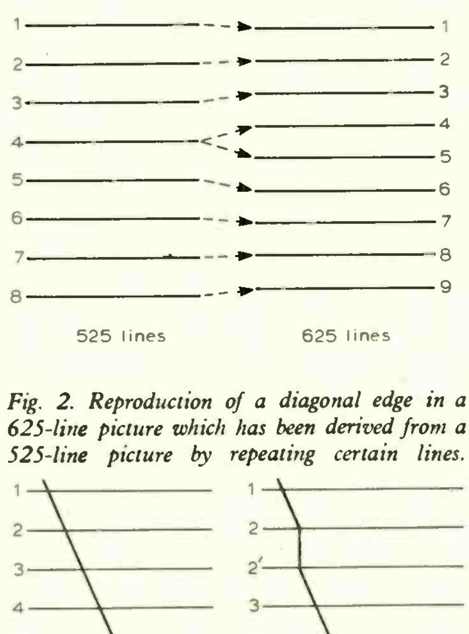
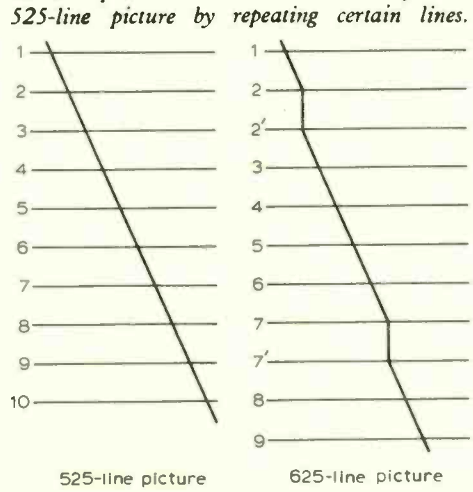


Fig. 2. Reproduction of a diagonal edge in a 625-line picture which has been derived from a 525-line picture by repeating certain lines.



Principles of the Advanced Converter

A televised scene is described by means of discrete fields which are analogous to the frames of a cine film and show the successive positions of moving objects at regular intervals of time. Each field is divided into a number of discrete lines, each describing the brightness (and colour) of a narrow horizontal strip of the scene. In all modern television systems the interlace principle is used in which the lines interlace with each other on two successive fields. Half of the lines form field number 1 and all odd-numbered fields thereafter, while the other half form field number 2 and even fields thereafter. Two successive fields form a complete picture. The U.K. standard contains 625-lines per picture (i.e. per two fields) and the field frequency is 50 per second. The American standard contains 525-lines per picture at 60 fields per second.

The converter takes an input signal at the American standard and converts it to the U.K. standard by electronic processing. The conversion consists essentially of two processes. Firstly, the input line signals are used to construct, by interpolation† between them, a set of output line signals; secondly, these signals are subsequently each delayed by an appropriate amount so that they occur at the correct times relative to a train of synchronizing pulses at the output standard.

Fig. 1 shows the relative positions of lines at the two standards on a screen, with the vertical scale considerably expanded. The left-hand set of lines at the 525-line standard are more widely spaced than those on the right at the 625-line standard. The simplest way of producing 625 lines given a set of 525 would be to choose the nearest one in each case. For example, in Fig. 1 lines No. 1, 2 and 3 on the left can be used for lines No. 1, 2 and 3 on the right, line No. 4 on the left must be used for both lines No. 4 and 5 on the right; and lines No. 5, 6, 7 and 8 on the left can be used for lines No. 6, 7, 8 and 9 on the right. Thus some sequences of input 525 lines can be used directly as output lines, but approximately once every five lines an input line must be repeated. A

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† Interpolation means the process by which a new intermediate signal value may be derived from two existing values.

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complete output field of $312\frac{1}{2}$ lines can be constructed by repeating just 50 lines of an input field of $262\frac{1}{2}$ lines.

The effect of repeating lines is illustrated in Fig. 2 which shows the appearance of a diagonal edge in the picture. At the 525 standard shown on the left, the edge is straight but if lines are repeated (here lines 2 and 7) to form a 625-line picture the edge takes on a serrated appearance as shown on the right of Fig. 2. This problem was encountered in the development of line-store converters between the 625- and 405-line standards and was overcome by interpolating between successive lines, Each output line is synthesized as a mixture of the video signals of two input lines in a ratio depending on the relative positions of the input and output lines. Fig. 3, which corresponds with Fig. 1, illustrates this process and shows a possible set of interpolation ratios which could be used. (These ratios are the fractions marked on the diagram.) Line signals are not now repeated but it should be noted that output lines Nos. 1' and 2' are both generated from both input lines Nos. 1 and 2 and will appear simultaneously. As before 50 extra lines will be produced for each complete field.

To display the output lines sequentially, delay must be introduced into the signal path each time an extra line is generated. If the line durations on the two standards were identical, a delay unit equal to a line would be suitable. However, the actual line durations are approximately 63.5 μs for the 525-line standard and 64.0 μs for the 625-line standard and the actual delay unit is chosen to make the output field of the correct duration. Since 50 extra lines are added to each field, 50 extra delay units are introduced and the delay unit must be one fiftieth of the difference between the field durations. In practice the value of the delay unit is 66.3 μs approximately. While this choice of unit will result in correct output field duration, the timing of output lines will be in error by at most a few microseconds due to the difference in line durations between the standards.

The increase of delay in the store for one field is about $3\frac{1}{3}$ms. The following fields can be treated similarly so that a further $3\frac{1}{3}$ms of delay must be introduced for each one. The process of increasing delay cannot continue indefinitely; however, after five input fields the delay has increased by $5 \times 3\frac{1}{3}$ms, i.e. $16\frac{2}{3}$ms which is equal to the input field duration. A complete field is now stored in the delay units and it is possible to omit the next input field. The following input field can be used to form the next output field if the delay is returned to zero and there will be no interruption in the output signal. Fig. 4 shows a sequence of input fields and the derived sequence of output fields. Input fields Nos. 1 to 5 form output fields Nos. 1 to 5.

Input field No. 6 is omitted and output field No. 6 is formed from input field No. 7. In the long term the increase in the number of lines is balanced by the decrease in the number of fields and there is no overall accumulation of delay.

The omission of fields causes disturbances to the portrayal of movement in the television picture. A moving object in the scene

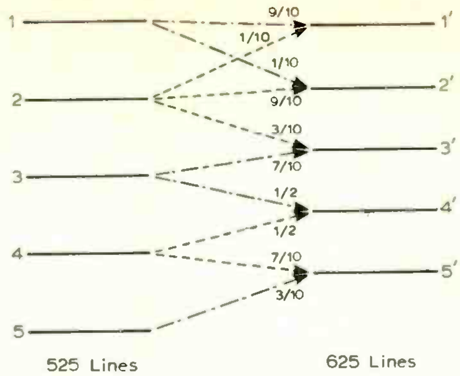

Fig. 3. Synthesis of 625 standard lines by interpolation between 525 standard lines. For example, output line 1' is formed by adding nine-tenths of the amplitude of input line 1 to one-tenth of the amplitude of input line 2.

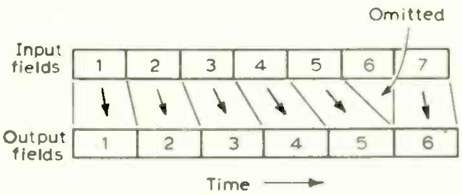

Fig. 4. Sequence of input fields and the output fields derived from them.

appears to move smoothly for five fields but "jerks" to an unexpected position in the sixth field. This results in a "judder" at the frequency of field omission, namely 10Hz. To reduce this effect a process of interpolation between successive fields is employed in the same way as interpolating between successive lines was used to improve the portrayal of diagonal edges.

Practical Conversion System

Fig. 5 is an outline block diagram of the conversion system. The synchronising pulses associated with the input 525-line signal are fed from the sync-pulse separator to a logic unit which supplies waveforms to control the actions of the interpolator and the delay store.

The interpolator contains a line delay‡ and a field delay‡ so that adjacent lines of a complete input picture can be made available simultaneously. These are mixed in appropriate ratios to form line signals suitable for the output standard.

On account of the difficulty of maintaining accurate matching between different signal paths, frequency modulation of a carrier is used for transmission through the delays and signal mixing is carried out by averaging the modulation frequencies. Mixing is limited to the proportions $\frac{1}{4}$, $\frac{3}{4}$ and $\frac{1}{2}$, $\frac{1}{2}$. Two signal connections to the delay store are necessary to accommodate the extra lines.

The delay store consists of a number of ultrasonic delay units and it is arranged by means of switches that the signal can traverse each delay and bypass it. The delay durations are approximately in binary progression and the action is illustrated in Fig. 6.

Fig. 6(a) shows the arrangement of the first three stages of a delay store. The delay durations are binary multiples of a unit, T, and the switches have two alternative states, also shown in the figure. Fig. 6(b) shows the switches in the "all-up" position so that signals entering the store at terminal A will traverse the store with no delay. If now an extra line signal is transmitted from terminal B, coincident with a line at A, it will traverse the $1T$ delay and emerge immediately following the line which entered at A. By changing switch 2 to the "down" position at this time, one line may be made to emerge from the store following the other. The new path for signals requiring $1T$ delay is shown in Fig. 6(c). The next extra line can now enter the store at A and traverse the $2T$ delay, thereby arriving at switch 3 in time to be fitted into the sequence. Fig. 7 is a more complex diagram showing the increase of delay from 0 up to $3T$ units. It can be shown that the process can continue with an indefinite number of binary delays. When the maximum delay is reached the path which traverses all the delays is in use (i.e. entering at B in Fig. 6(b)) and it should be noted that the other path is also set up in which there is no delay in circuit. This path can be used immediately after a field is omitted when the delay returns to zero.

Following the delay store (see Fig. 5) timing errors due to differences between the line durations of the 525 and 625 standards and to imperfections in the delay store are removed in the timing corrector. In practice, since the input and output standards are not locked together in a fixed ratio, it is necessary to have a capacity rather greater than a line duration to accommodate slow changes in the relative phase of the two standards. A device similar to the line-store converter is used. The signal conversion is now complete and there remains only the addition of output standard synchronising pulses in the final processing unit.

‡ Ultrasonic quartz delay units are used as the storage medium in the converter. An acoustic wave is propagated through the quartz, crystal transducers attached to the quartz being used to generate the acoustic signal and recover the electrical signal. The quartz is usually in the form of a thin plate with many reflecting faces. Delays between about 16 μs and 4ms are obtainable with adequate response for television purposes.

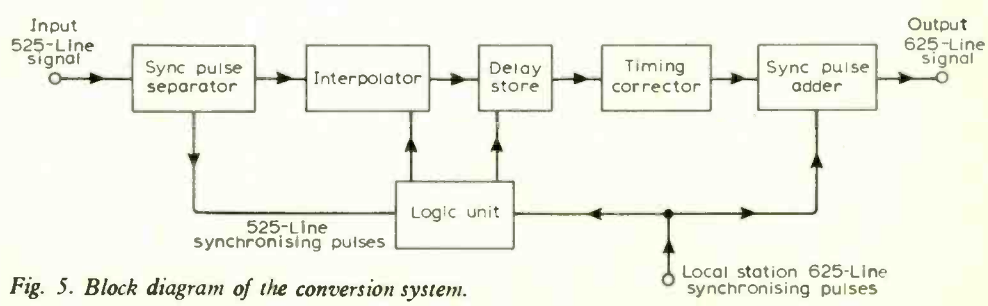

Fig. 5. Block diagram of the conversion system.

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Although, in principle, an electronic converter with sufficient bandwidth can handle colour signals equally as well as monochrome, certain difficulties arise in connection with the coding system. The incoming American N.T.S.C. signal is first transcoded[9] to an intermediate colour system which is similar to N.T.S.C. but uses a higher subcarrier frequency. After conversion, the signal is transcoded again to the PAL system as required for the 625-line standard.

Future Developments

The advanced converter can accept both line and video tape recorded programme generated on the American standard and can handle both colour and monochrome signals. It is intended shortly to produce a converter working from the European 625-line standard to the American 525-line standard. Similar techniques will be used.

The use of a converter working on these principles to synchronise colour signals from remote sources on the same nominal scanning standards has also been suggested.[10] It is operationally advantageous in a broadcasting system to have all signal sources synchronised together to allow mixing and cutting between them. A solution[11] to this problem is already available but can be used only in certain circumstances.

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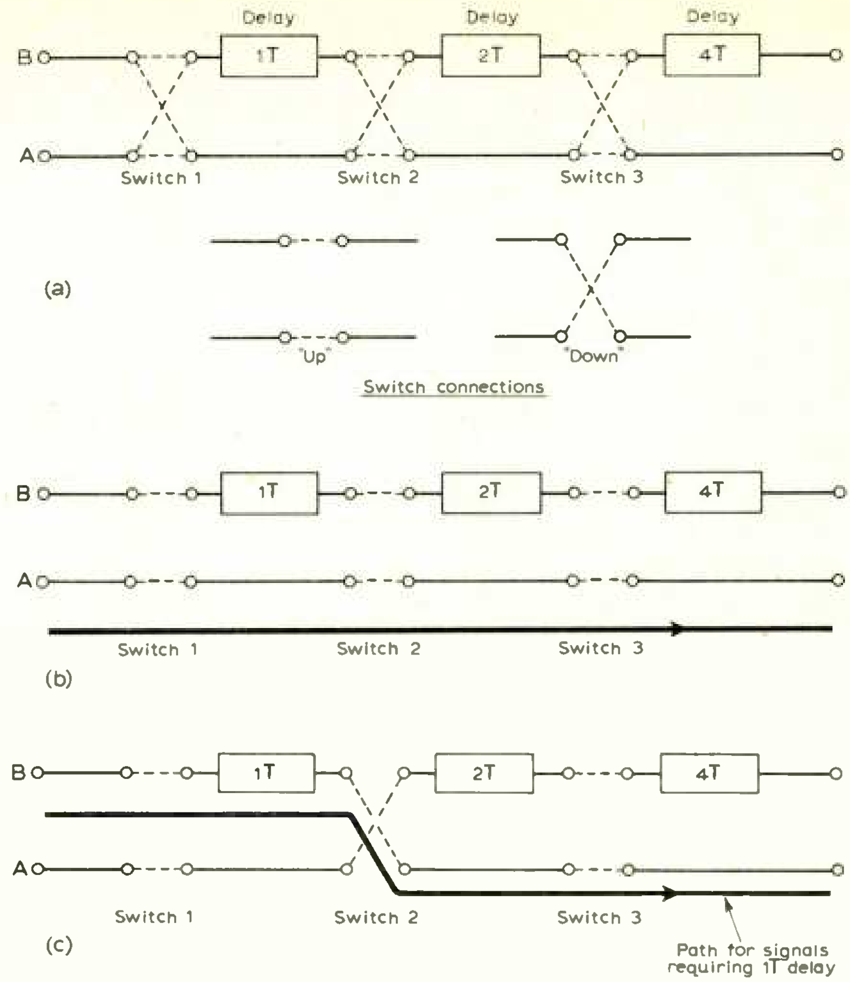
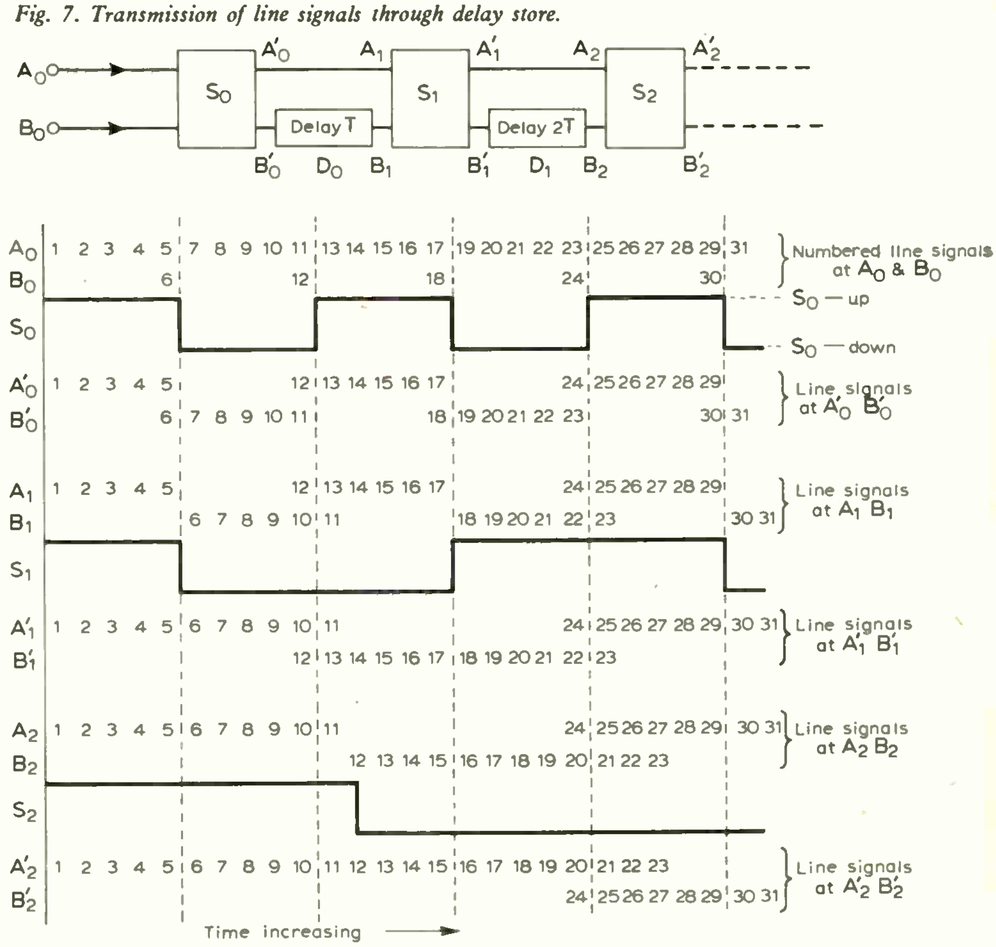


Fig. 6. The delay store: (a) first three stages of the store; (b) "all up" connections; the heavy line shows the zero delay path; (c) switch 2 "down" for selection of 1T delay.

Fig. 7. Transmission of line signals through delay store.



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News of the Month

Old thinking, new methods and television

The video telephone known as the Picturephone developed by the Bell Telephone Laboratories of America may, in future, employ a bandwidth reducing principle that was devised as long ago as 1929 when the Nipkow disc was still the order of the day.

The bandwidth required for any signal is proportional to the amount of information that the signal has to contain. In a television signal, especially in video telephone applications, the same information is transmitted frame after frame with only minor variations; lip or eye movement for instance. The bandwidth reducing principle, which would allow three Picturephones to share a line intended for only one, requires that the only information transmitted is the difference between the current frame and the previous one.

The television signal from the camera is translated into streams of pulses using the p.c.m. technique invented by an Englishman, Alec Reeves. A complete television field is stored in a delay line store and the next frame is compared with it. If there are any significant differences the difference information only is transmitted and the store is updated. The technique of transmitting the difference information only and using it to update a stored frame has been called "conditional replenishment" by Bell Labs (sounds a bit like a tea break!).

A video-telephone picture showing the areas of significant change in one-sixtieth of a second.

The television picture information employs an eight-bit p.c.m. code and a 7-bit code is used for the position of difference signals.

The principle of transmitting television frame difference signals was described in an article "Saving Television Bandwidth" which appeared in the April 1953 issue of *Wireless World* and details of the Picturephone were given in the February 1968 issue.

Thick-film domestic electronic equipment

The advantages of using thick-film circuits in domestic electronic equipment has been clearly demonstrated by the AEG-Telefunken Banjo Automatic 101 a.m./f.m. radio receiver. This receiver incorporates a thick-film tuner, i.f. amplifier and audio amplifier (not the output stage) as separate modules. The receiver was released for sale in Germany in the autumn of 1967 and during the first six months not one module was returned for service. Since then returns, said to be barely recordable, have amounted to only a very small fraction of one per cent.

It is usual, after designing a circuit for thick-film production, to build it first in discrete component form so that all "bugs can be ironed out". The circuit is then drawn in a form compatible with thick-film techniques.

In a typical manufacturing process the conductor pattern would first be screen printed and then fired at 760 to 1000°C on an alumina ceramic substrate. The firing fuses the conductor pattern into the substrate. A resistor pattern is then overprinted and fired on to the substrate and the values of the resistors are adjusted by sand-blasting part of the composition away. Capacitors are layed down by depositing first the bottom electrode and firing and then printing on a dielectric layer which is allowed to dry before depositing and firing the top electrode. Conductor cross-overs can be made by printing an insulating glaze on a fired conductor and depositing another conductor on top. Finally, lead-out wires, transistors and large capacitors are added as discrete components and the whole assembly is tested before encapsulation in a suitable protective coating. All the chemicals used by Telefunken were produced by Dupont. Telefunken are at present designing thick-film modules for television and record player applications.

University-industry scheme bears fruit

In 1966 Professor Heginbotham of the Department of Production Engineering and Production Management at Nottingham University presented his ideas on automatic assembly methods for production lines. As a result of the interest aroused a consortium of five interested firms was formed, who contributed £500 each. In return each firm received a basic "pick and place" machine. This machine lifts a component and positions it in its allotted place reader for fixing. The long-term hope was that firms would ask the department to develop the basic prototype into a machine more suited to their particular needs. For this, the firms would supply the necessary finance.

The plan is working well and detailed discussions are in progress with a number of firms. The first product to emerge from the scheme will be a machine for electron gun

The automatic assembly machine developed at Nottingham University for use in Mullard's picture tube plant at Simonstone. The machine assembles part of the electron gun.

assembly that will be used at the Simonstone plant of Mullard Ltd. The machine forms the grid 3 assembly by placing together three components and making eight welds.

GaAs diodes for microwave applications

Nippon Telegraph and Telephone Public Corp. and Hitachi Ltd, both in Japan, have developed a series of gallium arsenide diodes for microwave communications.

The efficiency of microwave diodes is determined in part by electron mobility. The time it takes for electrons to travel through the crystal of the diode base is critical because it limits frequency response. The maximum electron velocity is greater in gallium arsenide than in the commonly used germanium. However, unwanted impurities in the crystal have so far limited practical use of GaAs devices.

A Hitachi-NTT team has solved this problem through development of a special purifying process which increases electron mobility in the gallium arsenide crystals to a

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figure which is close to the theoretical limit.

In practical microwave relay experiments a GaAs Gunn diode was used as an oscillator, replacing the conventional klystron. During 8,500 hours of continuous operation, the GaAs device achieved outputs of 150mW at 13GHz and 250mW at 10GHz, as a result of the low transit time characteristics of the purified crystal.

The high electron mobility lowered the noise of the Gunn diode, both in frequency and amplitude. The Gunn diode also outperformed the klystron in thermal characteristics.

In all, two types of diode have been produced and successfully tested under the joint research programme. These are bond-type for frequency multiplication and mixing, and diffusion-type for frequency multiplication.

European Physical Society

The European Physical Society came into being on September 26th, 1968, in Geneva. Its inaugural conference will take place in Florence from the 8th to 12th of April. One of the sessions, which will be of particular interest to *Wireless World* readers, is on quantum electronics and optics.

Anyone wishing to attend the conference should write for an application form to the Secretariat, European Physical Society, P.O. Box 1227 Carouge, Geneva, Switzerland.

Antarctic survey employs satellite navigation

Equipment is to be fitted to the vessel *Shackleton* to enable it to employ the navigation satellite system on its latest exploratory mission. The object of the trip, which is organized by the British Antarctic Survey, will be to investigate the Scotia Ridge where normal optical navigation is very difficult because of persistent cloud cover.

The equipment will consist of a Magnavox satellite navigation system operating in conjunction with a Hewlett-Packard computer. The ship's position will be read-out every two hours to an accuracy of about 100 yds. Using the system it will be possible to relate magnetic and seismic data from different voyages to each other and the sea bed.

The satellite navigation system to be fitted in the Shackleton.

The new communications centre recently commissioned by the Parts and Accessories Department at Vauxhall Motors, Dunstable headquarters. The object of the centre is to speed up the supply of spare parts to the trade. The centre has the largest telephone answering system in the U.K., a teleprinter terminal and a computer visual display installation. Roughly 2,500 orders for spare parts, from a 58,000 item stock inventory, are processed each day.

Omega coverage extended

The coverage of the Omega radio navigation system is to be extended to cover all parts of the world before the end of 1972. The four transmitters in operation at the present time allow accurate position fixing to be carried out (within one mile) in the north Atlantic and in the eastern section of the north Pacific.

The additions to the system, as announced by the American Defense Department on October 22nd, will consist of another four transmitters sited to cover the western Pacific, the Tasman sea, the Indian Ocean and the southern tip of South America. Rather than seek permission to erect and operate American stations on the territory of other countries, the intention is to enlist the countries concerned in a joint operation to the advantage of navigators of all nations.

During the past year American representatives have discussed the question of siting the transmitters with officials from countries in which the stations might be located. These overtures have been met with a "general enthusiasm" for the joint venture scheme.

The first U.K. merchant ships to install an Omega receiver are the *Manchester Challenge* and the new Cunard liner *Queen Elizabeth 2*. These receivers are manufactured by the Northrop Corporation of America and marketed in the U.K by Marconi Marine.

A replacement for the t.w.t.?

Germanium avalanche diodes have converted direct current to both pulsed and c.w. power at room temperature with an efficiency of 43% at the American Bell Telephone Laboratories. This represents more than three times the maximum efficiency obtained with the earlier Impatt (for impact avalanche transit-time) mode of operation first reported by Bell Labs in early 1965. When operating in the new mode, the germanium diodes produced 5.3W of c.w. power at 450MHz, and 7.5W of pulsed power at 3GHz.

The new mode of operation resembles the Impatt mode during part of a cycle, but long delays due to "trapped" carriers occur during the rest of the cycle. Therefore the new mode has been named Trapatt, for TRApped Plasma Avalanche Triggered Transit.

Last year scientists at R.C.A. had obtained high efficiencies from pulsed silicon avalanche diodes at u.h.f. (from 500 to 1000MHz). These results were explained by saying that microscopic filaments were formed within the diodes. Because the enormous current densities that would occur in a filament would almost certainly preclude continuous operation, which is essential for most communications applications, only limited importance was attributed to the early results. The recent work established an alternative mechanism for high efficiency operation and in addition revealed natural phenomena which suppress filament formation in diodes operating in the Trapatt mode.

High efficiencies were observed at Bell Laboratories early in 1968 during studies of a wide variety of Impatt diodes. The formation of new modes of oscillation in these diodes depended critically on the external circuit conditions.

Therefore, several computer programmes were developed to simulate the new modes of oscillation. Precise measurements of experimental circuit and diode parameters provided the input data for these simulations. Computer-generated displays were then made to show how certain interdependent physical and electrical parameters within the diode vary as a function of time.

Essentially, it was discovered that the high efficiencies were the result of an alternate cycling of the diode between a zero-voltage, high current state (the "trapped plasma"), and an Impatt period, which is a high-voltage, low current state. The output frequency of a Trapatt diode is at most one half that of a corresponding Impatt diode.

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In addition to explaining the high efficiencies exhibited by a diode in the Trapatt mode, the analysis of the computer output also suggests that it may be possible to simulate on a computer a whole family of related microwave power generation modes, as yet unknown and unobserved.

For at least some applications, Bell Labs claim that avalanche diodes operating in the high-efficiency Trapatt mode may eventually replace the high-frequency travelling-wave tube, one of the last members of the electron tube family to be threatened by the continuing trend to solid-state devices.

The Trapatt mode was described in two letters to the *Proceedings of the I.E.E.E.*, September issue.

New cable links to the Continent

A £3M contract has been awarded to Submarine Cables Ltd, of the GEC-AEI group, by the Post Office. The contract is for three submarine cable systems to be installed between the U.K. and Germany, the U.K. and Belgium and the U.K. and the Netherlands.

The cable systems, which employ transistor repeaters and have a design life-time of 25 years, use 21 supergroups in each direction providing 1,260 telephone circuits at 4kHz intervals. Where local conditions render it prudent the cables will be armoured.

New display contract for Heathrow

Recommendations are being drawn up by the British Airports Authority's consultants Electronic Facilities Design Ltd on new display equipment for Heathrow airport.

The new equipment will be needed because of the impending introduction of the Boeing 747, America's "Jumbo Jet", in 1970. The seating capacity of the new aircraft is 490, meaning that during peak periods baggage and passenger reception facilities will have to handle 5,000 arrivals per hour.

To cope with this flow comprehensive display and information equipments will be required. Various electronic and mechanical keyboard-operated displays are being evaluated for the system.

It will be interesting to see if the "wired in" display systems will win the day over the more expensive, but more flexible, software controlled displays.

Lidar applied

The diversity of the work carried out at the Ministry of Technology's Warren Springs Laboratory at Stevenage, Herts, can be assessed in a recently published annual report (H.M.S.O., price 9s 6d). The Laboratory's committee says that six firms have derived a new annual turnover of over £1M after spending only £15,000 on sponsored research at the laboratory.

The laboratory has purchased a Lidar system (Laser Radar—see "News of the Month" September 1968, p.307) to study the mechanics of smog production. Work on pollution of the atmosphere has shown that the importance of carbon monoxide as a pollutant may have been over-emphasised in the past and further work is going on to confirm this.

The twelve one-week courses on computer control of chemical and process plant held by the laboratory were well attended and the possibility of holding more is being discussed with a number of firms.

Methods of handling powdered and granular materials, of increasing importance in these days of thick film circuits, is also being studied.

Single-tube colour camera

A single-tube colour television camera has been produced by R.C.A. that will be available in this country shortly at about half the cost of a conventional colour television camera. The operating principle is quite straightforward. Light from the scene to be televized passes through a striped filter before impinging on the target of a vidicon

Various display systems being demonstrated to the British Airport Authority at Heathrow. The large display at the centre of the picture is an Eidophor.

The single-tube colour television camera from R.C.A.

tube. The filter is divided into 250 vertical strips, alternate strips passing only red or only blue light.

The target is scanned in the normal way. However, in scanning, the electronic circuitry takes into account the fact that known sections of the target correspond to the blue component and other sections to the red component of the scene being televized. The signals corresponding to red and blue can therefore be reconstituted and by normal matrixing methods the green signal can also be formed.

The camera will be available initially with an N.T.S.C. output only. The camera weighs about 45kgs and is 25cm high, 12.5cm wide and 63cm long.

Military electronics in the '80s?

"Electronics; The Armor of the Eighties," was the theme of the address by Russel D. O'Neal, assistant secretary of the U.S. Army at the Army Concept 85 Symposium, jointly sponsored by the Electronic Industries Association and the Army's Combat Development Command in America.

Gazing into the crystal ball and attempting to foresee the use that will be made of electronics in the eighties, Mr. O'Neal said; "I think we derive a clue to one answer by examining two contemporary systems. The counter-mortar radar, in use on the battlefield today, detects and tracks mortar shells in flight in order to compute the position of the mortars from which they were fired. The Sentinel radar system detects and tracks ballistic missiles with such precision that defensive missiles can be launched and guided to intercept them."

He said that on the basis of these two systems, "one is entitled to make a speculative extrapolation. I suggest for your consideration small, fast-scanning, phased-array radars, perhaps aided by infrared and able to detect and track incoming bombs, artillery shells and mortar rounds. Then counterweapons will be speedily, automatically and precisely directed against the incoming munition and will destroy or disable it before it arrives

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within lethal radius of its target."

In addition to the detection, location and guidance aspects of electronics, Mr. O'Neal noted that electronic warfare would probably take place in the form of computer-controlled jamming devices. "Even laser range finders will be attacked and disabled electronically," he said.

Integrated circuit logic systems design and practice

This is the title of a one-week course being held jointly by Mullard and the Northern Polytechnic in London. At the time of writing (late November) the first course has just been completed and according to the sponsors has been a great success. In all, seven courses are to be held at the rate of one each month for about twenty engineers.

The courses are intended for engineers as yet unfamiliar with the subject. The sessions are arranged to move progressively from an introduction to the theory of logic, to the use of integrated circuits in typical systems. A good deal of emphasis is being placed on practical work.

Interested readers should contact the Department of Electronic and Communications Engineering, Northern Polytechnic, Holloway Road, London N.7. The fee for the course, which includes all meals and hotel accommodation, is £26 16s 9d.

Weather radar ring completed

The last of the eight wind-finding and weather-watching radar units to be installed in Australia has been commissioned at Darwin airport, Northern Territory.

Known as the WF 44, the radar has been designed and manufactured by Plessey Radar Ltd, at a cost of $A180,000 a unit. The other units are at Brisbane, Queensland, Laverton, Victoria, Mt Gambier, South Australia, Port Hedland, W.A., Port Moresby, Territory of Papua-New Guinea, Sydney, N.S.W. and Woomera, S.A.

The radar has a dual role—it can be used to detect winds in the upper atmosphere for military, civil aviation, and general forecasting purposes, and to detect tropical cyclones and storms up to 150 miles away.

Meteorologists at Darwin will be able to provide airline pilots with up-to-the-minute forecasts and warnings of extreme weather conditions at take-off and landing, particularly during the wet seasons when turbulence and thunderstorm activity are at their maximum.

This fully-automatic equipment records signal generator frequency drift at the Fleetville Works of Marconi Instruments in St. Albans. Checks are carried out at two temperatures over a 15-hour period. The equipment was designed and assembled by the company's test gear maintenance section.

Diploma of measurement and control

The Institute of Measurement and Control has established its own diploma which is roughly equivalent to H.N.D. Accordingly an examination will be held in north and south England and in Scotland based on a syllabus designed by the Institute which has been used as a guide for many years in several schools and colleges.

The announcement was made by D.C. Nutting, president of the Institute, at the annual dinner of the Manchester section on November 14th. The diploma will have value in fields other than those of measurement and control, as Mr. Nutting said: "It may be called a diploma of a certain proficiency in automation, because automation depends entirely on control, which, in turn, cannot be exercised without measurement".

A further part two qualification specified by the Institute will allow the successful candidate to proceed to corporate membership. Details of part two will be announced by the Institute in the near future and will be comparable to a degree.

Martel contract

An order worth several million pounds sterling has been placed with The Marconi Company by the Ministry of Technology, for television guidance systems for the first production models of the Anglo-French *Martel* guided missile.

This order follows a successful series of firing trials in which the performance of the complete missile system was confirmed. The missile is now being evaluated by the Joint Services Technical Unit, based at Boscombe Down. The missile has been developed jointly by Marconi (guidance), Hawker Siddeley Dynamics and Engins Matra of France.

A small sensitive television camera, carried in the nose of the missile, provides a high-quality picture from which any type of target can be positively identified.

This "Missile-eye-view" is transmitted back to the launching aircraft, where the observer is able to follow the missile flight on a high-brightness television monitor.

A joystick control in the cockpit enables him to adjust the field of view of the camera, over a command radio link. Control signals are then generated within the missile itself to align the flight path with the axis of the television camera.

TV licence fees

The increase in the television licence fees announced by the Postmaster General on July 23rd come into effect on January 1st when the monochrome licence is increased from £5 to £6 and that for colour from £10 to £11. The sound radio licence remains £1 5s.

The Regulations laid before Parliament on November 19th also introduce a new licence for Old Persons' Homes. This will cover the use by residents of sets in their own rooms and the fee will be 1s per resident. Homes will be eligible for the new licences provided they meet the following conditions:

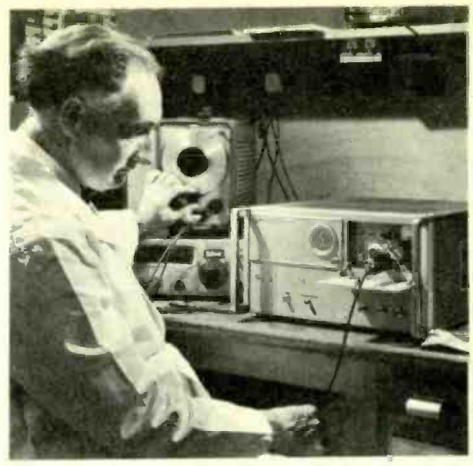
(a) the purpose of the Home is to provide accommodation for pensioners:

(b) they have some communal facilities for their residents:

(c) they are provided by a local authority, or registered with the local authority, or provided by a housing association in collaboration with the local authority.

The existing Old Persons' Homes Licence introduced on March 1st, covers the use by residents only of battery-operated sets. The new licence covers both mains- and battery-operated radio and television sets. The Postmaster General announced this extension on July 25th.

The concession applies only to sets privately owned by residents and used in their own rooms. Any communal sets will still need to be licensed at the standard fee.



Three atomic caesium beam clocks are to be employed at the Royal Greenwich Observatory at Herstmonceux. Two of the clocks have already been installed by Hewlett Packard.

British t.t.l. range receives C.N. approval

Ferranti Ltd. announces that C.N. (Common Network) approval has been granted by the design authority, the Royal Radar Establishment, Malvern, for t.t.l. integrated circuits in the Micronor 5 range. The qualification approval covers 32 plastic dual-in-line and flat-pack devices in the military series 5400E and 5400F, and in the industrial series 7400E and 7400F. This is the first occasion on which such approval has been granted for wholly British-designed, developed and produced t.t.l. integrated circuits.

Naval contract

The digital Systems Department of Ferranti Ltd., with Decca Radar Ltd. as a major subcontractor, has been awarded a contract worth over £1m to meet the Royal Navy's requirement for an automated operations room for frigates and similar ships. The system is known as Computer Assisted Action Information System (C.A.A.I.S.).

The equipment, based on a FM1600B computer, correlates information from sonar, radar and other electronic aids to target tracking and presents it in an easily assimilated form.

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Circuit Ideas

The first selection of readers' designs submitted in reply to our open invitation

A unity gain amplifier for very low frequency filters

Active lowpass filters require amplifiers having precise gain, low offset and low drift. A convenient system is to use amplifiers with full voltage feedback, that is, with precisely unity gain in a network such as that of Fig. 1 which has a second order Butterworth response. Where the cut-off frequency is 1 Hz or less the resistors R may well exceed a few megohms in value, calling for an amplifier with an f.e.t. input stage.

As the cheapest f.e.t. opamps are still around the £8 mark, the circuit of Fig. 2 is proposed for v.l.f. filters. Brief characteristics are as follows:

Open loop gain 50dB
Input current .... 10^{-11} amp
With full voltage feedback,
Output impedance .... 0.1 ohm
Input impedance .... 5 pF
Frequency response .... flat to 100kHz
Max. unloaded output swing ($\pm$9 volt supplies) .... 8V peak-to-peak
Supply tolerance .... $\pm$6V to $\pm$15V
Current consumption 6mA
Min. recommended load resistance ... 1kΩ
Approximate cost of materials is £1.8s.

N. BETT,
Cavendish Laboratory,
Cambridge.

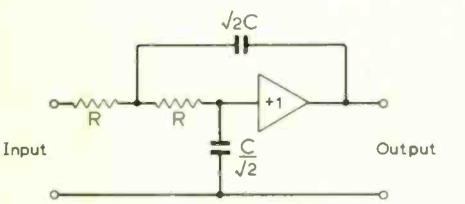
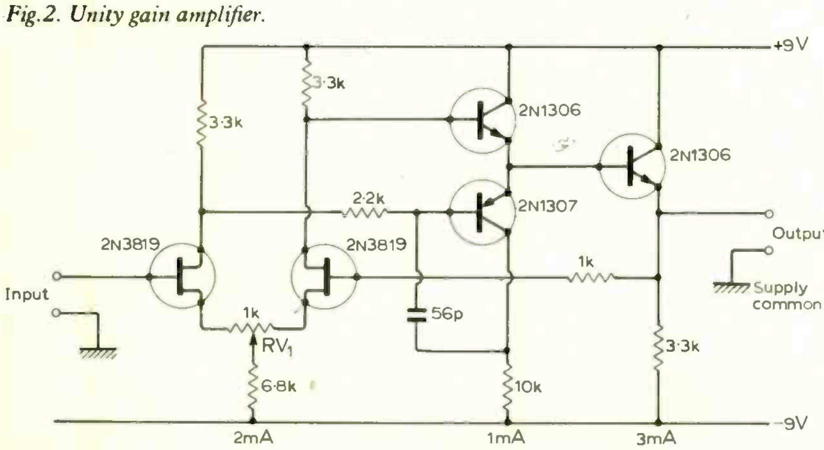


Fig.1. Active configuration for second order Butterworth response using a unity gain amplifier.

Fig.2. Unity gain amplifier.



Extra diode improves noise limiter

In view of the importance of good impulse-noise limiting in the reception of a.m. signals, particularly under v.h.f. mobile conditions, the following modification to the well-known self-adjusting shunt diode noise limiter may be of interest.

The conventional circuit using thermionic siodes is shown in Fig. 1 and is quite effective. When, however, the circuit is used with semiconductor diodes in a transistor i.f. amplifier of relatively low output voltage, the performance is found to deteriorate as the receiver input signal drops in amplitude, and this is because the 'knee' in the diode forward characteristic sets a limit to the lowest attainable clipping level.

The measured forward characteristics of several diodes are shown in Fig. 2 and it will be seen that the minimum clipping level attainable with a silicon junction diode is about 550mV and with a germanium gold-bonded device, about 250mV. In order, therefore, that the clipping level should be self-adjusting right down to the receiver noise level, the knee voltage must always be "backed-off".

As shown in Fig. 3, this result may be achieved by simply adding an extra diode D_2 to the conventional forward-biased detector circuit. The back-off diode should be of the same type as the shunt diode, D_3; however, if the supply voltage is stable and ambient temperature variations are small, D_2 may be replaced by an appropriate resistor with little loss in performance. Because of their relatively high slope resistance, the performance of point contact diodes is inferior to that of germanium gold bonded devices.

When the circuit of Fig. 3 was tested with a transistor receiver covering the 70MHz amateur band, excellent suppression of car ignition interference was observed, even in the absence of a received carrier and with a peak-to-peak receiver background noise output at D_3 anode of only 150mV.

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Chemistry Department,
Glasgow University

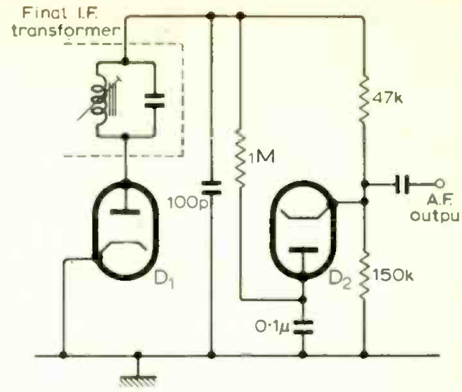


Fig.1. Conventional self-adjusting shunt diode noise limiter using thermionic diodes (see for example the A.R.R.L. Handbook).

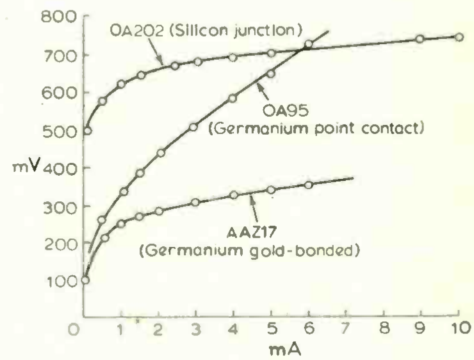
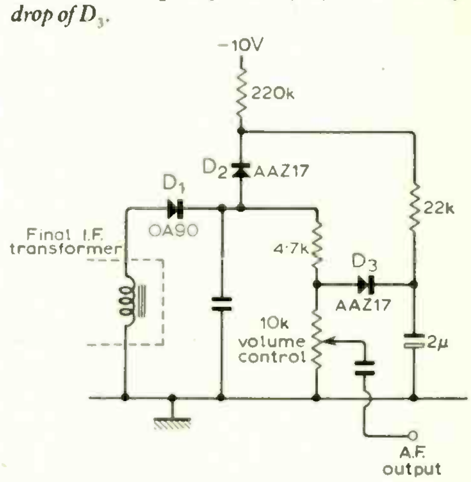


Fig.2. Forward characteristic of some semiconductor diodes.

Fig.3. Semiconductor version of shunt diode noise limiter; D_2 compensates for forward voltage drop of D_3.



High Performance Automatic Gain Control

Circuitry employing high level detection and amplified and delayed a.g.c., for improved linearity at small signal levels, and obtaining greater audio output

by L. Nelson-Jones, M.I.E.R.E.

With the exception of certain specialized communications equipment, the majority of a.m. receivers, and tuners have some form of a.g.c. system to allow for widely differing signal levels, and to combat fading. Some years ago when thermionic valves were the rule for all such receivers, the a.g.c. performance of all but the cheapest receivers was of quite a high order. However with the almost complete takeover by semiconductors, particularly in the consumer market, the performance of many a.g.c. systems seems to have taken a big step backwards.

The almost universal use of low level detection systems may be one of the reasons for this state of affairs. The low level detector performs well from the detection point of view, but in producing only a low level of d.c. output, does not lend itself well to the requirements of an a.g.c. system, or the inclusion of accurate a.g.c. delays.

High level detection

Some three years ago the author started developing a high level detection system which incorporated delayed, but not amplified, a.g.c. This first step in itself gave much improved results, and was incorporated in a very successful automobile broadcast receiver.

Fig. 1 shows the circuit used. The delay of the application of a.g.c. comes from the emitter potential of the controlled stages. The transistor Tr_2 being reverse biased until the emitter potential of Tr_1 exceeds that of the controlled stages. The high level detector is a conventional diode circuit, but instead of a resistor, the diode load is the input of an emitter follower, resulting in a high value of load resistance, and enabling the whole secondary winding of a typical double tuned i.f. transformer to be coupled to the detector. The result is a d.c. rectified output linear up to several volts at the emitter of Tr_1. The limit to linearity being set by overload of the last i.f. amplifier. The detector diode and emitter follower are forward biased by the small voltage developed across the 330 Ω resistor in order to further improve the linearity at small signal levels. The greater complexity of the high level detector is offset to a great extent by the much higher level of audio output obtained at the emitter of Tr_1, (typically 200–600 mV r.m.s. for 30% modulation).

Amplified a.g.c.

Further development of the high level detector has led to a circuit having a similar number of components, but giving amplified, and delayed a.g.c.—see Fig. 2.

The high level detector itself is very similar to that of Fig. 1, except that silicon devices are used, and the forward bias is derived from two forward biased diodes D_1 and D_2. Now however instead of using an emitter follower in the a.g.c. control system, a p-n-p transistor Tr_2 is connected in the collector circuit of the n-p-n emitter follower of the high level detector. This transistor is caused to conduct, producing a.g.c. current when the collector current of Tr_1 rises to a point where the voltage drop across the collector resistor R_1 exceeds the forward voltage required to cause Tr_2 to conduct, i.e. when $R_1 . I_{Tr_1} = V_{be}$. The emitter potential of Tr_1 will then have risen to a value of

$$\frac{V_{be} . R_2(1+\beta)}{R_1\beta},$$

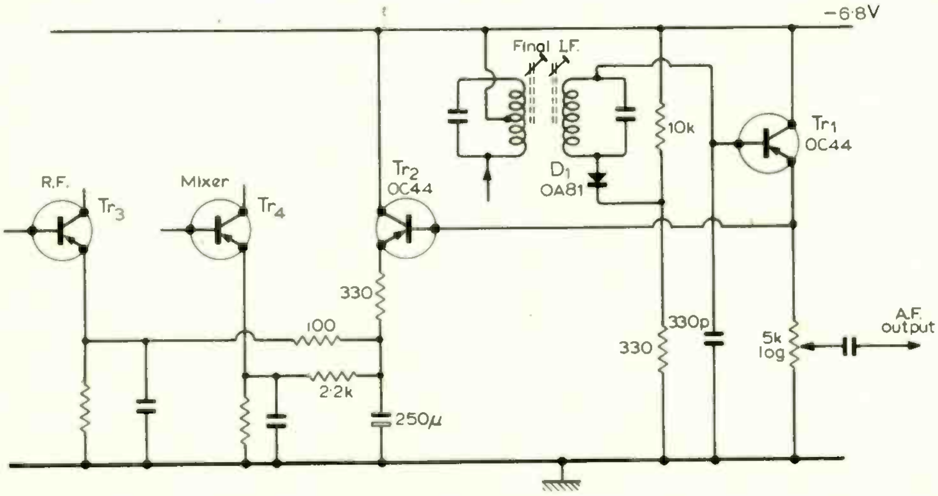
which for $\beta \gg 1$ approximates to

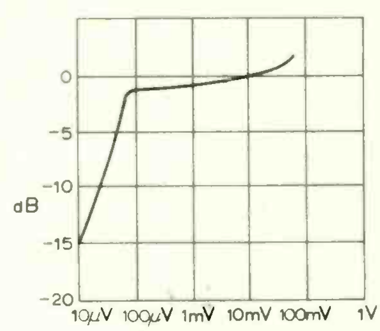
$$\frac{V_{be} . R_2}{R_1}.$$

An emitter voltage of +2 volts was decided upon, giving a value of $R_1 = 1{\cdot}5$ kΩ with a 5 kΩ emitter resistor (volume control potentiometer with log. track).

R_1 is bypassed by an electrolytic capacitor in order to eliminate the audio components of the collector current of Tr_1. The a.g.c.

Fig. 1. Tr_1 provides a high value of load for detector diode D_1 in the high level detector circuit. Tr_2 controls the current in Tr_3 and Tr_4, when the emitter of Tr_1 becomes more negative than the emitter of Tr_2.





Performance of complete receiver

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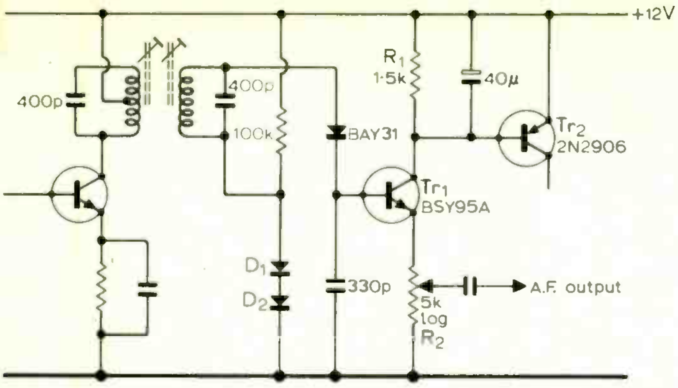

Fig. 2. Delayed a.g.c. current is provided by Tr_2 when the voltage drop in R_1 exceeds the forward bias of Tr_2.

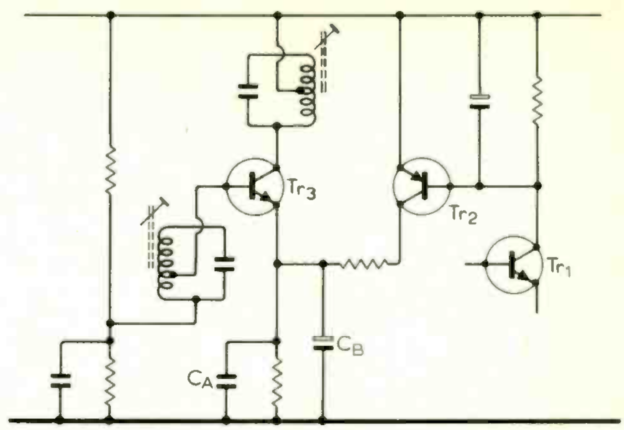

Fig. 3. The a.g.c. current from Tr_2 reduces the gain of Tr_3 by reducing the current of the stage as the current in Tr_2 rises.

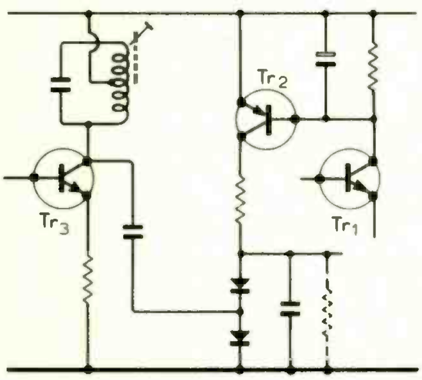

Fig. 4. The a.g.c. current from Tr_2 reduces the slope impedance of the diodes with increasing current in Tr_2, producing increased shunting of the load of Tr_3.

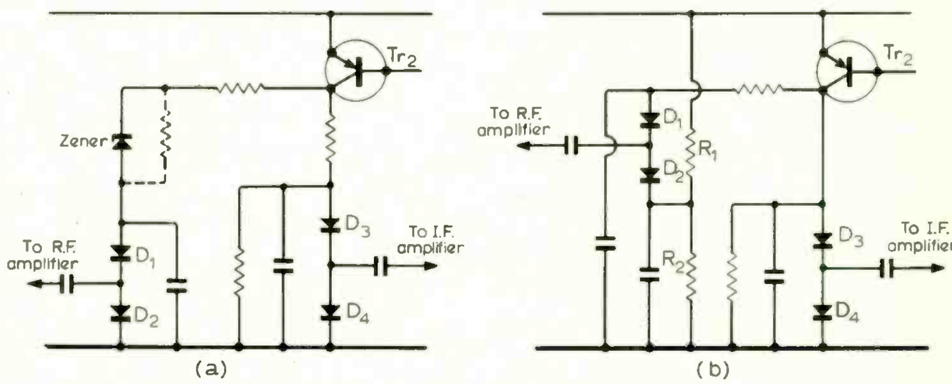

Fig. 5. Additional delay is applied to early stages either by (a) placing a zener diode in series with the feed to the first diode attenuator D_1/D_2, or by (b) reverse biasing these diodes.

current from Tr_2 may be used in a number of ways, for instance:—

A resistor may be connected as shown in Fig. 3 so that an increase in current in Tr_2 causes a decrease of current in Tr_3, the controlled stage. This is of course normal reverse bias a.g.c., and has a number of disadvantages. First the controlled stage is called upon to handle the largest signals when it is least able to do so, through lack of current. Secondly under these conditions of low gain, and hence low current in the controlled stage, severe distortion of the modulation envelope can take place, unless very careful attention is paid to the application of the control current to the various controlled stages. It is also necessary to bypass the emitter resistor of the controlled stages to both r.f. and a.f. in order to combat distortion, as shown in Fig. 3. This is a point often overlooked by designers.

There is the alternative method of control, using the collector current of Tr_2 to vary the loss of a diode attenuator network. A suitable circuit is shown in Fig. 4. The diode network is used to shunt some high impedance point in the amplifier, so that the stage gain is progressively reduced by increasing current in Tr_2.

The use of a balanced circuit with two diodes ensures that the collector resistor of Tr_2 does not also shunt the signal path, and that the attenuator has a large linear region for both positive and negative going signals, since the V_f/I_f curvature of the two diodes will cancel to a large extent so far as signals applied to the junction of the two diodes are concerned. The capacitor connected across the diodes ensures that the diodes are effectively in parallel at radio frequencies, whilst being in series to the d.c. control signal. The resistor shown dotted, is needed to ensure that there is a sharp knee to the a.g.c. characteristic. The diode current required to produce quite appreciable gain reduction in such a circuit is only of the order of a few microamperes, at which current the control transistor Tr_2 will have little current gain. The resistor bypassing the diodes ensures that the current in Tr_2 reaches a level at which the transistor has reasonable gain before the diodes begin to conduct. With a bypass resistor of 4·7 kΩ, and with silicon diodes, the a.g.c. action begins when the collector current of Tr_2 reaches approximately 250 μA.

Practical application of the a.g.c. system

It is normal in a receiver to apply a.g.c. to more than one stage, and also to apply additional delays to the various stages so that control is first applied to the later stages, and then to earlier stages as the signal level rises. This staggering of the application of control is necessary in order to obtain the best overall signal to noise ratio.

Having established the level of signal at which the a.g.c. control loop commences to function, it is necessary to modify the control circuits to all but the final controlled stage to ensure that they come into operation in the correct sequence. Figs. 5(a) and 5(b) illustrate two ways in which this may be achieved.

In Fig. 5(a) a zener diode is used so that the current in the diode attenuator connected to the earlier stage does not commence to flow until the current in the diode attenuator connected to the later stage has already produced considerable attenuation of the overall gain. The resistor shown dotted is sometimes needed to ensure a smooth transition as the first attenuator takes over.

In Fig. 5(b) a similar effect is produced by the reverse bias applied to the attenuator diodes.

Although many good transistor a.g.c. systems must have been designed over the last few years, very little seems to have been published about them, whereas nearly all textbooks, and manufacturers' literature contain simple a.g.c. systems, using low level detection and unamplified a.g.c.

The author has therefore attempted to

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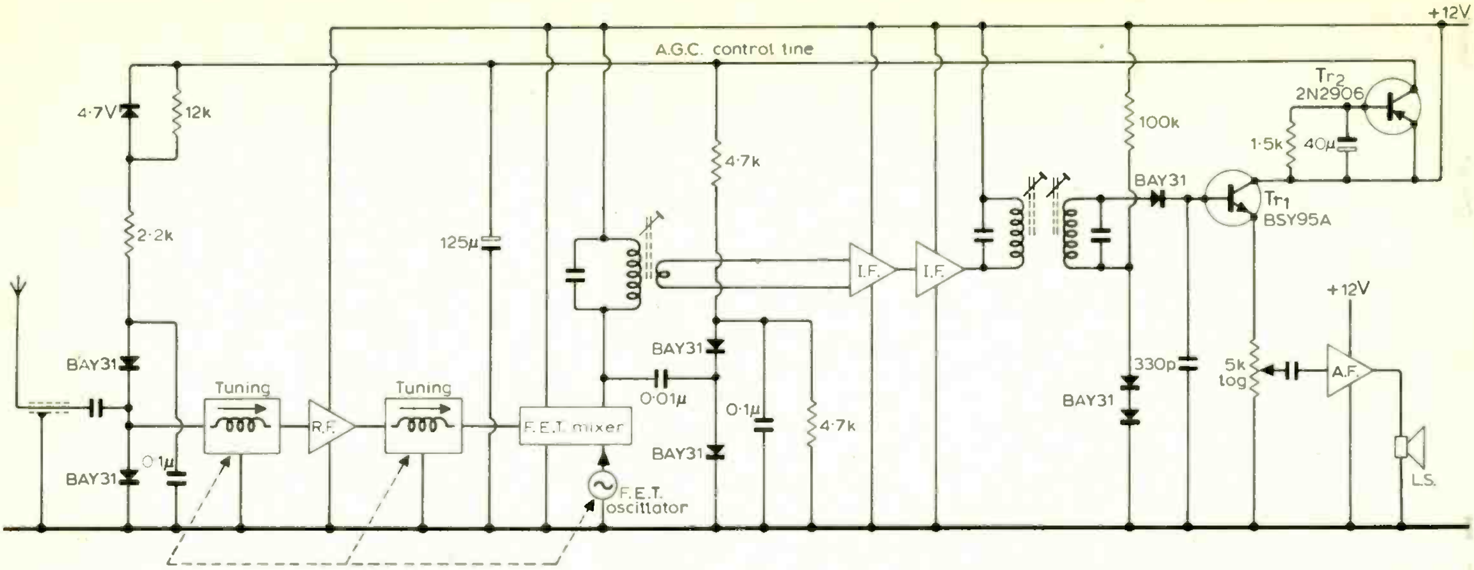
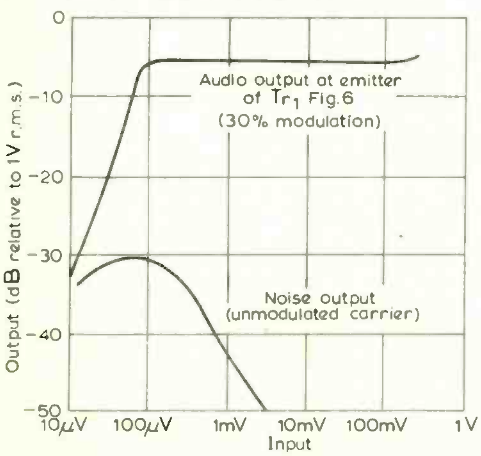


Fig. 6. Delayed and amplified a.g.c. system applied to an automobile broadcast receiver. Fast attack with slow decay characteristics are given to the a.g.c. loop by the 125 and 40 μF capacitors.

outline one method of approach which he has found to be most effective in producing a good a.g.c. performance, providing of course that it is correctly applied. It is important to ensure that overloading of stages does not take place. In this respect it is most important that no reverse bias a.g.c. is applied to the i.f. stage driving the detector, or insufficient power will be available, the stage will overload at high levels of signal, and a high level of distortion will be present in the detected output. It is also important to ensure that the delays chosen to separate the levels of operation of the a.g.c. loop on the various stages should have a small overlap. For example it is important to ensure that if the control range of the last controlled stage is say, 40 dB, then the second control loop must come into operation just before the signal has risen 40 dB above the level at which a.g.c. commences. This aspect is not normally a problem with diode attenuators since their effect is an increasing attenuation up until Tr_2 bottoms, so that it is obvious that earlier attenuators must come into operation before this point or they will be totally ineffective. It is therefore only necessary to set suitable voltage levels for the changeovers, bearing in mind the available voltage excursion at the collector of Tr_2. The exact changeover points must be the subject of experiment, especially if the optimum noise and intermodulation performance is being aimed at, and in this respect a diode attenuator at the input of the receiver can greatly assist in reducing intermodulation, and may also be of assistance in protecting the input stage from voltage surges due to static. On the subject of noise and intermodulation the author would refer his readers to a most excellent book by Rheinfelder[1] on these subjects.

Fig. 7. Audio and noise output versus input level for the circuit of Fig. 6.



Finally, Fig. 6 shows the system described, as applied to a recent automobile broadcast receiver, an application where a.g.c. is of great importance. The performance achieved is illustrated in Fig. 7. A transistor is used in the r.f. stage, with a diode attenuator at the aerial input. The mixer and oscillator stages use n-channel f.e.ts. The f.e.t. of the mixer stage is used with a transistor to form a cascode arrangement allowing a higher value of load impedance without instability problems. A low level of oscillator injection is used to reduce intermodulation and spurious responses. The f.e.t. oscillator stage is zener diode stabilized.

In Fig. 6, it will be seen that there is an additional electrolytic connected to the collector of Tr_2. This capacitor provides the a.g.c. time constant together with the capacitor in the base circuit of Tr_2. This arrangement results in a fast attack time and a slow decay time. The relative rate of decay to attack can be controlled by the value of the capacitors used, particularly the value of the capacitor in the collector circuit of Tr_2. In an automobile receiver a moderately slow decay has been found desirable with a very fast attack time, in order to both protect the listeners ears from sudden blasts of sound when tuning across the band, and to prevent sudden blasts of noise as the vehicle passes under screening structures, such as railway bridges. Finally a word of warning. It is tempting to place a small capacitor across the emitter resistor of Tr_1 to further remove residual r.f. from the audio output, but to do so will cause a very adverse ratio of d.c. to a.c. load as seen by the detector, resulting in an inability to handle high modulation percentages. The input impedance of the a.f. stage following the detector should therefore be resistive up to, and including, the intermediate frequency and the response of the amplifier should be arranged to remove the small residual i.f. component.

REFERENCE

1. 'The Design of Low Noise Transistor Input Circuits' by William A. Rheinfelder, published by Hayden Book Company, New York.

"Noise in Transistor Circuits"

In Part 1 of this article (Nov. issue) the footnote to the middle column of page 392 should read as follows:

***The shot-noise formula is usually given in the form of equation (9), i.e. $\overline{i_N^2} = 2qI_{dc}B$. If, however, the device giving shot noise is fed with constant current, then the shot-noise voltage across it is given by: $\overline{e_N^2} = 2qI_{dc}Br^2$, where r is the small-signal a.c. resistance of the device.

In Part 2 (Dec. issue) the following corrections should be made to Fig. 9. In diagram (b) the formula for the right-hand noise current generator should be $\frac{\sqrt{2q\,I_c\,B}}{r_{b'e}\,g_m}$. In diagram (c) the right-hand current generator should be labelled $-g_m\,v_{b'e}$.

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Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents.

Further Bailey amplifier mods

I read with interest the modifications of the 30-watt amplifier by Dr. Bailey in the November issue. It seems that I am not the only person who has been troubled by the reversible output electrolytic which is both big and expensive. Maybe it will be of interest to your readers to see how this capacitor can be eliminated if a power supply with positive and negative rails is used. As the main reason for using the output capacitor is to avoid d.c. voltages across the speaker, it is obvious that a heavy negative d.c. feedback could do the same thing. A double *RC* filter with a long time constant is used. In order to ensure good a.c. attenuation in the feedback loop, the bias resistors of Tr_2 have been changed. The lower part is in fact formed by the filter resistors in series with the speaker. No bad behaviour of the modification has been noticed, and it has furthermore been possible to put a complete stereo-amplifier into a box measuring only 28 x 19 x 5 cm^3.

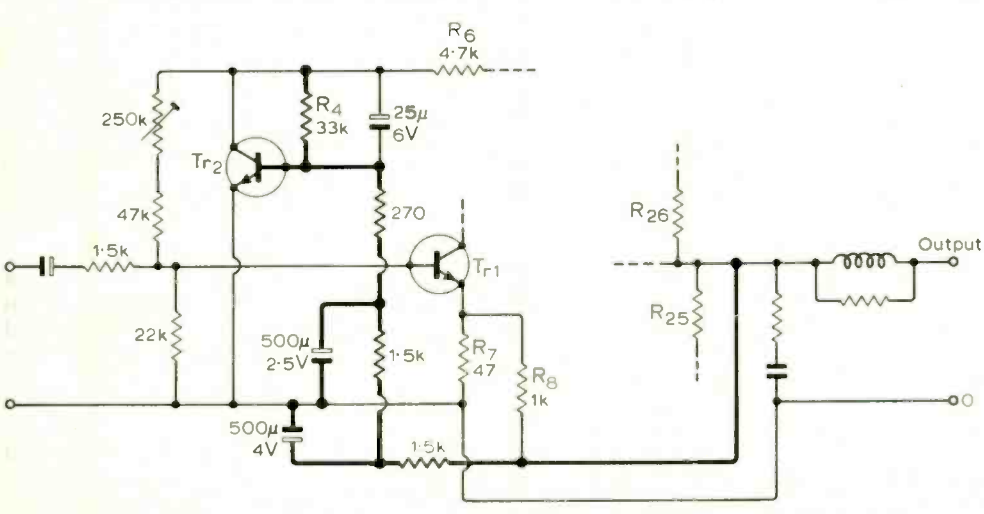
OLE HOLMSKOV,
Hørning,
Denmark.

The author replies

I was very interested to read the letter from Mr. Holmskov. I quite appreciate his point regarding the size and cost of the output capacitor and agree that it would be better if it could be omitted entirely. For most speaker systems the amplifier will be quite safe with the capacitor omitted, even in the original circuit, but difficulties arise if the output is short-circuited owing to the very low output impedance. As the d.c. output impedance is so low (10 to 20 milliohms), then only a very small offset voltage will cause a large current to flow in a short-circuited output. This will eventually destroy at least one of the power transistors unless an extremely large heat-sink is used. The same problems apply where the amplifier is used to drive into a transformer. What is required therefore, is a high output impedance at d.c., and negative *current* feedback at d.c. is therefore to be preferred to additional voltage feedback. I have not looked at possible means of doing this, but with one or two additional transistors it may be possible.

I therefore feel that the possibility of catastrophic failure exists in Mr. Holmskov's circuit, although admittedly under conditions of misuse. Nevertheless, amplifiers are liable to misuse, so I cannot help feeling that any loss in possible reliability is to be avoided, even at the cost of using an output capacitor.

ARTHUR R. BAILEY



Helical u.h.f. aerials

Mr. Davies' article in the November issue in which he describes a helical aerial for the reception of Bands IV and V, prompts us to give a reminder that good aerial performance is an important factor in obtaining the best results from the u.h.f. television transmissions. Any suggestion which promotes the use of good domestic aerials is certainly to be welcomed. Whilst not wishing to detract from Mr. Davies' intentions in this direction, we must point out a serious drawback to the general adoption of circularly polarized receiving aerials.

In planning for national u.h.f. coverage of up to four television programmes with a limited number of available channels, it is inevitable that the same channels must be shared by a number of transmitters and relay stations. By employing horizontal polarization for the transmitters and vertical polarization for the relay stations, and assuming certain minimum performance characteristics for the viewer's aerials, it is possible to plan for acceptably low levels of co-channel interference. The assumed aerial characteristics in this context relate to the discrimination against the opposite polarization (i.e. against vertical polarization if the local transmissions are horizontally polarized and vice versa) and to the horizontal pattern which provides directional discrimination. (Recommended minimum characteristics are laid down by the C.C.I.R.) As a circularly polarized aerial will respond equally to any orientation of linear polarization, it will give insufficient protection against co-channel interference. To put it another way, the widespread use of aerials having no discrimination between horizontal and vertical polarization would have the effect of reducing the service areas of transmitters, because the limit of service would correspond to higher field strengths (up to 8dB higher) to achieve the same standard of reception.

Mr. Davies suggests that the helical aerial is less prone to "flutter" effects. Whilst it is true that a radio link using circularly polarized aerials at both the transmitter and receiver terminals has some immunity from the effects of random reflections, it is difficult to see why helical aerials should be better on the average in this respect when the transmissions are linearly polarized.

J. L. EATON,
L. F. TAGHOLM,
B.B.C. Research Department,
Tadworth,
Surrey.

Editorial comment

The writers are perfectly correct, of course, in pointing out the potential danger of co-channel interference in some areas, if aerials which do not discriminate against the polarity of transmission of the unwanted station are used. We would go further and emphasize that this danger is not always appreciated on initial installation because all the u.h.f. transmitters planned for national coverage are not yet operating, and interference which is absent at that time may appear at some time later. The opening paragraph of the article did state that the characteristics of the helical aerial may be a disadvantage in some areas, and the question of co-channel interference is a case in point. However, while the transmission polarization may remain reasonably constant throughout the normal service area, the wave may arrive at a more distant receiving aerial displaced from the true vertical or horizontal, and in these cases the helical aerial may be used with advantage. The distance between transmitter and receiver at which the aerial described was used was 65 miles and while this is well outside the designated service area for the Oxford transmitter, there are many cases where viewers attempt reception from adjacent

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areas until their locality is served by its own transmitter. It may be that even in urban areas with four local transmitters in operation, due to multiple reflections, the four waves may arrive at different angles of polarization. As regards the statement that the helical aerial is less prone to "flutter", this was based entirely on the author's practical experience. The aerial shown in our photograph is erected on a bungalow in the flight path of a large airfield which is approached by aircraft at a height of 500ft. Under these conditions, when using a conventional horizontal Yagi array, large colour changes are produced on a colour receiver, but not when using the helix.—ED.

Correction

It has been pointed out by E. H. Davies, the author of the article "A Helical Aerial for Bands 4 and 5", that the dimension S in Fig. 4. should have been drawn from the centres of the tubes.

Frequencies for amateur TV transmitters

From a report appearing in *The Engineer* for 11th October 1968, it is understood that Mr. J. R. Brinkley of S.T.C. is urging that the lower limit of the ultra-high frequency band allocated to business radio should be extended downward from 450 to 420 MHz.

I wish to draw the attention of your readers to the fact that the bands from 425 to 429 MHz and 432 to 450 MHz are allocated on a shared basis to the Amateur Service and other users.

This portion of the sprectrum which Mr. Brinkley wished to annex is extensively occupied both by communications stations and some 70 privately owned television transmitters in all parts of the United Kingdom.

D. S. REID,
British Amateur Television Club.

Until recently, the Amateur Service occupied a continuous band of frequencies from 426 to 450 MHz on a shared basis with other services. The G.P.O. told *Wireless World* that the other users, whose identity they cannot disclose, now have exclusive use of frequencies between 429 and 432 MHz and to compensate for the loss of this band of frequencies, the amateur band has been extended down to 425 MHz. (See also "United Kingdon Licence Changes" in this month's "World of Amateur Radio"). ED.

Improper oscillations in transistors

Everyone well acquainted with the literature on the parameters of available transistors knows that one resistor and one capacitor cannot cause a transistor to oscillate. The limit of phase-shift of a single *RC* combination, the known phase shifts within the transistor itself, the rigid limits of voltage and current magnification in the three usable configurations; all these considerations seem to rule out such a possibility completely.

Happily, the transistor (like the well-known Columbian egg) does not read, and can therefore be persuaded to oscillate cheerfully under the conditions mentioned. There is but one proviso: the transistor employed must be of an appropriate species, namely one of *planar* or similar internal geometry, of reasonably high gain, and preferably of the high-frequency type.

Since the general introduction of silicon planar, high-frequency transistors, there have been occasional complaints of "spurious oscillations" when these newer devices have been directly substituted for the older types. What follows is not intended to provide an anodyne for the resulting headaches but, on the contrary, to elevate the oscillations themselves to a position of respectability, by giving them the dignity of a definition and a name.

For convenience and brevity, any transistor that can be induced to oscillate in a circuit recognisably similar to that in Fig. 1, will be said to exhibit "P-effect." The circuit shown represents the *minimum* necessary conditions under which the presence of the effect may be registered. Since *C* need only be very small in practice (a few pico farads), it might well be represented by the effects of associated wiring. This is mentioned so that anyone wishing to check the writer's conclusions may take the obvious precautions.

The components *R* and *C* act effectively as timing elements, *R* doubling rôles as a supplier of current bias to the transistor.

To produce the effect in a practical circuit, select a high-gain transistor, and with *C* equal to 0.01 μF and *R* a variable resistor of, say, 1 megohm, adjust the bias until, with a supply voltage of 9 volts, around 10mA flows in the supply line. An audible tone may now be extracted at medium impedance from the base, or at low impedance from the supply line, the source impedance (assuming a battery to be used) providing the load.

By inspecting the resulting waveform (Fig. 2) the nature of the oscillation is immediately apparent. The steep transients and the familiar saw-tooth shapes, show that the term "relaxation oscillator" is appropriate.

As might be expected, the frequency is roughly proportionate to the inverse of the *RC* product, and the simple modification to the circuit shown in Fig. 3 allows this to be verified over a fair range of frequencies.

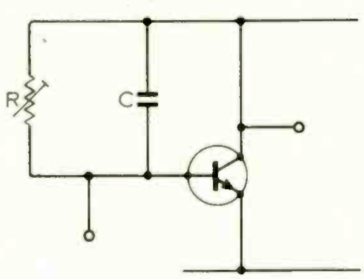

Fig. 1.

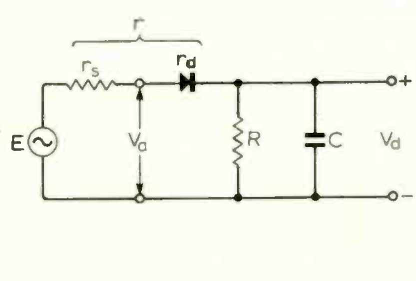

Fig. 2. (below)

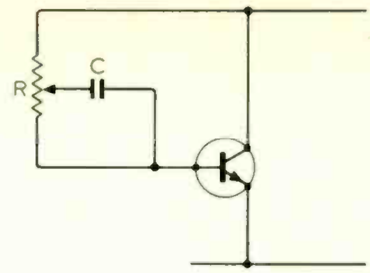

Fig. 3.

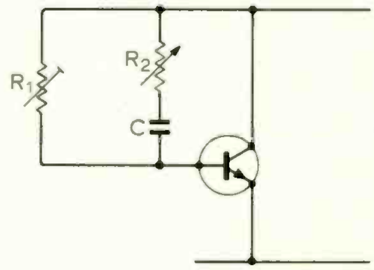

Fig. 4.

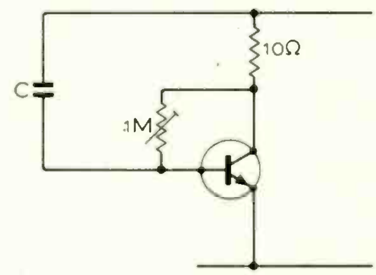

Fig. 5.

The addition of a second resistor (Fig. 4) may obscure the basic simplicity of Fig. 1. but introduces the interesting feature of *series charging* of capacitor *C*, R_2 being now the principal timing element.

The introduction of a current limiting resistor is a natural temptation, especially as this can function as a formal load against which to extract the signal.

The results of such modifications are interesting. P-oscillations tolerate only trivial loads in both emitter and collector circuits. Moreover, the effects of both types of load are very similar. It appears, indeed, that the transistor "sees" such loads merely as an addition to the source impedance.

Predictably, P-oscillations are readily synchronised with sharp pulses applied to the base of the transistor, at a frequency slightly higher than the free-running value. This feature immediately suggests a number of practical uses.

In a letter, commentary must necessarily be abbreviated, so the following five short notes must do duty for a more elaborate analysis.

1. Thermal stabilization by feedback resistor (Fig. 5) is the more practical method.
2. Transistor noise in P-mode operation is a problem, but not an insuperable one.
3. Extended practical tests show that P-oscillation is not a destructive process.
4. The range of frequencies obtainable is surprisingly great; the ratio 1000:1 is typical.
5. At the upper frequency limit, the waveform closely approximates to a sinusoid of diminished amplitude.

Naturally, the writer has his own views on the precise nature and cause of these oscillations, but the need for brevity precludes comment on this relevant aspect.

D. B. PITT
Nottingham

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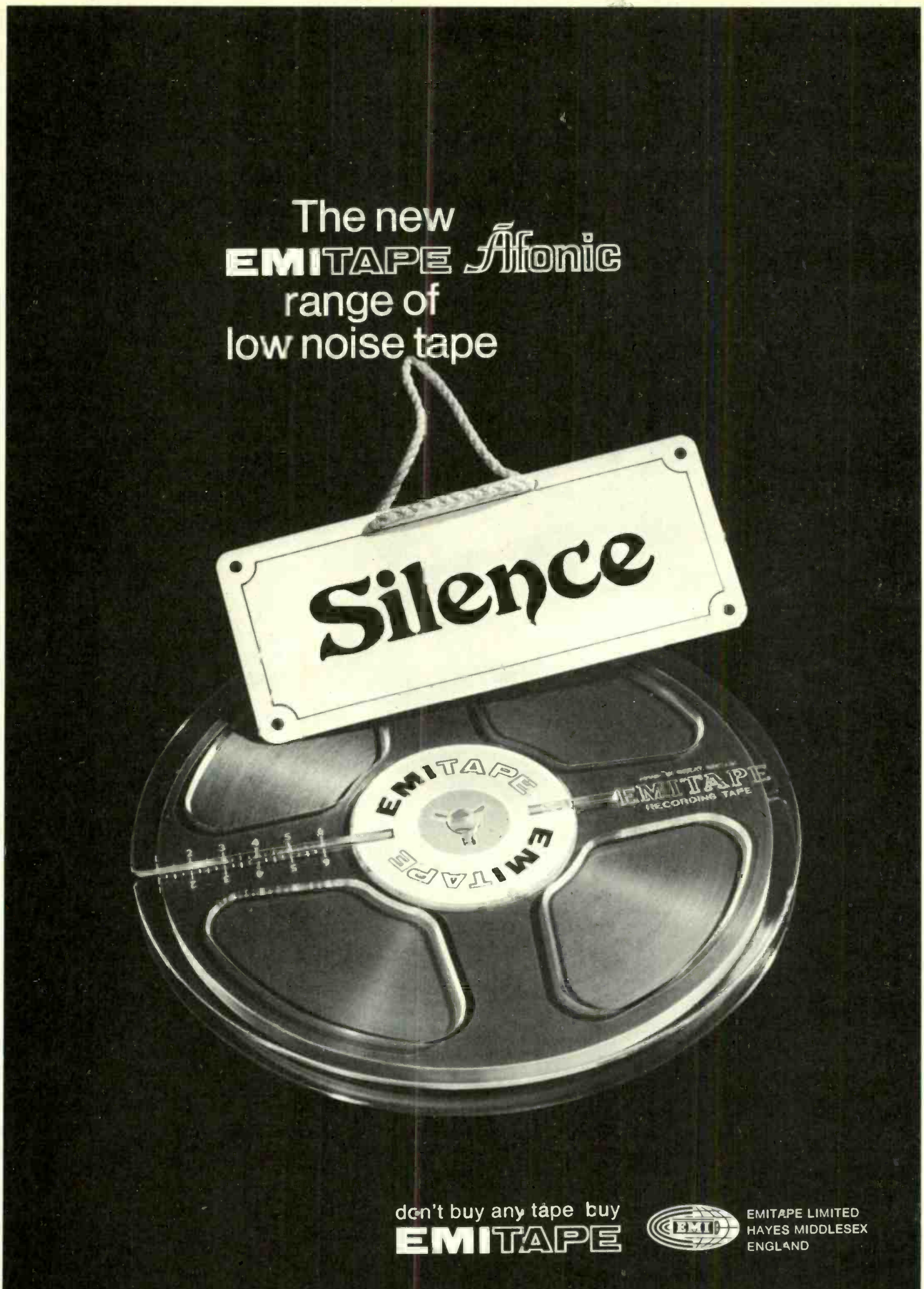

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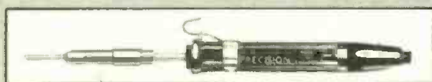

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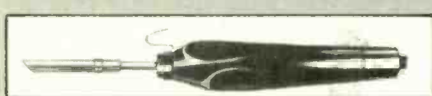

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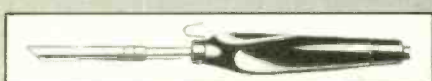

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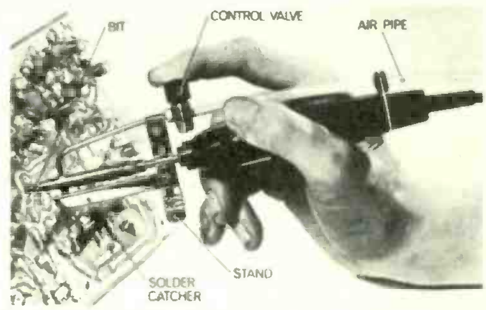

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A balanced voltage supply unit and an economical voltage stabilizer

by C. F. Ho, M.Sc.(Eng.), M.I.E.R.E.*

In circuit development work a power supply with both positive and negative outputs relative to a common terminal is often needed. To use two separate power packs to achieve this end is undesirable as there is a perpetual shortage of power supplies in most laboratories. Fig. 1 shows a circuit which permits the formation of two balanced supplies from a single unbalanced one. It was constructed as an adaptor to be used with the economical voltage stabilizer; however, it may be employed with any conventional voltage regulator.

The circuit operates as follows: A voltage divider, R_1, R_2 and R_3, establishes a reference voltage at the base of transistor Tr_1 which is equal to half the input voltage. Tr_1 and Tr_2 form a differential amplifier where the base of Tr_2 is in the negative feedback path from the emitters of transistors Tr_5 and Tr_6. When unbalanced loads are connected to the output terminals, the output common terminal's potential tends to shift up or down with respect to the positive or negative rails. The resultant difference voltage, which occurs between the bases of Tr_1 and Tr_2, is amplified by the two differential amplifiers and is used to turn on Tr_5 or Tr_6 thus correcting the output voltage at the common terminal.

With the component values shown the unit can provide an output of up to 12V at a maximum current of 250mA. Larger output current is obtainable by replacing Tr_5 and Tr_6 with higher power transistors. Resistors R_{11} and R_{12} need not be used if the input voltage regulator is current limited.

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Economical voltage stabilizer

The voltage regulator, the circuit of which is shown in Fig. 2, is conventional. The potential divider, R_{12}, R_{13}, R_{14} and R_{15} samples the output voltage. An emitter-coupled differential amplifier formed by transistors Tr_6 and Tr_7 compares this sample with a reference voltage and the resultant difference signal is amplified by transistor Tr_5 and applied to the base of the control element Tr_3 and Tr_4. A pre-regulator, Tr_1, is employed to improve the input voltage regulation and to reduce the output resistance of the regulator.

Short-circuit protection is incorporated by means of Tr_2. Under normal operation, Tr_2 is not conducting. When the regulator output is short-circuited or overloaded, the potential at the base of Tr_2 becomes more negative than that at its emitter. Thus, the collector current of Tr_2 flowing through R_6 is applied to the base of Tr_5 and is sufficient to saturate the latter. The control element has its base at ground potential and is turned off instantaneously. As soon as the short-circuit is removed, the regulator is restored to its normal operation. The overload trip-current is set by R_3.

The output voltage of the regulator can be varied from 0 to 25V at 500mA. Output resistance is less than 0.1Ω and maximum peak-to-peak ripple voltage is not more than 200 μV.

All diodes are formed by the base emitter junctions of CS9013 transistors. Incidentally all transistors are Fairchild planar silicon types.

Fig. 1. Balanced power supply circuit.

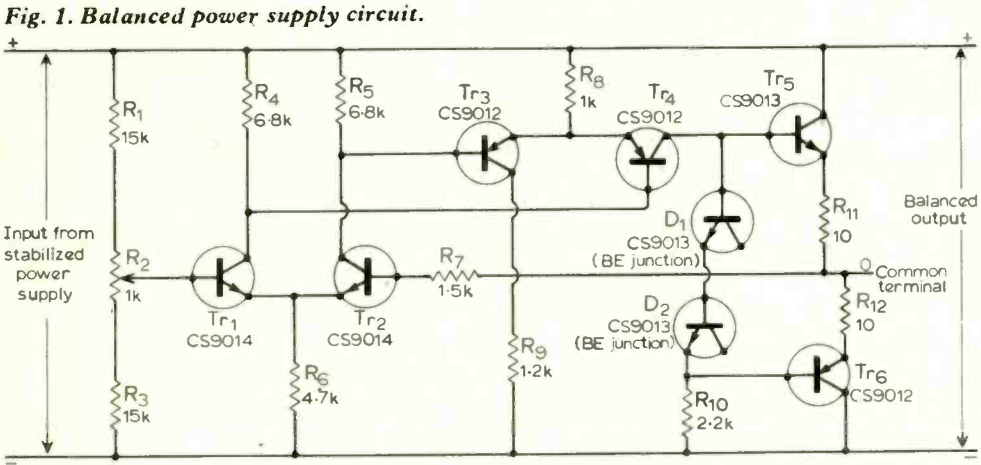
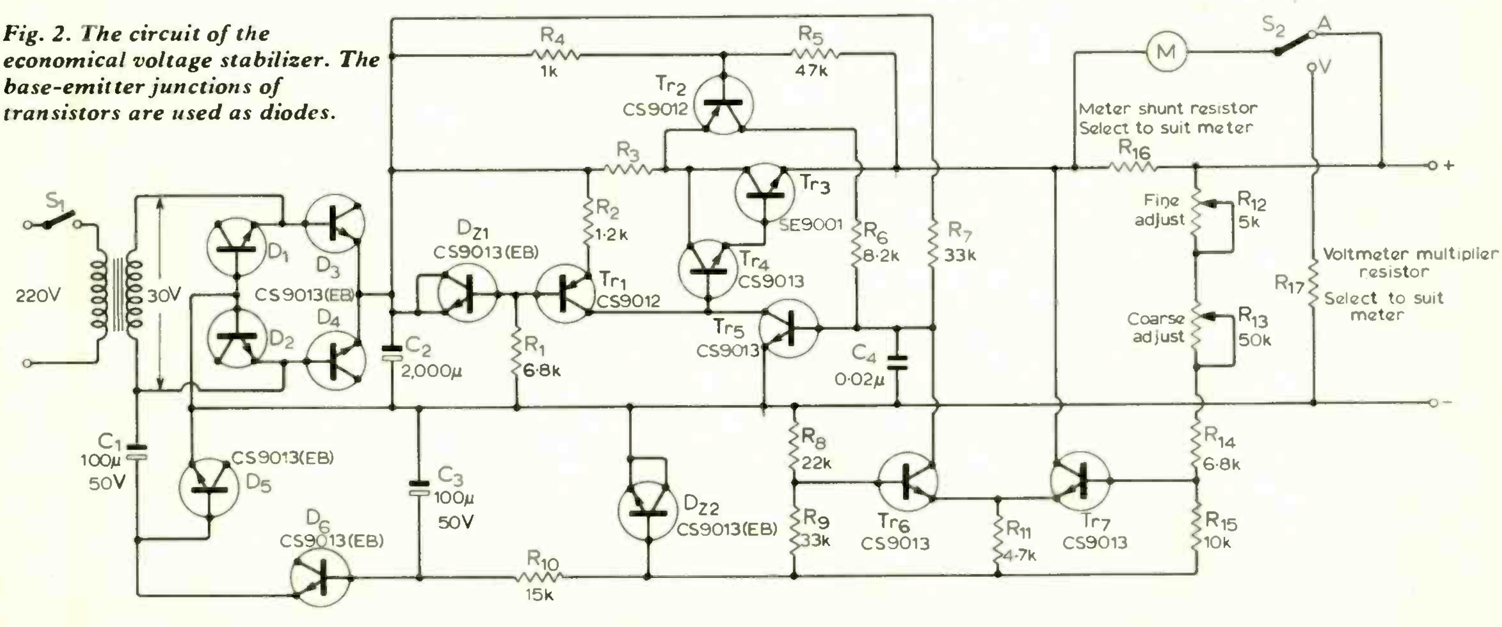


Fig. 2. The circuit of the economical voltage stabilizer. The base-emitter junctions of transistors are used as diodes.



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Digital Exposure Timer

Stable exposure times are obtained from a timer having a logarithmic scale with eighth-root-of-two intervals.

by G. Coates, B.Sc.

A reader's letter in *Wireless World*[1] brought attention to the fact that present photographic exposure timers were not designed with photographers in mind! This timer is an attempt to resolve the position. It can increase exposures in increments of one-eighth stops; can time subsequent exposures at the same setting to within 10 ms; and has an accuracy of better than one percent.

The main components, transistors, diodes and resistors, can be bought from advertisers in this journal for about 3d, 2d, and 1½d each, respectively. In this way the timer can be built for less than £10 including the case.

Although the timer has been designed as an enlarger exposure timer, sufficient details are given to enable the basic design to be modified to suit other applications.

The circuitry is quite extensive, and care should be taken to test surplus components before use, otherwise fault-finding becomes somewhat tedious.

Determination of the binary equivalent of each state

For photographic purposes a timer is required whereby the ratio of each time increment to the one following is a constant.

If successive times of

$$T;\ a_1T;\ a_2T\ \ldots.\ \text{etc.}$$

are required, then:

$$\frac{a_1T}{T} = \frac{a_2T}{a_1T} = \frac{a_3T}{a_2T} \ldots.\ \text{etc.} = \text{a constant.}$$

therefore:

$$a_1 = \frac{a_2}{a_1} = \frac{a_3}{a_2} \ldots.\ \text{etc.}$$

Grahame Coates was educated at Nottingham University from 1959 to 1962 during which time he specialized in automatic control systems and was president of the University Radio Society. He then joined the East Midlands Electricity Board as a graduate trainee, and is now an assistant commercial engineer with Eastern Electricity, responsible for power supplies, and for industrial development in the Luton district. His hobbies include electronics and photography.

and:

$$a_2 = a_1^2;\ a_3 = a_1^3\ \ldots.\ \text{etc.} \qquad \ldots.\ (1)$$

If n divisions are required between binary stages, then:

$$a_nT = 2T \text{ or, } a_n = 2.$$

From (1),

$$a_n = a_1^n = 2$$

$$\therefore a_1 = \sqrt[n]{2}$$

and,

$$a_2 = 2^{2/n};\ a_3 = 2^{3/n}\ \ldots.\ \text{etc.}$$

Appendix I gives a rigorous proof that the time divisions for each state can be found on the counter by sampling the binary equivalent of the appropriate root of two. These binary numbers are independant of the basic time interval T.

The time between one stage on the counter and the next can therefore be divided into any number of parts according to the basic law of the nth. root of two.

Appendix II shows how to calculate the binary equivalent of $2^{x/n}$, so that the reader can construct a decoding network for a greater or lesser number of divisions between stages. For the timer described, however, the binary equivalents of $2^{a/8}$; where $a = 0,1,2 \ldots. 7$ are given in the table below.

Power of 2	Equivalent Binary No.
0	1000000
1/8	1000110
1/4	1001100
3/8	1010011
1/2	1011011
5/8	1100011
3/4	1101100
7/8	1110101

Principle of operation

The timer is basically two binary counters, connected in series, which count 10 ms pulses derived from the 50 Hz mains. The counters count to a number which is selected according to an 8th-root-of-2 law, thus giving "eighth stop" times. One counter determines the "full stop" and the other adds the fractions between "stops".

Consider a 4-stage binary counter. The waveforms of the output voltages of each stage are shown in Fig. 1.

The timer is arranged to switch on at T_0 and switch off between times T_1 and T_2. Time T_2 is twice T_1 i.e. it is one time value greater than T_1, because cascaded binary stages divide by two. During the period T_1 to T_2, the timer exists in eight different states. The outputs of the bistables are I or O (representing output

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evels of — 9V or oV) and a binary number, between IOOO and IIII can be written for any particular state. State IIOO would, or example, be $1.5T_1$.

If only one intermediate value between T_1 and T_2 were required, hen this would be $2^{\frac{1}{2}}.T_1 = 1.414T_1$. There are eight possible states, representing $1.000T_1$; $1.125T_1$; $1.250T_1$ etc. As 1.375 is nearest to 1.414, this could be chosen.

The binary equivalent of 1.375 is I.OII, and therefore the desired ntermediate state would be when the output of stages 1; 3 and 4 are at I; and stage 2 at O.

The outputs of the binaries are fed into a NAND gate, the diodes forming a tree as shown schematically in Fig. 1. It is not necessary o use the complement output of the binary stage (at O), as there is no ambiguity in this circuit.

There is an inaccuracy in following the $^n\sqrt{2}$ law, because 1.375 was chosen as the nearest "fit" to 1.414. The absolute accuracy for each value of n is different, but calculable, as shown in appendix III. The inaccuracy can be made as small as required by using a larger number of stages. The prototype timer has a seven-stage counter, increasing the n-root-two-law accuracy to 0.85% or better.

With seven stages, $64(=2^6)$ states are possible, of which eight are chosen to give the nearest fit to the timing law, giving eighth time values. In fact a greater number of divisions could be easily made, as the additional complexity of, say, twelve divisions would be very small (a matter of adding twelve diodes to the decoder).

A greater number of stages will increase the minimum timing period (T_1 in Fig. 1) for a given input frequency, as this is divided by two for each stage. In this design, the number of stages, k, is related to the minimum timing period, T_{min}, and the input frequency, f, by the expression:

$$T_{min} = \frac{2^{k-1}}{f}$$

The accuracy of "fit" to any law is a function of the number of stages, and is 100×2^{-k}% or better.

This seven-stage counter will time between T_1 and T_2 only. Times in excess of T_2 can be obtained by reducing the input frequency. A nine-stage binary divider feeds the counter, so that nine ranges, each one time-value wide, can be selected, by adding the desired number of divider stages in front of the counter.

The outputs of the binaries are reset to I at the start. The first pulse sets all the stages to O, switches the output on, and the count begins. The circuit is arranged to operate in this way, as otherwise the output would not necessarily switch on at the start of an input pulse.

Although the frequency of the mains can fluctuate by more than 1%, variations of this order only occur during periods of winter peak demand: normally fluctuations are smaller than this. For photographic purposes the error is negligible. Obviously, the accuracy could be increased up to the limit set by the decoding error by deriving the counter input from a crystal controlled oscillator.

Detailed description

The timer utilizes sixteen bistable circuits. The bistable circuit used in the prototype is given in Fig. 2, and is that of a "pre-assembled logic unit" offered by one of the advertisers in *Wireless World* for 5/- each.

Almost any bistable circuit is usable and that given for the *Wireless World* digital computer[2] could be used as an alternative, with appropriate changes in the line voltages.

Since times are derived from the 50 Hz mains supply, to obtain the required accuracy the decoder requires seven binary stages. Thus the smallest setting of the timer is $2^7 \times 10^{-2} = 1.28$ s. The longest period required is 10 minutes, i.e. $60{,}000 \times 10$ ms. The maximum count where 16 stages are used is 2^{15} which is 59,904, equivalent to a duration of 9 minutes 59.04 seconds. 16 stages are therefore required.

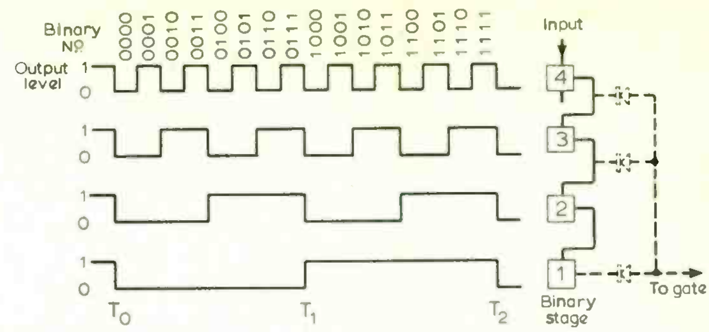

Fig. 1. Counter waveforms.

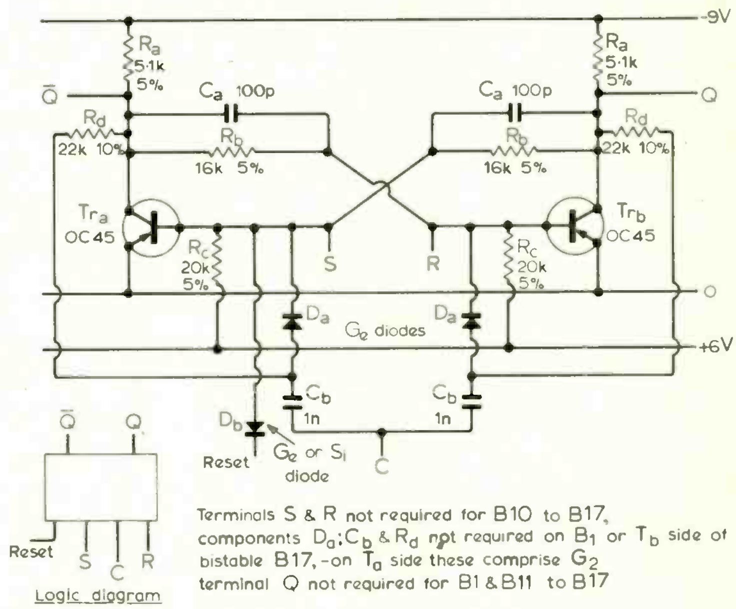

Fig. 2. Bistable circuit and logic diagram.

The counter logic diagram, and decoder circuits are shown in Fig. 3. 10 ms pulses in antiphase are fed into a pre-selected binary stage by S_{1a} and S_{1b}. S_1 allows for selection of the basic time periods, each equivalent to an increase in exposure of one stop. The time values are numbered from 1 to 9 in the prototype, as it is quite unnecessary to know the time in seconds for photographic purposes. Switching to the next higher time unit will double the timing period, which is precisely the method best suited for timing exposures.

One-eighth time values are selected from the outputs of B_{10} to B_{16} inclusive. These outputs are fed into a diode decoding network, the appropriate fractional time values being selected by S_2. S_1 provides a one-stop increase or decrease in exposure whatever the position of S_2.

Although the decoder looks complicated, it represents only the diode inputs of a diode-transistor NAND gate, G_1. The diodes are connected to the outputs of the bistable stages according to the presence of a I in the binary equivalent of each state.

B_{17} is a bistable, the purpose of which is to lock off the output after one timing period.

G_3 is a NAND gate which drives the thyristor through a pulse amplifier. The load is on when the output is O.

The operation of the circuit is as follows:—

Assuming the a.c. load to be off, the output of G_3 will be I. S_5 is pressed closed, driving the reset line to I. This holds all the counter stages at I and drives the output of B_{17} to I. As all stages of the counter are at I initially, G_1 output will be at O, whatever the position of S_2. This output is connected to the input of theNAND gate, G_3 and the output of G_3 will therefore be at I, holding the a.c. load off.

If S_5 is now released, the counter will be allowed to count. The

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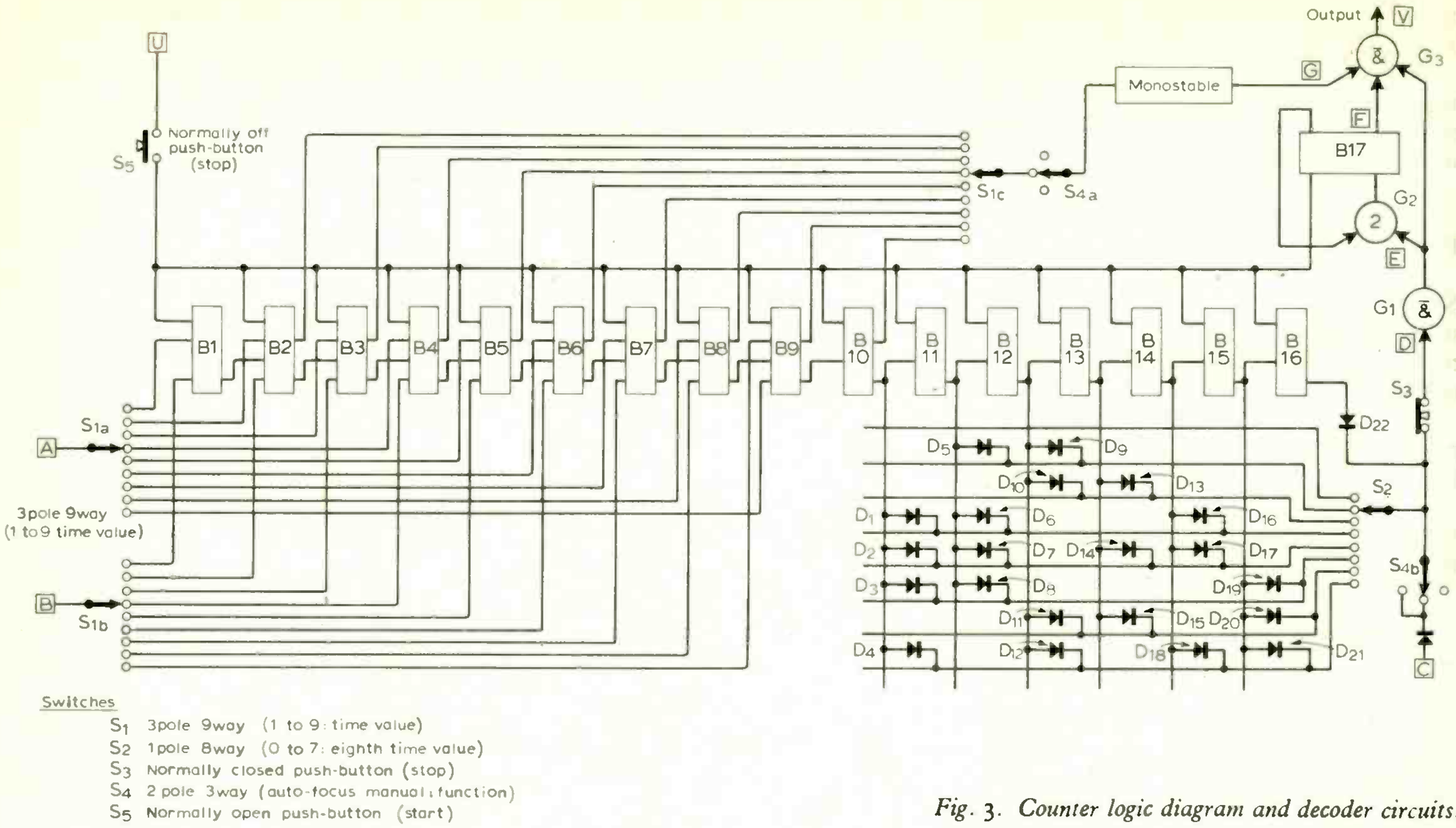

Fig. 3. Counter logic diagram and decoder circuits.

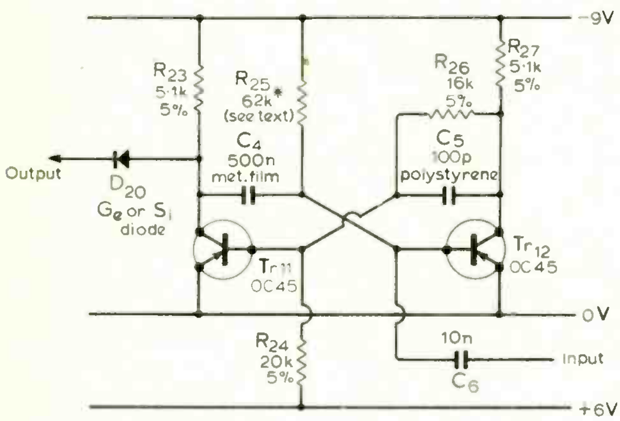

Fig. 4. Monostable circuit.

first 10 ms. pulse will ripple through the counter changing all the outputs to O. G_1 will go to I, and G_3 to O, as both the inputs of the gate will be at I. The a.c. load will switch on as a result. The bistable, B_{17} will not be affected, as a positive pulse through gate G_2 is required to switch it.

The count continues until all the diodes in the selected decoding tree, and D_{22}, are connected to I outputs. The effect of this is to turn the output of G_1 to O for the duration of 10 ms. A positive pulse through G_2 switches the bistable so that gate G_3 goes to p, and remains at I whatever the state of G_1; as the output of B_{17} is I, and cannot be reset to O until S_5 is again pressed. G_3 thus switches the a.c. load off.

C_1 is included in the circuit of G_1 so that it's input has an inherent delay. This is necessary as when the counter ripples through a pulse to the end of the counter, (i.e. when B_{16} is about to change to I), the decoder diodes "see" a I on each stage for a short transient period.

C_1 is selected such that the gate does not pass this transient, but passes the 10 mS. pulse at the end of the timed period.

S_{4_b} includes a position to allow manual operation of the unit. One of the inputs of G_1 is held at O by D_{23} connected to the 0V rail. No pulse can now be passed through G_1, and the timer does not switch off until the stop button, S_3, is pressed.

S_3 may be used when timing to switch off the load before the end of the count. This is useful too when the apparatus is initially switched on, should B_{17} fall into the "wrong" state.

The focus position of S_4 allows the lamp to run at half-power, by gating the output so that one cycle in two is passed.

The same effect could have been obtained by half-wave rectifying the lamp supply, but in this case direct current would be drawn from the supply. This is undesirable, as it is usual for the lamp supply to be taken via a constant voltage transformer, when colour prints are made with an enlarger. (Variation in supply voltage would cause a variation in colour balance in the print). The operation of the constant voltage transformer would be adversely affected should it pass direct current.

20 ms pulses are obtained from the $\bar{Q}$ output of the bistable following the input bistable, selected by S_{1c}, The output goes to O about 3 ms. after the start of a half-cycle, thus it is not possible to apply these pulses directly to the output gate, G_3, as the Thyristor would have fired at the start of one of the two half-cycles which must be suppressed. The pulses are applied to a monostable, such that a positive-going pulse on the input causes the output to drop to O for about 27 ms.

Whilst S_4 is in the "focus" position, the inputs of G_3 from B_{17} and G_1 are arranged to be at I. A O on the input from the monostable will therefore cause the thyristor to stop conducting at the end of the current half-cycle. When S_4 is in either of the other two positions, the monostable will remain off, with the output at I, and will not affect the other modes of operation.

As the output of the monostable drops to O some 3 ms after the start of a half-cycle, it can only inhibit the output of the timer for the two subsequent half-cycles, and the duration of the quasi-stable state must be such that the monostable output returns to I at the end of the second half-cycle. Resistor R_{25} in the monostable should be selected to achieve this. The value used in the prototype was 68 kΩ. If an oscilloscope is not available for selecting this value, a d.c. voltmeter can be inserted across the lamp: R should be varied until the needle oscillates about its unenergised position.

The 50 Hz. input to S_{1a} and S_{1b} is derived from a 12 volt winding

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on the mains transformer. The diodes, D_{30} and D_{31}, provide pulses in antiphase for driving the d.c. inputs of the bistables.

The full circuits of the monostable, gates and thyristor output are shown in Figs. 4 and 5. The connexion of these circuits to the bistables is straight forward, and is indicated in Fig. 2, which also shows the diode decoding network connexions.

Power supplies

Supplies of −9V and +6V are required. The power supply stabilizer regulates with only a small voltage drop across the series transistor. Also, it is cheap to construct with selected surplus transistors.

The power-supply circuit diagram is shown in Fig. 6. The prototype was designed to be used with a constant-voltage transformer, which had an isolated secondary winding.

The bridge rectifier, D_{26} to D_{29} connects each of the two poles of the supply alternately to the −9V rail, which is therefore connected to the earthed chassis.

If the timer is to be used without an isolating transformer, either the components must be screened from earth (the screen being connected to the −9V rail) or an alternative method of switching incorporated which does not require the circuits to be floating, otherwise 50 Hz hum will cause maloperation of the timer.

The 10 ms pulses are obtained from (B) and (C) (Fig. 6). These pulses are, in fact, half-sine waves: this does not matter, as the bistable connected to them will square them up for the following stages.

The n-p-n transistors of the stabilizer should be silicon planar types, and the series stabilizer transistor Tr_5 (Tr_{10}) should be germanium. This is essential, as the voltage across R_{17} (R_{18}) should be as large as possible for the efficient working of the stabilizer, but is limited to the difference between the base-emitter voltages of Tr_5 and Tr_6 (Tr_7 and Tr_8). Loop instability is avoided without the use of a capacitor by selecting a high frequency transistor for Tr_9 (Tr_{10}), and a low-frequency transistor for Tr_5 (Tr_7). R_{19} should be selected to give a voltage of −9V, and R_{21} to give +6V.

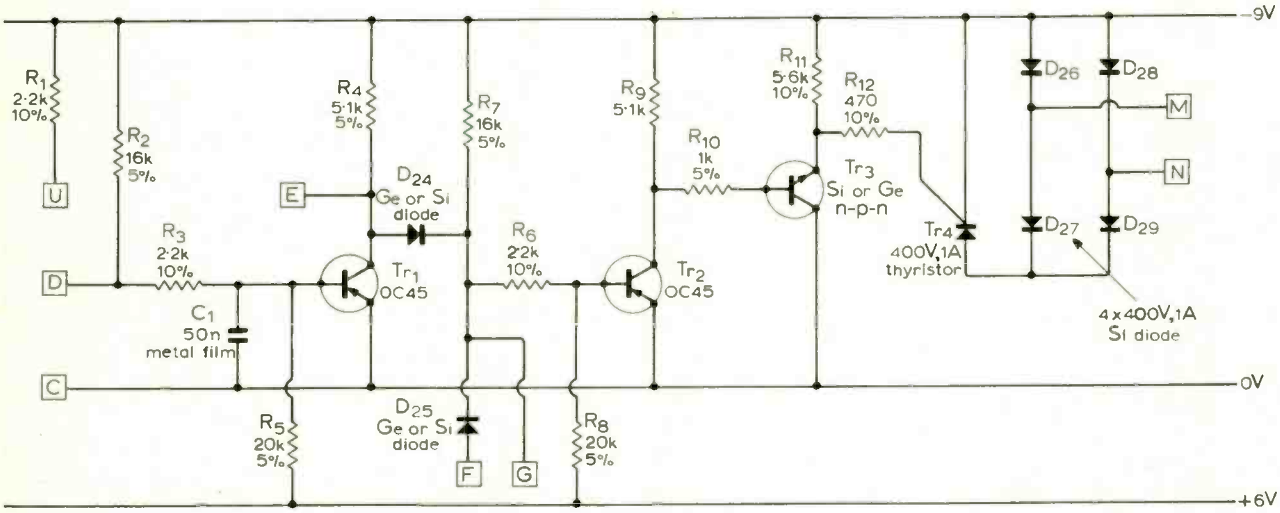
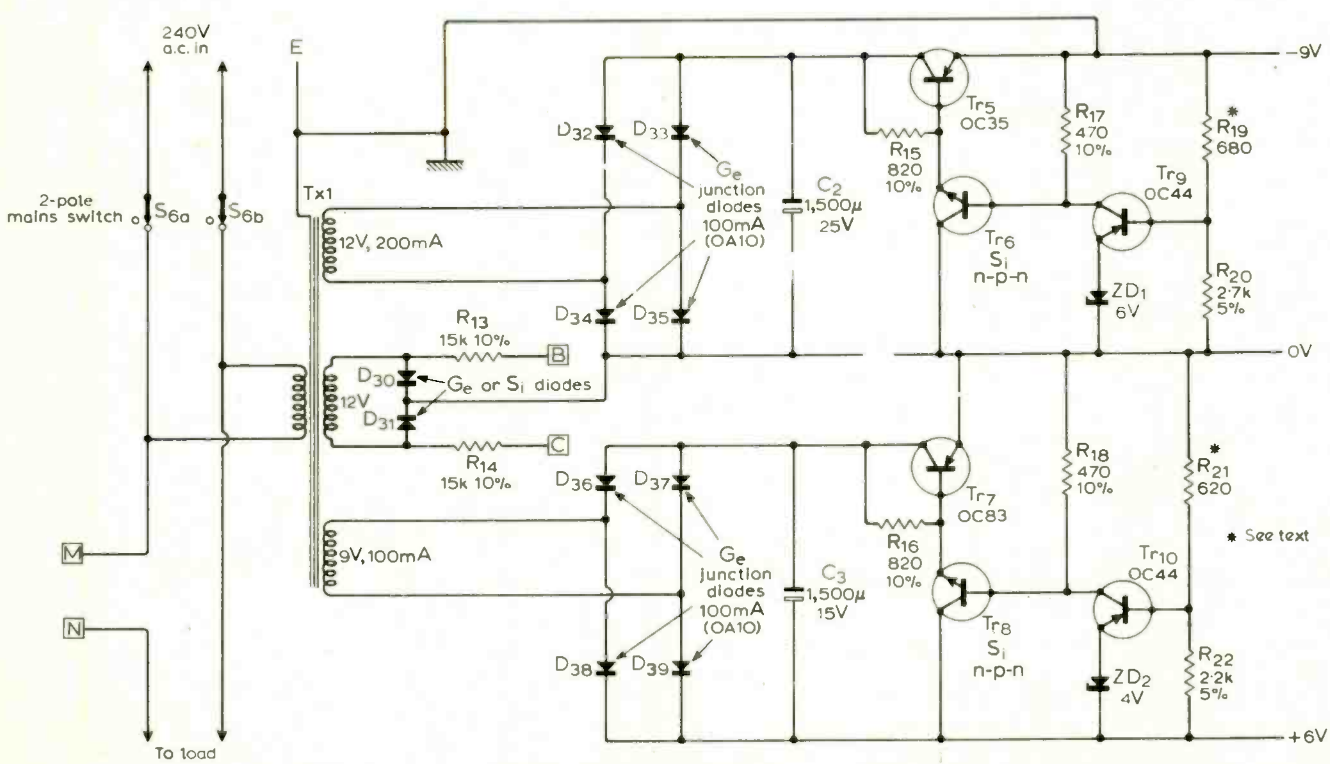


Fig. 5. Power control circuit.

Fig. 6. Power supply circuits.



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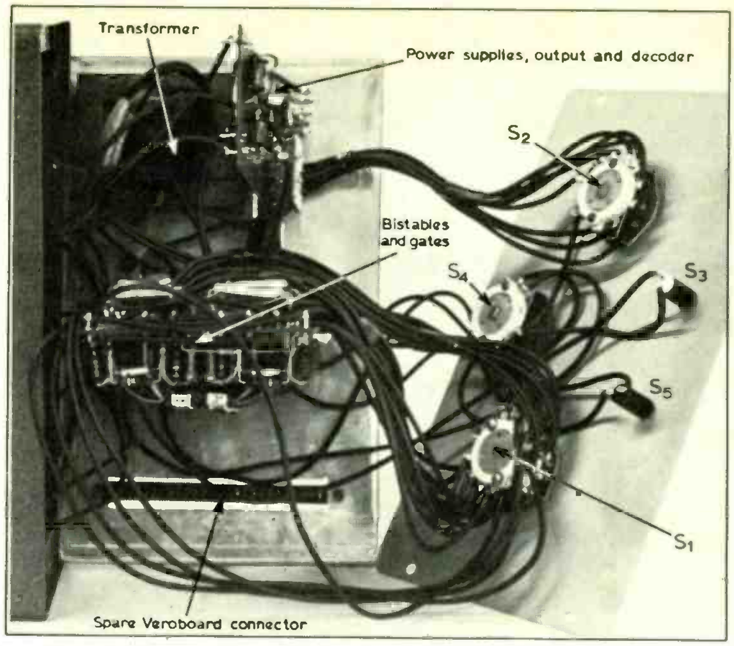
The completed timer



(Right) Fig. 7. Completed assembly.

Construction

The bistables and gates were built on a $5'' \times 3\frac{3}{4}''$ piece of Veroboard, and the power supply on a piece $3\frac{3}{4}'' \times 2\frac{1}{2}''$. The high packing density to achieve this was facilitated by pre-assembling the bistable circuits—the photographs make this clear.

No indicator lamps were used in the prototype, as the timer is used for colour printing which is carried out by the author in complete darkness—even a red light would affect the colour emulsion.

Operation

The mode of operation is selected by S_4. In the auto position, the exposure is made by depressing and releasing the start button, S_5, the duration being set by the position of S_1 and S_2. This can be cut short, if required, by depressing the stop button.

The focus position allows the lamp to be run at half power. In this way a larger lamp can be used in the enlarger without overheating it, as it is left on for the longest period whilst the desired size and framing of the print is chosen. The final focusing can be carried out at full brightness by pressing and holding the start button. Alternatively, the manual position of S_4 can be used, which allows the exposure to commence by pressing S_5, and finish by pressing S_3.

The timer described offers a method of timing based on a logarithmic law, with high accuracy and repeatability, and can be used for timing enlargements in black-and-white and colour.

Nearly all serious amateur photographers who process their own colour prints use the "white light" (one-exposure) method; whereby the colour corrections are made by inserting subtractive colour filters in the path of the light. This timer enables the tri-colour (three-exposures through red, green and blue filters) method to be used too. This has hitherto been almost impossible, as the inaccurate repeatability of other methods of timing made the cancellation of colour imbalance a matter of chance.

The timer also allows small adjustments to the exposure to be made without affecting the colour balance.

When used with the "white light" method, the timer allows the use of logarithmic filter factors, (see App. IV). This simplifies the calculation of exposures when changing filters to addition and subtraction, instead of multiplication and division.

The spare Veroboard connector indicated in Fig. 7 is reserved for circuitry allowing audible indication of completed timing periods. No further details are given here, but the author hopes to publish details shortly.

Appendix I

Consider a counter of k stages, with an input pulse period of τ_k secs, then the period of the next stage is τ_{k-1} secs, $(=2\tau_k$ secs.) etc. to the first stage, the period of which would be τ_1 $(=2^{k-1}\tau_k)$ secs.

The k-stage counter could exist in 2^k different states. If the counter started counting from zero to a number, then the time T, taken to reach this number would be:—

$$T = \phi\tau_k = 2^{1-k}\phi\tau_1$$

where ϕ is an integer.
Expanding,

$$= a_1\tau_1 + a_2\tau_2 + a_3\tau_3 \ldots\ldots a_{k-1}\tau_{k-1} + a_k\tau_k.$$

The coefficients,
a_1 a_2 etc. can have the value of O or I, as the output of each stage of the counter can only be one of two states.
Thus:

$$a_1a_2a_3 \ldots\ldots\ldots a_{k-1}\,a_k$$

is a binary number equal to ϕ.

In this design selection can be taken from only half of the possible states of the counter, as states are selected only when $a_1 = 1$.

ϕ is therefore an integer between 2^{k-1} and 2^k; there are $2^k - 2^{k-1} = 2^{k-1}$ integers, of which n are chosen so that $T = 2^{a/n}\tau_1$ (a = an integer between O and $n-1$)

$$\therefore \phi = 2^{a/n}.2^{k-1}.$$

The binary equivalent of each state is therefore obtained by calculating the binary number equal to the appropriate root of 2 and multiplying it by 2^{k-1}. (This, in effect, merely removes the "decimal" point from $2^{a/n}$ expressed in binary form).

Appendix II

Calculation of the binary equivalent of $2^{x/n}$

If a binary number equal to $2^{x/n}$ is written:

$$1.a_1a_2a_3a_4 \ldots\ldots a_n$$

(the most significant digit must be an I)

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Then, $a_1 = \frac{1}{2}$ (decimal) $\quad a_1 = 2^{-1}$ or O

$a_2 = \frac{1}{4} \quad a_2 = 2^{-2}$ or O

$a_3 = \frac{1}{8} \quad a_3 = 2^{-3}$ or O

$a_n = 2^{-n}$

Each digit may, of course, be zero, depending on the number changed to binary notation.

The decimal fraction of $2^{x/n}$ is first calculated, and all possible coefficients of the binary number are subtracted from the fraction. A I is written for each possible subtraction, and a O for each impossible one.

The following example will make this procedure clear.

Example

Calculate the binary equivalent of $2^{\frac{1}{2}}$

$$\log.2 = 0.3010300$$
$$\div 2, = 0.1505150$$
$$\text{antilog} = 1.414214$$

Decimal	Binary
1.414214 1	I
0.414214 0.5 0.25	IO IOI
0.164214 0.125	IOII
0.039214 0.0625 0.03125	IOIIO IOIIOI
0.007964 0.015625 0.007813	IOIIOIO IOIIOIOI

∴ binary number equal to $2^{\frac{1}{2}}$, to seven significant digits.

= I.OIIOII

and the "binary equivalent" is IOIIOII.

Appendix III

Calculation of errors

The decoding error is the ratio of the decimal equivalent of the binary number used for decoding, to the actual decimal number.

For example, the decimal equivalent of IOIIOII is $1 + 0.25 + 0.125 \ldots$ etc. $= 1.421875$.

The percentage error is, therefore,

$$\frac{100(1.421875 - 1.414214)}{1.414214} = 0.542\%$$

The maximum percentage error is plus or minus the duration of the $^{(k+1)}$th. significant digit, as a percentage of $2^{1/n}$.

Hence:

Maximum decoding error $= \pm\, 100.2^{-k}.2^{-1/n}\%$.

The maximum error for this equipment is therefore, $\pm 0.85\%$.

Appendix IV

Filter factor conversion table

To find the logarithmic value of the filter factor, (filter value *Fv*) read the time value in the top row, and the fractional time value in the left column, for the appropriate factor.

E.g. find the filter value of 6: Nearest factor = 6.2; $Fv = 2\frac{5}{8}$.

	0	1	2	3	4
0	1.0	2.0	4.0	8.0	16
1/8	1.1	2.2	4.4	8.7	17
1/4	1.2	2.4	4.8	9.5	19
3/8	1.3	2.6	5.2	10.5	21
1/2	1.4	2.8	5.7	11.5	23
5/8	1.5	3.1	6.2	12.5	25
3/4	1.7	3.4	6.7	13.5	27
7/8	1.8	3.7	7.3	14.5	29
1	2.0	4.0	8.0	16	32

When changing filters, the sum of the filter values of the old pack is subtracted from, and the sum of the filter values of the new pack is added to, the exposure (in time values).

Tables for fractions other than $\frac{n}{8}$ can be calculated from the expression:

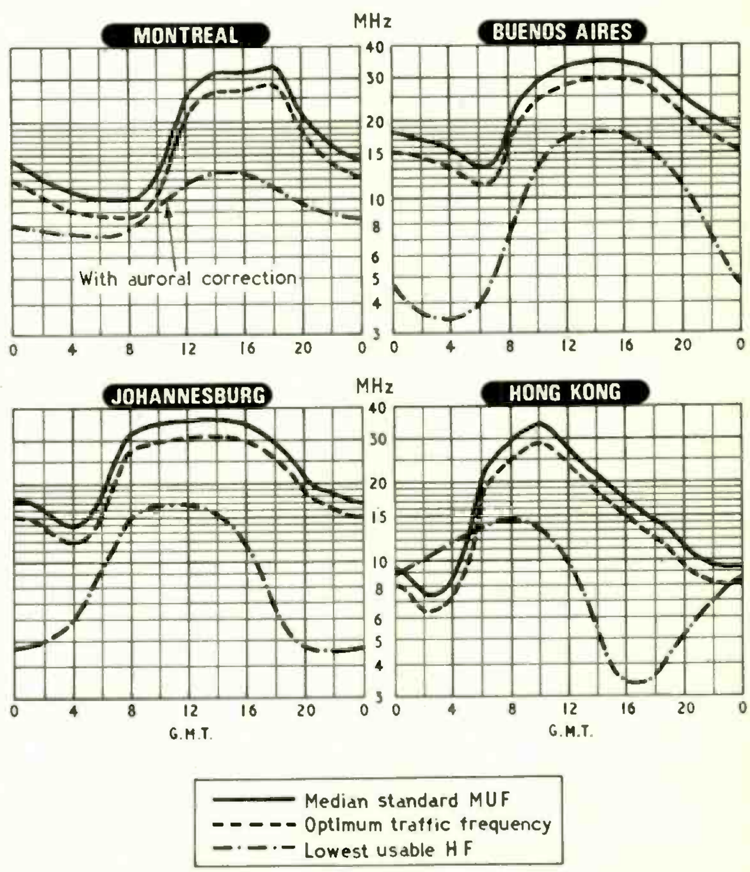
$$\text{filter factor} = 2^{Fv}$$

REFERENCES

1. Smethurst, P. C., "Electronic Devices", *Wireless World*, August 1967. p. 404 (Letters).
2. "Wireless World Digital Computer," *Wireless World*, August 1967, pp. 369–371.

H.F. Predictions—January

Ionospheric and magnetic storms are becoming more frequent, a rough pattern being two disturbed periods per month spaced by about ten days. The 27-day recurrence cycle, which is moderately successful as a basis for long-term forecasts, places the first disturbance around the 5th to 9th. Paths crossing the auroral zones are subject to a variable excess, sometimes total, absorption. Most of the variations can be overcome by operating near the FOT as indicated by the Montreal LUF curve. When this correction is not required the predicted LUF drops to 3MHz from 22.00 to 08.00 G.M.T. and peaks to 8MHz at 16.00. All LUFs are calculated by Cable & Wireless for reception in the U.K. of point-to-point telegraph transmissions at quiet sites with directive aerials.



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Wireless World Colour Television Receiver

8. I.F. amplifier construction and alignment

Several photographs show the layout of components on the printed-circuit i.f. board. The main copper area is at chassis potential and the −20-V supply line is a copper ring around the periphery of the board. As explained in Part 7, the positive of the supply is the earthy side.

The transistors used in the vision i.f. stages are types BF167 for the first stage and BF173 for the other two. These are metal case types with a small projecting tag. Held upside down with this tag towards one and looking at the four connecting wires, the connections are base, emitter, collector and screen, starting with the wire to the left of the tag and going round clockwise. The BF184 for the video stage has the same connections.

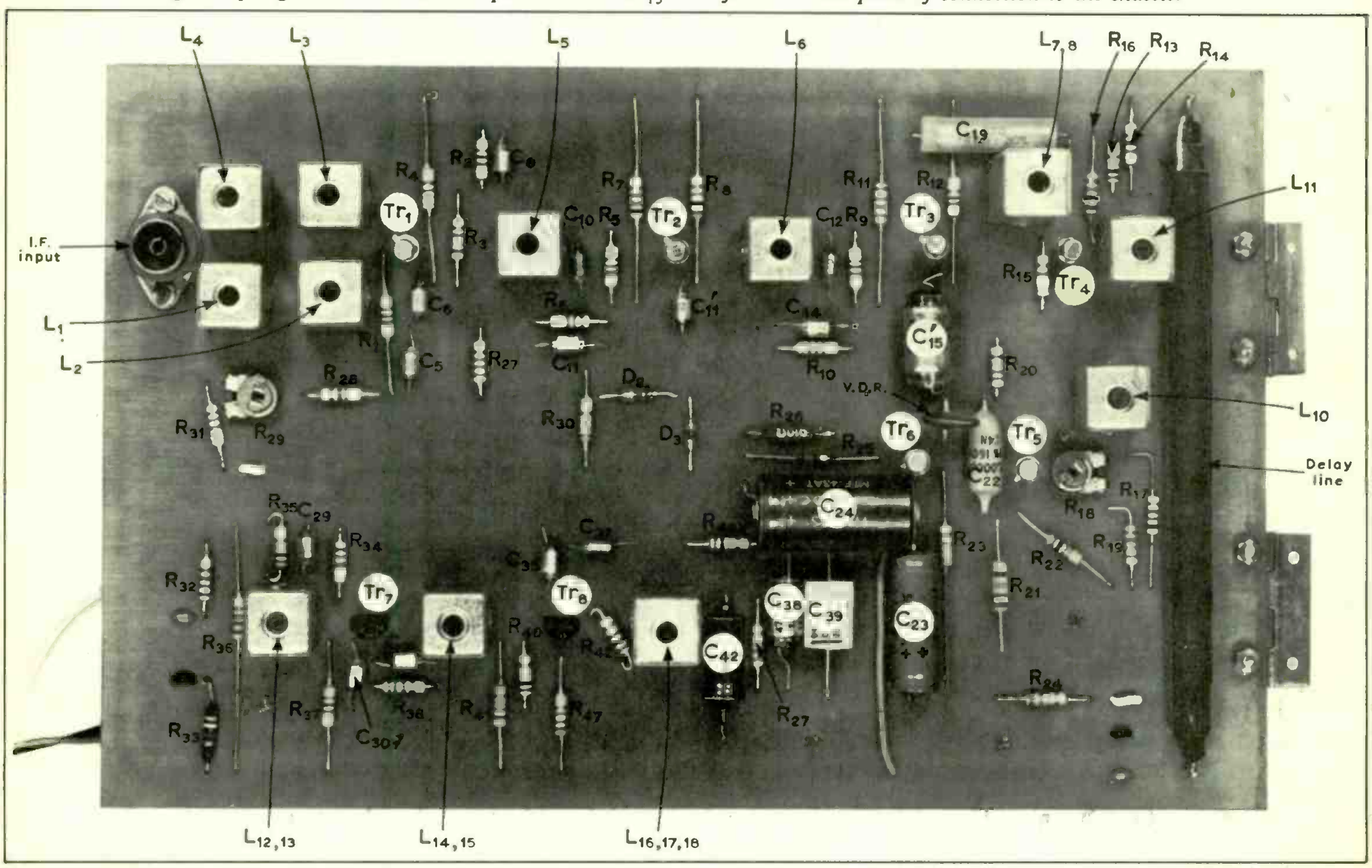
In the sound i.f. amplifier BF194 transistors are used. These are in moulded cases and held upside down with the flat side of the case towards one the connections are base, emitter, collector, starting from the left. Apart from their cases the BF184 and BF194 are substantially identical.

The BC108, used for the a.g.c. circuits, is a metal-case type with a tag at the side, like the BF167, BF173 and BF184, but there are three leads only. Note particularly that the order of connection is different; going clockwise and starting with the lead on the left of the tag, the order is emitter, base, collector.

Before mounting them it is a good plan to check all transistors and diodes with an ohmmeter. With the Model 8 Avometer on the ohms range, the forward resistance between base and emitter is about 1.8kΩ and the back resistance is too high to indicate; between emitter and collector the resistance both ways is too high to indicate.

The BC108 type has a somewhat lower forward resistance between base and emitter, around 1kΩ. Diodes have a lower

Top view of the complete vision and sound i.f. amplifiers, first video stage and a.g.c. system. Note that C'_{15} of 0.01 μF is not shown in the circuit diagram of Fig. 1, Part 7. It is in parallel with C'_{15} save for its actual point of connection to the chassis.



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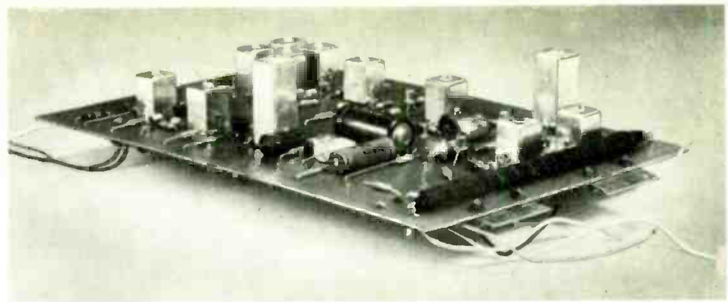
forward resistance which varies from about 500Ω to 1kΩ according to type, and a back resistance too high to indicate.

The test is a rough one and shows only gross defects. Nevertheless it definitely indicates a broken-down junction, for this will show low resistance in both directions. The test is also useful when the components are wired in circuit, but it is then less definite for there are nearly always other resistances in shunt which prevent an infinite reading of back resistance from being obtained. However, usually the resistance read in the forward direction will be lower than that in the backward.

The test can also be used to indicate the 'way round' of diodes for in some types this is not always completely clear from their marking. The forward direction of low resistance is, of course, with the positive of the ohmmeter battery applied to the anode and the negative to the cathode. It is all a little confusing, however, because it is the cathode of the diode which is indicated in red when a coloured marking is adopted because, when a diode is used as a rectifier, the d.c. output is positive at the cathode.

Then with the usual multi-range meter the terminal marking and lead colours are normally arranged to indicate polarity for the measurement of an external voltage, which means that when used as an ohmmeter with an internal battery the polarity of the voltages available at the leads for external use is the other way round. Thus, with the usual meter, forward conduction of a diode is obtained when the positive terminal of the meter is connected to the diode cathode!

It is advisable, of course, to check all components before mounting them. One does occasionally meet with good parts which are wrongly marked. In colour coding, brown and red or yellow and orange can be mistaken for each other in some lights, especially if all the resistors are not of the same make. This warning is not just academic, it actually occurred in the development of the equipment. A resistor coded for 4.7kΩ turned out to be 470Ω; this was actually wrongly marked for there was no question but that the band was red.

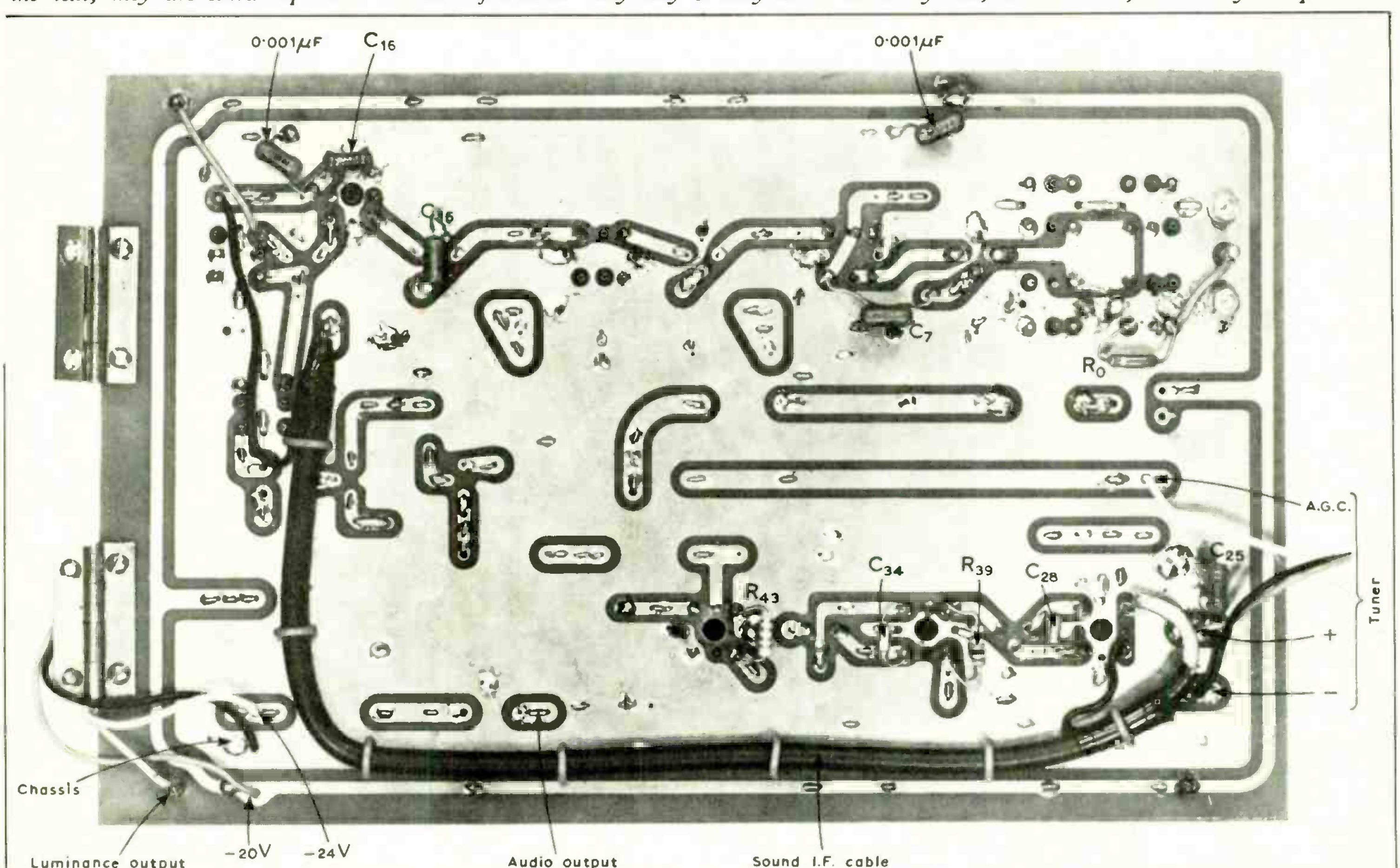


General view of the i.f. board with the sound channel towards the front of the picture and the delay line on the right.

When mounting components on the printed circuit it is advisable to bend over the ends of the leads before soldering. It is advisable, however, not to have the component resting on the board on one side and the leads bent over tightly on the other. With the component resting on the board and the leads through the mounting holes in the board, bend the leads at right angles with about 1/16-in clearance from the board. Then solder the leads to the board so that the component itself stands clear of the board by this amount.

This greatly facilitates the removal of the component if it should ever be necessary. By applying a soldering iron alternately to the two leads while pressing gently on the component it can be pushed back against the board so that the bent ends of the leads stand clear and can be straightened. A second application of the iron then allows the component to be easily removed.

Under view of the printed-circuit board. The two capacitors marked 0001 μF are not shown on the circuit diagram. As explained in the text, they are extra capacitors to reduce feedback. They may or may not be necessary and, in some cases, others may be required.



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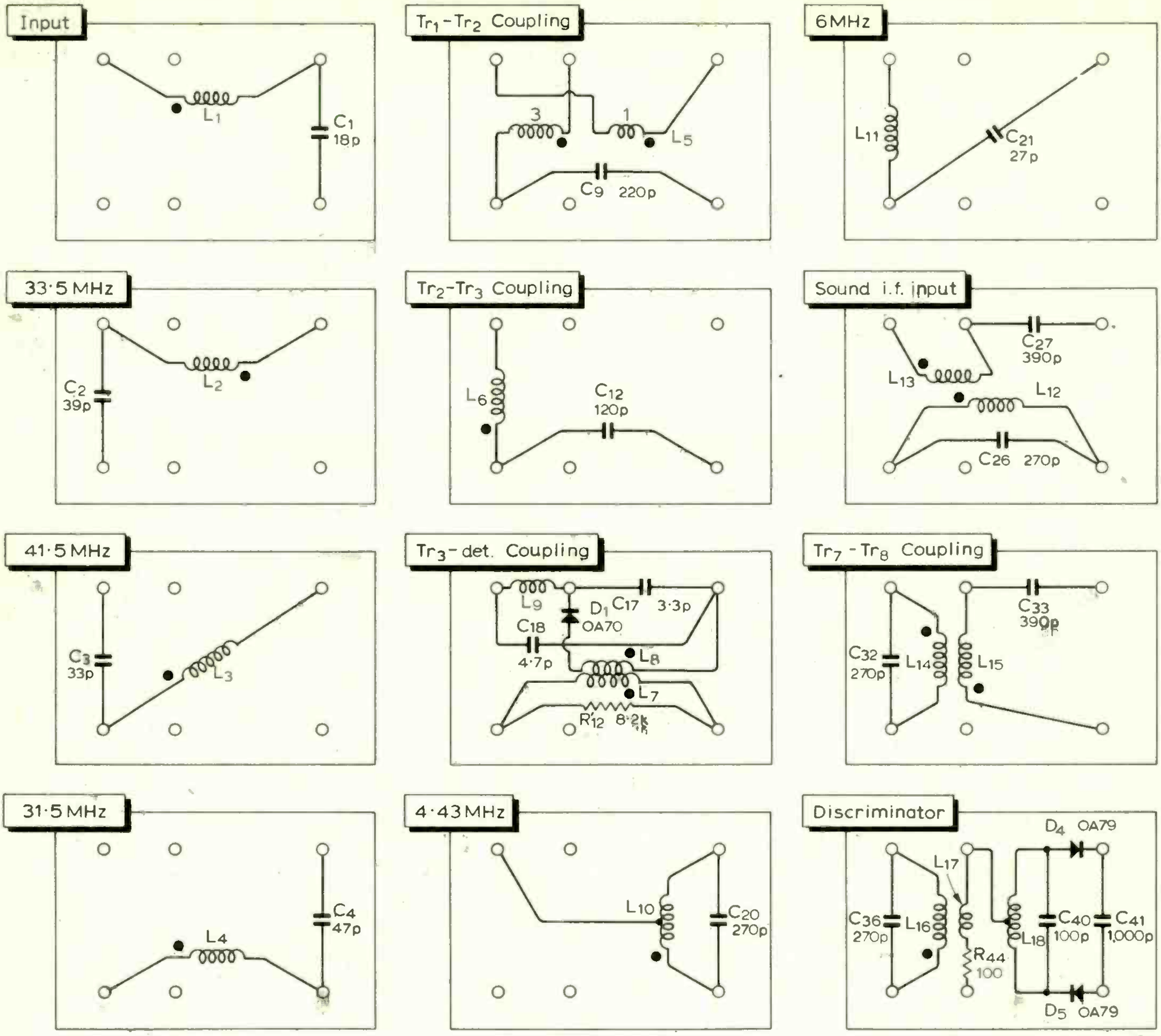

Coil	Wire Gauge	Turns	Coil	Wire Gauge	Turns	Coil	Wire Gauge	Turns
L_1	30	15	L_6	24	5½	L_{12}, L_{13}	40	22each spaced 3.5mm*
L_2	24	14	L_7, L_8	38	25each bifilar	L_{14}, L_{15}	40	22each spaced 3.5mm*
L_3	24	11	L_9	42	75 on Neosid CH_2 core			
						L_{16}	40	18†
L_4	24	14	L_{10}	38	36 C.T.	L_{17}	40	12†
L_5	24	3 + 1	L_{11}	42	70	L_{18}	42	25+25 bifilar†

*L_{12} and L_{14} are at the bottom of the former

†L_{18} is at the bottom of the former L_{17} is spaced 2.5mm from L_{18} L_{16} is at the top of the former with no spacing from L_{17}

All wire is s.w.g. enamelled copper. All coil connections are as viewed from underneath.

Fig. 1. In Part 7 the type numbers were given of Brayhead coil formers and cans. These are no longer available but identical parts can be obtained from Neosid under different type numbers. With two exceptions, all formers are type 722/1 with cans 7100. The exceptions are $L_{7, 8}$ and $L_{16, 17, 18}$, which have 722/4 formers and 7101 cans. All formers required a terminal base 5027. They all have a diameter of $\frac{3}{16}$ in.; the available winding length of the short ones is $\frac{5}{8}$ in. and that of the long ones $1\frac{9}{16}$ in. $L_{7, 8}$ and L_{18} have Neosid long screw cores $4 \times 0.5 \times 12.7$; all other coils have short cores $4 \times 0.5 \times 6/900$.

In particular, do not bend over the tags of the coil cans. If they are bent over the cans are very difficult to remove and in the process the tags usually break off. Let the tags pass straight through the board and let the solder pile up round the tags.

Details of the coils are given in one of the drawings (Fig. 1.) and in most cases the winding is straightforward. The vision-detector and the ratio-detector couplings are the most difficult because the whole detector circuits are included in the cans as well as the coils. The difficulty arises because there is little room within the cans and great care must be taken to avoid

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short-circuits to the cans. Physically small components and subminiature diodes are essential.

The board is mounted on a pair of hinges alongside the luminance-amplifier board and connected thereto by leads of just sufficient length to permit either board to be lowered to the horizontal position with the other vertical. This can be done without the video lead exceeding about 3 inches, and the length of the others is not important. On the vision side all coil cores except that of the detector coupling are adjustable from the top; only the detector is adjustable from the bottom. On the sound side, however, each can has two cores, one adjustable from the top and the other from the bottom.

Details of the delay line will be given in a future article. It is not necessary until the colour circuits are brought into operation and on monochrome it serves no useful purpose save to provide some i.f. filtering. Until the colour circuits are operating, therefore, it can be replaced by an r.f. choke, which can be a duplicate of L_9.

The tuner used is a commercial one and is the A.B. Metal Products "U.H.F. Quarter Wave Transistor Tuner". The connections for it are given in Fig. 2. This has two transistors, one acting as an r.f. amplifier and the other as a mixer-oscillator. This particular tuner consumes about 6mA at full gain and about 10mA at low gain, at 12V. For it, resistor R_{32} is made 560Ω and R_{33} is 100Ω and a resistor of 2.2kΩ is connected between the two, but at the tuner end. This arrangement gives a tuner supply which varies between about 10V and 12.5V with a.g.c. and brings the negative tuner line above the −20-V line by the proper amount to give the correct minimum bias to the r.f. stage.

The drawings show the tuner connections. In addition to the components which are mounted on the underside of the printed circuit board of the tuner and which are supplied with it, a 470-Ω resistor R' is connected as shown for the emitter resistor of the r.f. stage; a 2.2kΩ resistor R'' is connected between the tuner positive and negative lines and a capacitor C' of 68pF is connected between the X terminal and the tuner case, the coaxial output cable being joined across this. This cable should not exceed 2ft in length and the capacitance actually used for C' must be modified in accordance with the length of cable actually used so that the total measures 72pF.

In normal commercial practice receivers are dual standard and cover Bands I, III, IV and V. This receiver is 625-line only and covers only Bands IV and V. The usual practice is to employ virtually two tuners, one for v.h.f. and the other for u.h.f. even if they are not physically separate. Generally, on u.h.f. the v.h.f. mixer is converted to an i.f. amplifier. The net result is that on u.h.f. there is one more i.f. stage operative than on v.h.f.

We are using a u.h.f. tuner feeding straight into a normal i.f. amplifier. The usual extra stage is missing and so the total gain is lower than is normal in commercial practice.

It was felt to be undesirable to fit an extra i.f. stage to the main amplifier because it was thought unlikely that adequate stability could be achieved. A trial shows that the sensitivity without this extra stage is adequate for many, if not for all, purposes. Used in central London with a normal u.h.f. aerial on the top of an eight-storey building, BBC-2 can be received well. A detector output of some 4V p-p can be obtained at well below maximum gain. If greater sensitivity is needed, it is not difficult to build a single i.f. unit which can be fitted to the tuner, and its separation from the i.f. amplifier proper will greatly ease stability problems.

Many tuners, of course, are designed for all television bands and if one of these is used it will include this extra i.f. gain. The tuner employed must be left to the constructor's choice, for it must be remembered that television tuners are not things which are normally freely available on the retail market, just because there is little demand for them.

Any tuner should be usable with changes only to the feed resistors R_{32} and R_{33} and, possibly, to the coupling capacitance, but the constructor will have to work out for himself just what is needed.

Whatever is used, a good slow-motion drive is essential. Tuning for colour is much more critical than for monochrome, and so the constructor must be prepared to fit a different drive from the one provided with the tuner if a practical test shows it to be desirable.

We now come to alignment. It is almost essential to use a swept-frequency signal generator (wobbulator) and oscilloscope. A normal signal generator is also needed.

For the initial alignment of the amplifier disconnect the tuner i.f. input and plug the output leads of the signal generator into the input socket of the amplifier. Use an isolating mains transformer to feed the equipment for safety's sake and to ensure that the signal generator is not damaged as it may be if it is earthed and the receiver is live to the mains. Connect a voltmeter (e.g. Model 8 Avometer on 10-V range) across R_{17}. It is advisable also to connect a 0.001-μF, or thereabouts, capacitor across this resistor as a temporary measure to reduce the chance of the voltmeter leads introducing instability. Connected at this point the meter introduces less stray feedback than if joined to the detector load. Disconnect one end of D_2 to render a.g.c. inoperative.

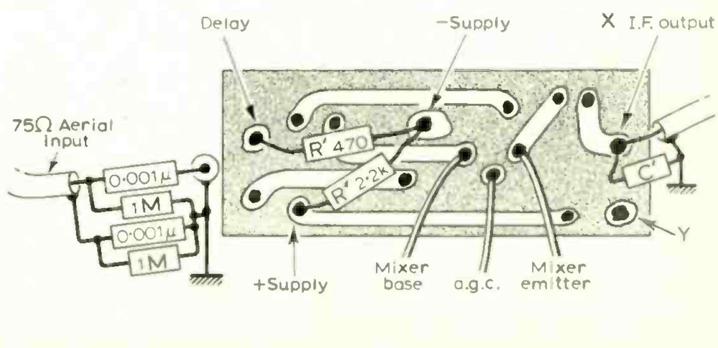
Set the signal generator (s.g.) to 37MHz and adjust the core of L_{7-8} for maximum output. The s.g. will have to give a large output at first, and this must be reduced as necessary for a reasonable indication on the meter. When possible work at about 2V output.

If no indication can at first be obtained, connect the s.g. between chassis and the base of Tr_3, inserting a 0.001-μF capacitor. There should then be no difficulty in obtaining sufficient output and, normally, an input of 20mV is needed for 2V output. The s.g. is unmodulated, of course.

Having tuned L_{7-8} at 37MHz, adjust L_6 and L_5 in turn for maximum output at 38.5MHz and 35.5MHz respectively with the s.g. connected to the input socket. Leaving the s.g. so connected adjust L_2, L_3 and L_4 for *minimum* output at 33.5MHz, 41.5MHz and 31.5MHz respectively. These adjustments are very critical and when the settings are nearly right the full output of the s.g. will probably be needed, and it may also be desirable to put the output voltmeter on the 2.5-V range.

It may happen that the tuning of the 31.5-MHz trap is much less determinate than the others. This is because it is trapping at a frequency at which the 33.5-MHz trap is still giving quite a lot of attenuation and the s.g. output may consequently not be enough to give a clear indication of proper tuning. If no reasonable proper setting can be found, screw the core temporarily

Fig. 2. Printed-circuit board of the tuner used in the development model. The actual arrangement used will depend upon the actual tuner employed and so must be worked out by the individual. In all cases, however, 0.001-μF capacitors should be connected between the aerial feeder and tuner, with 1-M Ω resistors as shown. This is because the chassis is live to the mains and the capacitors must be of at least 350 V working.



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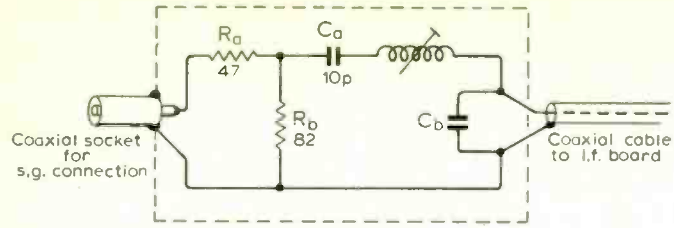

Fig. 3. Dummy tuner which can be used in place of an actual tuner for i.f. alignment.

right into the coil to make sure that at least it is not tuned above its correct frequency.

Now connect the s.g. between chassis and the emitter of the mixer stage in the tuner with a 0.001μF capacitor in series and connect the tuner cable to the i.f. board. Tune the i.f. circuit in the tuner for maximum output at 36MHz, and then L_1 of the i.f. amplifier. This completes the initial, somewhat rough, adjustments.

Replace the s.g. by the wobbulator and set it for a sweep of at least 15MHz centred on 37MHz. If it has no internal marker system or one of doubtful accuracy use the s.g. to provide a marker. The output to feed the oscilloscope can be taken from R_{17} or from the output of the delay line but with the latter the trace will be inverted. Adjust the controls to obtain a trace of reasonable amplitude. With the usual linear vertical amplifier of the oscilloscope it will not be possible to see at the same time the response within the pass-band and that due to the traps outside it. If there is a beautifully flat-topped response in the pass-band, beware; something is probably overloading!

To see the trap response it is necessary greatly to increase the input and overloading will then occur within the pass-band. Set up in this condition so that the three troughs of the traps, two below the pass-band and one above, can be seen. Set the marker to 33.5MHz and adjust L_2 so that the trough occurs precisely at this frequency. Then set the marker to 31.5MHz and similarly adjust L_4; it should now be quite easy to see when this is correctly tuned. Repeat with L_3 and the marker at 41.5MHz.

Now reduce the input so that the pass-band response shows clearly. Vary the i.f. gain control. Full gain will not normally occur with the control fully at one end of its travel. Starting from the maximum-gain end, the gain will usually increase slightly at first, reach a maximum and, as it is turned further, will steadily decrease. This arises because there is an optimum bias on Tr_1 for maximum gain. If R_{27} and R_{28} are chosen to provide this optimum bias with R_{29} at minimum-resistance, there is a danger that in some cases maximum gain would not be obtainable because of adverse component tolerances. In other cases, with tolerances the other way, the condition of reduced gain at minimum R_{29} could still occur. To avoid this R_{28} has been deliberately chosen so that with all likely tolerances maximum gain will be obtainable.

Increase R_{29} from the position of maximum gain, at the same time increasing the input if necessary and watch the shape of the response curve. Ideally, the shape of the curve should not change; in practice, it will do so. There are two factors which make it change. One is the variation of input and output impedance of Tr_1 with base bias. This cannot be avoided and the amplifier has been designed to minimize this effect. It will cause some change, but not a great amount. The second factor is feedback in the amplifier. The first thing to look at, of course, is the connection to the oscilloscope. Screened cable will, of course, be used, and a by-pass capacitor across R_{17} has already been recommended. There should be no trouble from this, therefore, but if touching the emitter affects the trace try 10kΩ in series with the oscilloscope lead and a further by-pass capacitor after it. Apart from this, try extra by-pass capacitors around the chassis, of 0.001–0.002μF. The capacitors mounted on the underside of the board, and visible in the photographs, are for this purpose and proved sufficient. The original hand-made model, which was referred to last month, actually needed rather more, which is a little surprising in view of the higher conductivity of copper sheet compared with deposited copper. One cannot guarantee that exactly the same by-passing will be needed in every case.

At this stage do no more than endeavour to reduce the change of shape with gain by extra by-passing. It will normally suffer a further reduction as the circuits are aligned for the proper bandwidth, for this will reduce the maximum gain and so the effects of any internal feedback.

The response at the high-frequency side of the pass-band is affected mainly by L_6, and L_7 is adjusted mainly for symmetry of response. The coil in the tuner has very little effect on the shape of the response for it is heavily damped by the mixer; it is normally adjusted for maximum amplitude of the trace. At the low-frequency end of the pass-band L_1 and L_5 have most effect.

Set the gain control for an output at least 6dB below maximum and if the equipment permits about 10dB below. Adjust L_7 for the best symmetry. Set the marker at 39.5MHz and adjust L_6 so that the marker appears half way down the high-frequency side of the response trace. At the same time adjust L_7, as necessary, to preserve a rough symmetry.

Set the marker at 35MHz and now adjust L_1 and L_6 so that the marker is half way down the trace on this low-frequency side, again adjusting L_7 as necessary for symmetry. If it is possible to obtain a 6-dB response at a frequency lower than 35MHz down to a minimum of 34.5MHz, well and good, but it is unlikely that it can be brought much below 35MHz since the bandwidth is limited by the trap circuits. Variations are likely to arise only because of tolerances on the capacitors in the traps.

The i.f. carrier is to be set at 39.5MHz and the 6-dB bandwidth must not be less than 4.5MHz if the colour components of the signal are to be passed. If it is a little greater, up to the maximum of 5MHz, definition will improve a little but there is a greater likelihood of sound-channel interference.

The aim in adjustment should be to secure a 4.5-MHz, or slightly more, bandwidth and within the passband the trace should be symmetrical and smoothly rounded with the maximum just below 37MHz.

When this has been achieved as nearly as possible increase the gain while watching the trace, and reducing the wobbulator output as necessary. Notice how the shape of the trace varies. If all is well the total bandwidth may increase slightly, although not to an extent which is noticeable without actual measurement. The curve is likely to become double-humped and the low-frequency hump may be a bit higher than the other. Readjust L_7 for equality of height of the humps and measure the peak-to-trough ratio and the 6-dB bandwidth. If the peak-to-trough ratio does not correspond to a ratio in excess of 1-dB, if the 6-dB bandwidth is not less than 4.5MHz, and if the 6-dB point still falls at 39.5MHz all is well, but it is now necessary to check that at low gain the response has not deteriorated too much. If it has, then a compromise adjustment may be needed. In general, it is more important to have the proper response at 6-10dB below full gain than at full gain, because the amplifier will rarely have to operate at full gain. If it did a.g.c. would not be working; for a.g.c. to work at all the i.f. gain must always be below maximum, for it comes into action first on the i.f. amplifier.

If it should happen that the shape of the response is affected much more than has been indicated by the gain control, then one must get down seriously to tracing the causes of feedback in the amplifier, for such feedback is almost certainly the cause of the trouble.

The sound i.f. amplifier is adjusted using the s.g. set at 6MHz. Connect it through a capacitor between chassis and the bases of Tr_8 and Tr_7 in turn, adjusting L_{16} first and then L_{14} and L_{15}

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for maximum output as read on a voltmeter connected across C_{42}. Then connect the s.g. between chassis and the base of Tr_4, again with a series capacitor, and adjust L_{12} and L_{13}. Readjust all cores except L_{18} carefully for maximum output. Set the s.g. output so that there is some 3V to 6V across C_{42}. Pick a pair of matched resistors of some 80-200kΩ. The exact value is unimportant but it is necessary that they should be alike within some 1%. Connect them in series across C_{42} and join a milliammeter from their junction to the junction of R_{46} and C_{38}. The 1-mA range of the meter can be used at first and reverse the meter leads if it reads wrong way. Adjust L_{18} for zero current. Turning the core one way will increase the current, turning it the other way will reduce it. It does not follow that the way of reducing current is the correct one, for the initial setting may be one which is right outside the range of the discriminator. If turning the core to reduce the current does not bring it to zero and then reverse the current, turn it the other way. It should then pass through a maximum, come right down to zero and then reverse. For a precise zero setting reduce the meter range to 50μA and check the zero-setting of the meter.

Now readjust the primary L_{17} for maximum voltage across C_{42}, and then check the zero setting of L_{18}.

With the signal generator still applied to the base of Tr_4 and still set at 6MHz connect an oscilloscope to the collector of Tr_4. The oscilloscope must be one having a Y amplifier which gives at least fair gain at this frequency and the input to Tr_4 should be no more than is needed to give a reasonable height of trace. Adjust L_{11} for minimum output. If the timebase can be adjusted to observe the waveform it will probably be found that this minimum is at 12MHz, the second harmonic of the input, the fundamental output being too small to be seen. This arises partly because of harmonics in the source but mainly because the input is being applied to a transistor which is initially biased at cut-off and which thus acts as a good harmonic generator.

Now set the s.g. to 4.43MHz and adjust L_{10} for minimum output. This circuit will give only a small reduction of output when tuned.

When aligning the amplifier it is neither necessary nor desirable to have the timebases and luminance stage operating. They can all be put out of action by removing the fuse F_2 of Fig. 1, Part 4, so that only the transistor power supply is operative.

With only tuner and i.f. amplifier working, one can search for a signal using the oscilloscope connected to the emitter of Tr_4 as an indicator, although it is helpful to have an audio amplifier and loudspeaker connected also. When tuned for maximum vision signal no trace of the colour burst will be visible. Tuning to the 6-dB point at 39.5MHz should make the burst distinctly visible. As transmitted it has the peak-to-peak amplitude equal to that of the sync pulse, but as displayed on the oscilloscope it will have an amplitude of only about one-half of this, since it falls at or near the other 6-dB point of the response curve. For it to be seen at all, of course, the oscilloscope itself must be able to respond to it and it is necessary, therefore, for its amplifier to have a response extending to at least 5MHz. This will also be necessary for checking in the colour circuits.

If the colour burst is not obtainable, do not at once conclude that something is wrong. BBC2 does not always transmit a colour signal; there are occasions when only a monochrome picture is transmitted and with this there is no colour burst!

There are two controls on the i.f. board which must be set on a signal. They are R_{29}, Set i.f. Gain, and R_{18}, Set Signal Level. With a weak signal both will have to be set for maximum output. With a moderately strong signal a.g.c. will control so well that R_{29} may appear to have little effect, for as i.f. gain is increased by this control a.g.c. acts to offset its action. It does, however, affect the ratio of i.f. to r.f. gain and so may under some conditions of signal strength affect the signal-to-noise ratio. In general,

VOLTAGE TABLE

Stage	With No Signal			With Typical Signal		
	V_R	V_F	V_C	V_R	V_R	V_C
Tr1	3.5	2.8	14.7	4.7	4	12.5
Tr2	9.9	9.35	18.7	9.6	9	18.1
Tr3	3.9	3.3	18.7	3.8	3.1	18.1
Tr4	0.6	0	18.6	6	5.2	12.4
Tr5	0	2.8	9.4	3.1	2.95	4.5
Tr6	0.75	0	0.15	0.66	0	4.5
Tr7	2.15	1.5	11.6	0.82	1.4	11.4
Tr8	10.2	9.6	18.4	9.6	9.15	18.1
C_{42}	0			3.5		
Tuner Total Current (mA)	4.8			8.3		
Voltage Supply at Tuner	12			9.8		
—Ve of Tuner Supply	1.4			3.35		
Tuner a.g.c. line	3.5			6.2		
I.F. a.g.c. line	3.55			4.8		

All voltages measured from the −20−V line except for the 'supply voltage at tuner' and with model 8 Avometer. Note: At the time of test the amplifier supply was 18.7V only.

therefore, R_{29} should be adjusted for the best results while watching a picture.

The normal operating output at the emitter of Tr_4 is about 4V p-p of vision signal including sync pulse; i.e., from the tip of the sync pulse to peak white. This gives an output signal to the picture tube which is normally greater than is necessary and which is reduced to the proper value by the contrast control. If the signal is strong enough, the output should be adjusted to 4V p-p by means of R_{18}. The minimum output from Tr_4 for a reasonable picture with the contrast control at maximum is about 2V p-p.

A table of voltages in the i.f. board is included with this article. Those for the no-signal condition should reproduce themselves reasonably closely in different amplifiers. Those for the signal condition naturally apply only for a particular signal input and are included only to give some guidance about the sort of changes which occur with a signal.

In conclusion, if it is desired to carry out i.f. alignment without a tuner it can be done fairly well by using a dummy tuner coil. Make another coil identical with L_1 and connect it in the arrangement shown in Fig. 3. For an s.g. of 50-Ωoutput impedance the two resistors are not needed; but with the usual 75-Ω output they are wanted. The connection between the dummy and the i.f. board is made using the piece of cable which will be used with the tuner. The coil in the dummy is then treated just as if it were the i.f. coil of a tuner. The coil is a reasonable approximation to an actual tuner output circuit, but final alignment must always be done with the actual tuner.

Notes

In the photographs of the luminance amplifier in Part 6 a capacitor is shown labelled C_{22}. This is in error. It should be labelled C_3. In Fig. 1, Part 7, the Set i.f. level control is labelled R_8 instead of R_{18}.

The printed-circuit board used for the i.f. amplifier described in Part 7 and in this article was supplied by Stanmore Electronic Services of 40 Coledale Drive, Stanmore, Middlesex. It costs 22s. 6d. plus 1s. 6d. postage.

Additional Reading

Colour Receiver Techniques, by T. D. Towers, is based on the twelve articles originally published in *Wireless World* from January to December 1967. It gives an account of current U.K. colour receiver practice. The emphasis is practical rather than theoretical. The first seven chapters describe the signal handling parts of the set. Chapter 8 describes power supplies, and chapter 9 aerials for colour television. The final two chapters describe test equipment and the "setting-up" of the colour receiver. The book is provided with a comprehensive index. Pp. 88. Price 35s. Iliffe Books Ltd., 42 Russell Square, London W.C.1.

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Codes and Code Converters

2. Mapping techniques and code converters

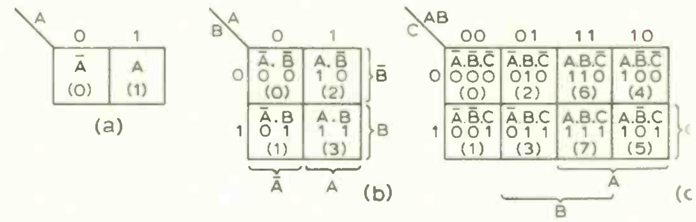
by N. M. Morris, B.Sc., M.I.E.E., M.I.E.R.E.

The various types of code systems described in Part 1 (Nov. 1968) can be displayed pictorially in a form which has become known as the Karnaugh map, after M. Karnaugh, its inventor.[1,2,3] A simplified treatment is given here to introduce mapping methods to readers who are unfamiliar with the technique. In what follows positive logic levels (see Part 1) are assumed, unless a statement is made to the contrary.

In the discussion of logic in Part 1 it was stated that the whole population of any community could be divided into binary combinations. If the whole population is represented by the area inside the whole rectangle in Fig. 9(a), then its division into two sections comprising those who are A, say adults for example, and those who are NOT A ($\bar{A}$) is as shown. The fact that the two divisions are allocated equal areas on the map is of no mathematical significance. In the figure A is allocated the value or "weight" of unity while $\bar{A}$ is given zero value.

When two variables A and B are considered there are 2^2 or 4 possible combinations. These are shown by placing two one-variable maps side by side as in Fig. 9(b). Variable A is now given the value 2_{10} or 10_2, and B the value unity or 01_2. Both $\bar{A}$ and $\bar{B}$ have zero or 00_2 value. The upper left-hand cell in Fig. 9(b) is the intersection of $\bar{A}$ and $\bar{B}$. It is therefore given the value 00_2 or zero. The upper right-hand cell is the intersection of A and $\bar{B}$ and has the value $10_2 = 2_{10}$. Other cells are located in this manner.

N. M. Morris, who graduated from Kings College, Durham University (now the University of Newcastle-upon-Tyne), spent 11 years in industry and then went to the North Staffordshire College of Technology, where he has been for the past 10 years and is now a senior lecturer in electrical and electronic engineering. His first book, on control engineering, has just been published.



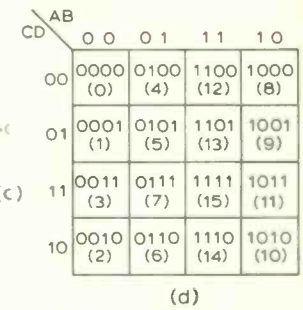


Fig. 9. Karnaugh maps for (a) one, (b) two, (c) three and (d) four variables.

A three-variable map comprises two two-variable maps placed side by side as shown in Fig. 9(c). A feature of the Karnaugh map is that the change in the binary combination when moving from one cell to an adjacent one is a unit-distance change. That is, the code combination changes by only one bit. Consider cell $AB\bar{C}$ (110_2). The adjacent code combinations are 010, 100 and 111 which are unit-distance changes from 110.

A four-variable map comprises two three-variable maps placed side by side as shown in Fig. 9(d). Here the weights given are $A = 1000_2$ (8_{10}), $B = 0100_2$ (4_{10}), $C = 0010_2$ (2_{10}) and $D = 0001_2$ (1_{10}) with $\bar{A} = \bar{B} = \bar{C} = \bar{D} = 0000$. As the Karnaugh map increases in size it is necessary to provide a method of locating the cells and to this end the code combinations of A and B are listed along the top of the map and combinations of C and D are shown down the left-hand side of the map. The code combinations for the various cells are as shown and it should be noted that the change between adjacent cells is again unit-distance. Inspection of the top and bottom rows of the matrix shows that each cell at the top of a column may be regarded as being adjacent to the cell at the bottom of the column since the change between them is a unit-distance one. This leads to the idea of a cylindrical version of the map in Fig. 10 in which the top and bottom of Fig. 9(d) are joined. Inspection of the left-hand and right-hand columns of Fig. 9(d) shows that adjacent cells exist. All adjacent cells can be connected by joining the ends of Fig. 10 together to form a toroidal shape.

A five-variable map is constructed by placing two four-variable maps side by side and a six-variable map by placing two five-variable maps side by side. This is about

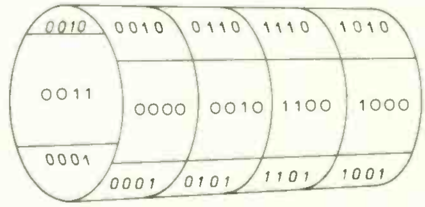


Fig. 10. The Karnaugh map may be wrapped in the form of a cylinder since the upper and lower cells are adjacent.

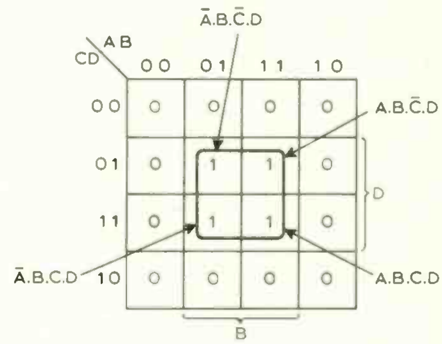


Fig. 11. Minimisation of the logical function using the Karnaugh map.

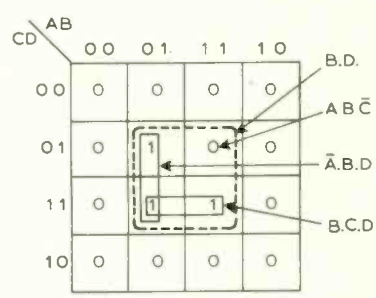


Fig. 12. Illustrating a method of grouping an odd number of cells.

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the useful limit of the Karnaugh map since both five- and six-variable maps call for considerable mental gymnastics in their use.

Minimisation using the map method

Logical problems are presented in many forms and it is often necessary to reduce the problem to its simplest form, known as the minimal form.

Consider the statement

$$Y = \bar{A}.B.\bar{C}.D + A.B.\bar{C}.D + \bar{A}.B.C.D + A.B.C.D$$

Each term is shown on the Karnaugh map in Fig. 11 as a "1"; the expressions in the other cells, being non-existent, have the value zero. The simplest expression for Y can be deduced either by a process of logical algebra from the above expression or from the Karnaugh map. The latter method is discussed here.

By associating blocks of adjacent cells in binary groups i.e. 2, 4, 8, 16 etc., the simplest expression can be obtained. In Fig. 11 the four cells are all adjacent to one another and can be grouped as the intersection of B and D, giving

$$Y = B.D$$

When an odd number of cells has to be grouped, three in Fig. 12, it is not usually possible to reduce the relationship to the simple form above. Here binary groupings of adjacent cells are made until all the cells marked with 1s are covered. In Fig. 12 the minimal solution obtained by this method is the logical sum (OR) of the two groups of 1s enclosed in the full lines, that is

$$\bar{A}.B.D + B.C.D = B.D(\bar{A} + C) \qquad (1)$$

An alternative approach is to say that the three 1s in Fig. 12 describe the area which is (B AND D) AND NOT the cell $A.B.\bar{C}.D$, that is

$$B.D.\overline{A.B.\bar{C}.D} \qquad (2)$$

The form of network which satisfies Fig. 12 which is finally chosen is dependent on which of equations (1) or (2) is the most convenient. If the function $(\bar{A} + C)$ is formed at some other point in the network and the function $\overline{A.B.\bar{C}.D}$ is not, then the form given by equation (1) is used, otherwise the network of equation (2) may offer advantages. The logical network satisfying equation (1) is shown in Fig. 13.

The minimal network is the one which gives the minimum number of logic gates together with the minimum number of interconnections between them.

"Can't happen" conditions

In many code sequences certain combinations cannot be allowed to occur. These are described as "can't happen" conditions and are utilized in minimisation techniques to give simple solutions.

Consider a problem in which an output signal is needed if the conditions $A.\bar{B}.C.D$ OR $\bar{A}.\bar{B}.\bar{C}.D$ exist. In addition the following code sequences cannot possibly occur: $\bar{A}.B.\bar{C}.D$, $A.B.\bar{C}.D$, $A.\bar{B}.\bar{C}.D$, $\bar{A}.\bar{B}.C.D$, $\bar{A}.B.C.D$ and $A.B.C.D$. In Fig. 14 the code conditions which give an output are marked with 1s and the "can't happen" conditions with Xs.

Since the states marked with Xs can't happen they can be regarded as 1s for the purpose of minimisation. This allows Fig. 14 to be minimised as shown, which gives a simple network giving an output if variable D alone exists, irrespective of the conditions of variables A, B and C.

Codes represented on the Karnaugh map

The Karnaugh map is an ideal medium for plotting code sequences. Consider the codes given in table 13. The codes are mapped in Figs. 15(a) and (b) for the 8421 b.c.d. and unit-distance codes respectively, the numbers in the cells representing the decimal values of the code sequence. The start of the sequence (zero) is signified by S to avoid confusion with the zeros in the binary code groups and the first code combination (number one) is signified by W.

Non-decimal to decimal code converters

A method of determining the logical requirements for non-decimal to decimal code conversion for the code in Figs. 15(a) and (b) is shown in Figs. 16(a) and (b) respectively.

In Fig. 15(a) both the S and W conditions cannot be looped with any "can't happen" conditions, hence they must be defined in

Table 13—Codes illustrated on the Karnaugh maps in Figs. 15(a) and (b)

Decimal value	8421 b.c.d				A unit-distance code			
	A	B	C	D	A′	B′	C′	D′
S	0	0	0	0	0	1	0	0
W	0	0	0	1	0	1	0	1
2	0	0	1	0	0	1	1	1
3	0	0	1	1	0	1	1	0
4	0	1	0	0	1	1	1	0
5	0	1	0	1	1	1	1	1
6	0	1	1	0	1	1	0	1
7	0	1	1	1	1	1	0	0
8	1	0	0	0	1	0	0	0
9	1	0	0	1	0	0	0	0
10 to 15	X	X	X	X	X	X	X	X

S = "Start" or zero.
W = First code combination or number one.
X = "Can't happen" condition.

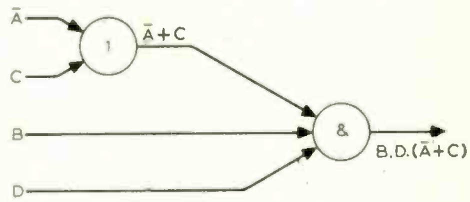

Fig. 13. One network which satisfies the Karnaugh map in Fig. 12.

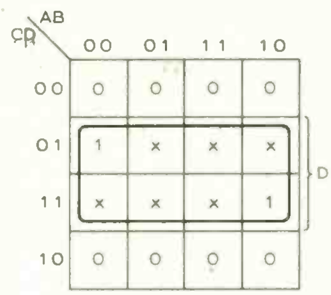

Fig. 14. "Can't happen" conditions can be utilised to simplify the solution of problems.

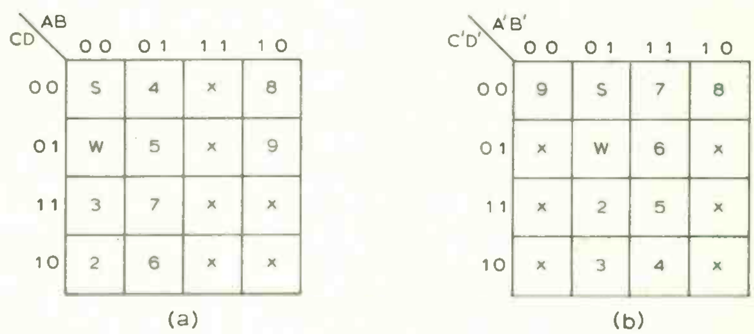

Fig. 15. Representation of (a) the 8421 b.c.d. and (b) a unit-distance code on Karnaugh maps.

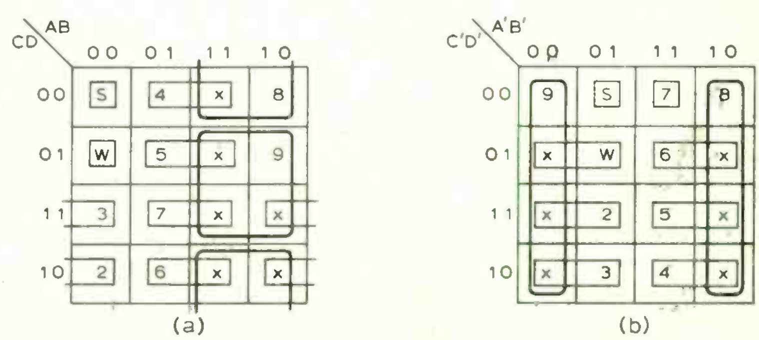

Fig. 16. Possible grouping of cells to give the code converter logic for (a) the 8421 b.c.d. and (b) a unit-distance code.

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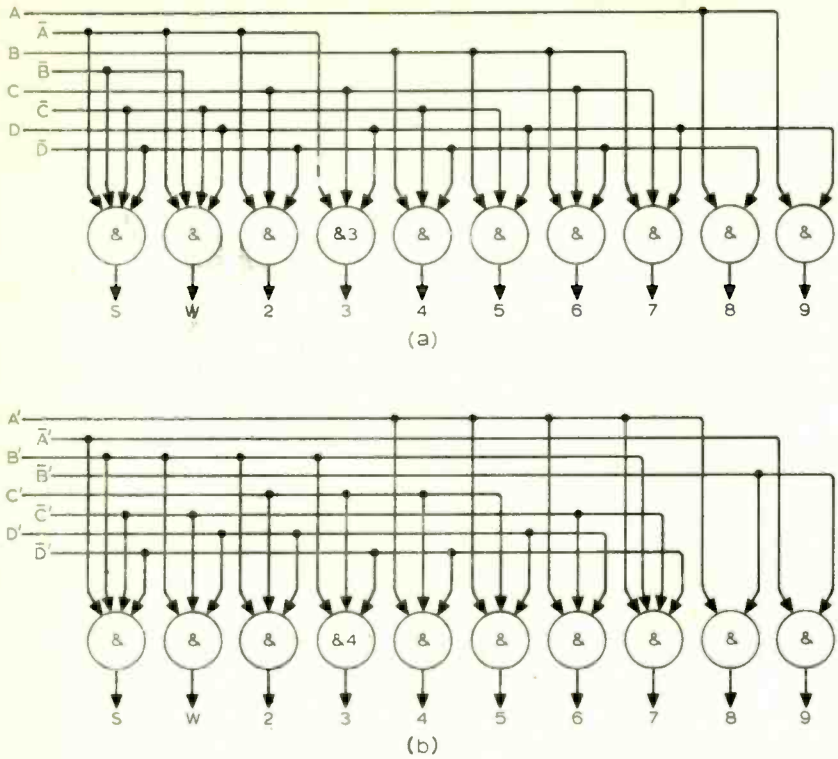


Fig. 17. The completed code converter using positive logic AND *gates for (a) the 8421 b.c.d. and (b) a unit-distance code.*

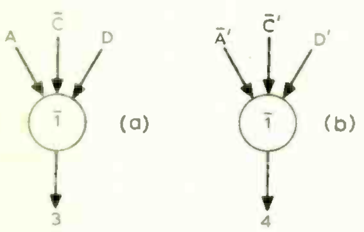


Fig. 18. Modification of the code converter to use NOR *gates.*

terms of all four variables A, B, C and D. Conditions 2, 3, 4, 5, 6 and 7 can each be associated with a "can't happen" condition, allowing the logic to be minimised in terms of three variables. Signals 8 and 9 can each be looped with three Xs. The procedure is similar in Fig. 16(b), the code converter logic being listed in table 14 together with appropriate logic networks for Figs. 16(a) and (b) in Figs. 17(a) and (b) respectively.

Since AND gates are used to detect the code condition, a logical "1" appears at the output of the appropriate gate whenever the code group exists, the outputs of all the other gates being zero.

NAND gates may be used to detect the code combinations, each gate having the same inputs as the equivalent AND gate. A logical "0" appears at the output of the appropriate NAND gate whenever the code groups exists, the outputs of all the other gates being logical "1". This can be understood by inspecting the device matrix for the positive logic AND gate (Fig. 5(b)). NOR gates can be used if the input logic levels are inverted, the NOR gate giving a logical "1" at its output when the correct code sequence is detected. Thus to detect the decimal value 3 in the 8421 b.c.d. code the inputs to the NOR gate would be A, $\bar{C}$ and D as shown in Fig. 18(a). To detect the decimal value 4 in the unit-distance code inputs $\bar{A}'$, $\bar{C}'$ and D' are required as shown in Fig. 18(b). OR gates can be used if the input logic lines are inverted as in the NOR gates and the code sequence is detected when a logical "0" appears at the output of the gate, as in the case of the NAND gate. That is the OR gate operates in negative logic.

Table 14—Code converter logic for table 13

Decimal value	8421 b.c.d. to decimal logic	Unit-distance code to decimal logic
S	$\bar{A}.\bar{B}.\bar{C}.\bar{D}$	$\bar{A}'.B'.\bar{C}'.\bar{D}'$
W	$\bar{A}.\bar{B}.\bar{C}.D$	$B'.\bar{C}'.D'$
2	$\bar{A}.C.\bar{D}$	$B'.C'.D'$
3	$\bar{A}.C.D$	$B'.C'.\bar{D}'$
4	$B.\bar{C}.\bar{D}$	$A'.C'.\bar{D}'$
5	$B.\bar{C}.D$	$A'.C'.D'$
6	$B.C.\bar{D}$	$A'.\bar{C}'.D'$
7	$B.C.D$	$A'.B'.\bar{C}'.\bar{D}'$
8	$A.\bar{D}$	$A'.\bar{B}'$
9	$A.D$	$\bar{A}'.B'$

Decimal to non-decimal code conversion

The logical network required to convert a decimal code to a non-decimal code is obtained by inspecting the columns of the binary code. If it is required to convert the decimal code to the 8421 b.c.d. there are ten input lines S, W, 2 . . . 7, 8 and 9, one of which is at the logical "1" level and the others at the "0" level. The four output lines from the network are designated A, B, C, and D, where A is the most significant bit.

Inspection of the A column of table 13 shows that the A-line must provide an output when either the 8-line OR the 9-line is energised. This is expressed symbolically as

$$A = 8 + 9$$

Here no mathematical significance can be applied to the plus sign. The other columns yield the following expressions from which the code converter network in Fig. 19(a) is drawn.

$$B = 4 + 5 + 6 + 7$$

$$C = 2 + 3 + 6 + 7$$

$$D = W + 3 + 5 + 7 + 9$$

If the decimal input is to be converted to the unit-distance code in table 13 the logic required is defined by the following which result from an inspection of each column of the code. The logical block diagram is shown in Fig. 19(b).

$$A' = 4 + 5 + 6 + 7 + 8$$

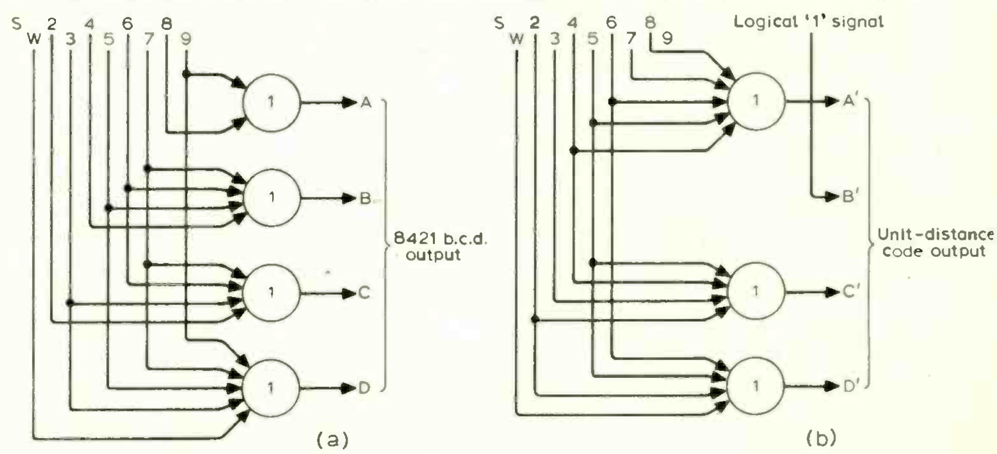
$$B' = S + W + 2 + 3 + 4 + 5 + 6 + \\ + 7 + 8 + 9 = \text{"1"}$$

$$C' = 2 + 3 + 4 + 5$$

$$D' = W + 2 + 5 + 6$$

It is of interest to note that in the unit-distance code the B' line remains at the logical "1" level irrespective of the states of the input lines and that the decimal 9 input line is redundant since no connections are made to it. In both networks the S-line is redundant.

Fig. 19. Logic for decimal to (a) the 8421 b.c.d. and (b) a unit-distance code converters.



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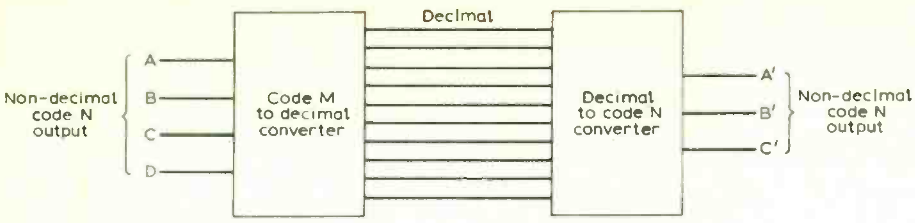


Fig. 20. Schematic diagram for a non-decimal to non-decimal converter.

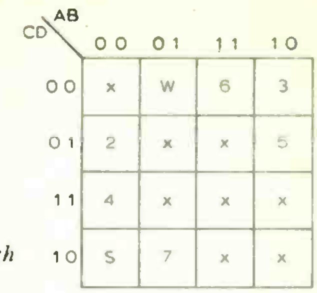


Fig. 21. Karnaugh map for code M.

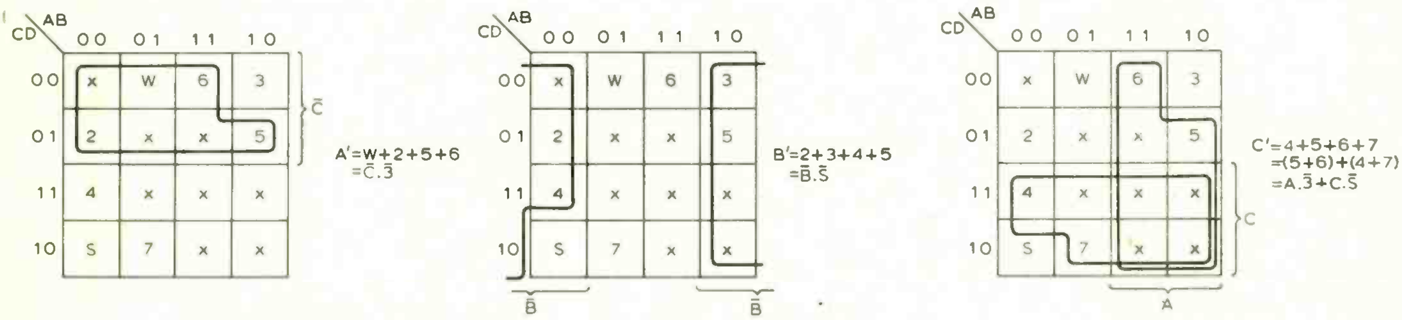


Fig. 22. Grouping of cells on the Karnaugh map to give the logic to convert from code M to code N.

Non-decimal to non-decimal code conversion

Utilising the principles already outlined a non-decimal to non-decimal converter can be developed using decimal as an intermediate stage. The block diagram of such a converter is given in Fig. 20. This process might at first be thought uneconomic, but inspection of the Karnaugh maps often yield a degree of simplification in the overall result. Depending on the type of logical devices used, intermediate decimal values may not be available in the final form of the converter.

Suppose it is necessary to convert from code M to code N in table 15. The

Table 15—Non-decimal to non-decimal code conversion

Position in the code	Non-decimal code M				Non-decimal code N		
	A	B	C	D	A'	B'	C'
S	0	0	1	0	0	0	0
W	0	1	0	0	1	0	0
2	0	0	0	1	1	1	0
3	1	0	0	0	0	1	0
4	0	0	1	1	0	1	1
5	1	0	0	1	1	1	1
6	1	1	0	0	1	0	1
7	0	1	1	0	0	0	1
8 to 15	X	X	X	X	X	X	X

S = "Start" or zero.
W = First code combination or number one.
X = "Can't happen" condition.

Karnaugh map of code M is drawn out in Fig. 21 showing the intermediate decimal-coded values of each cell. Inspecting the columns of code N gives the following logical equations.

$$A' = W + 2 + 5 + 6$$

$$B' = 2 + 3 + 4 + 5$$

$$C' = 4 + 5 + 6 + 7$$

The areas representing A', B' and C' are grouped in Fig. 22 together with appropriate "can't happen" conditions. The area representing A' encompasses the cells W, 2, 5 and 6 which is the area $\bar{C}$ AND NOT the area represented by cell 3, that is

$$C' = \bar{C}.\bar{3}$$

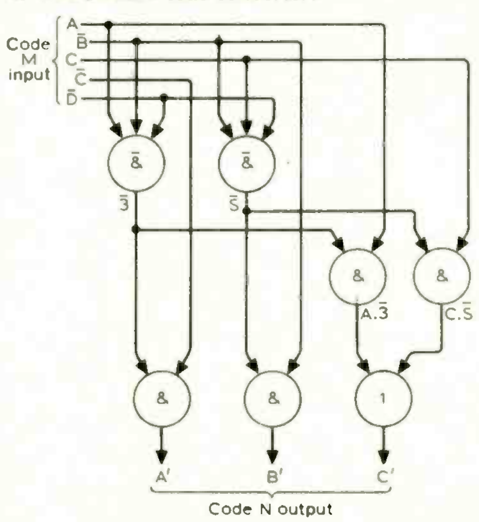
Following this line of reasoning the following equations for B' and C' are obtained

$$B' = \bar{B}.\bar{S}$$

$$C' = A.\bar{3} + C.\bar{S}$$

Cell S is defined by any of the following three combinations: $\bar{A}.\bar{B}.C.\bar{D}$, $\bar{B}.C.\bar{D}$, $\bar{A}.\bar{B}.\bar{D}$ and cell 3 by any of $A.\bar{B}.\bar{C}.\bar{D}$, $A.\bar{B}.\bar{D}$, $\bar{B}.\bar{C}.\bar{D}$. If we select the combination $\bar{B}$, C and $\bar{D}$ as input lines to generate S, then $\bar{S}$ is generated by the NAND gate shown in Fig. 23. Similarly $\bar{3}$ is generated by a NAND gate with input lines A, $\bar{B}$ and $\bar{D}$. The network shown in Fig. 23 assumes positive logic levels throughout.

Fig. 23. Block diagram of the non-decimal to non-decimal code converter.



The final form of the converter can be modified to use other gates in the manner described earlier in the article by inverting the logic levels.

Acknowledgement. The author wishes to thank the Principal of the North Staffordshire College of Technology for permission to publish this article.

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Our Next Issue

Operational Amplifiers. High-gain d.c.-coupled amplifiers, usable for a multitude of functions in electronics, are now widely available in packaged and integrated-circuit form. The first article of a short series will deal with their electrical characteristics and describe methods of testing them.

Solid-state Multimeter. Constructional details of a high-impedance f.e.t. multimeter, which incorporates some novel circuitry, will be given. The instrument has 18 ranges covering a.c. and d.c. voltage, and ohms.

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B.B.C. Sound-in-Vision System

Pulse code modulated sound inserted in a video waveform allows full television transmission on a single circuit

The distribution of B.B.C. televsion programmes from studio centres to the transmitting stations uses an extensive network of G.P.O. cables and microwave links. Separate circuits, and often different routes, are used for the vision and sound. A useful simplification of operational requirements would result if the vision and sound signals were to share a single circuit. Such a system has been developed by the B.B.C. Research Department for use with 625-line television signals. If adopted, this system would save £100,000 each year in G.P.O. land-line charges.

The System

The B.B.C. sound-in-vision system is essentially a form of time-division-multiplex in which the circuit is available to the sound signal for a period of 3.8μs within each 4.7μs line synchronizing interval, and the vision signal occupies the circuit during the remainder of the time; these 3.8μs periods are symmetrically disposed with respect to the leading and trailing edges of the line synchronizing pulse. The leading edges of the line synchronizing pulses are preserved during transmission.

The sound signal is sampled at twice the television line frequency. This permits an audio bandwidth of 14kHz to be transmitted. The two samples produced during each line period are converted to pulse code modulation (p.c.m.) signals; the two groups of pulses are then delayed, compressed in time and inserted into the television waveform during the next line synchronizing interval.

The system uses a 10-digit binary code. Thus, 20 sound pulses together with a marker pulse which identifies the start of the sound pulse group, i.e. 21 pulses in all, are accommodated within each line synchronizing period. An example of the resulting sound-in-vision signal is shown in Fig. 1.

In order to provide room for the sound pulses throughout the field blanking interval it is necessary to extend alternate equalizing pulses from 2.35μs to 4.7μs, but no other changes to the video signal are necessary before the sound pulses and video signal are combined.

At the receiving terminal the sound pulses are extracted and reconverted to normal audio signals and the video waveform is restored to standard form.

The sound pulses are of the 2T form, that is, a raised cosine having a half-amplitude duration of 182ns. The complete group of pulses occupies only 3.8μs; the spacing between the pulses is therefore 173ns. It will be noted from Fig.1 that two adjacent pulses combine to give an overall amplitude slightly higher than that of a single pulse; this is because with 173ns spacing, the signal amplitude at the peak of a pulse may contain contributions from pulses immediately preceding and following it.

Pulse code modulation and the use of high-amplitude pulses ensure that the sound signal is immune from all but the most severe interference and distortion. However, it is equally important to ensure that the presence of the sound pulses does not in any way impair the vision signal. If the phase and/or amplitude of low-frequency components is not correctly preserved by the transmission circuit, the post-line-synchronizing blanking level may be perturbed by variation in the mean level of the sound pulse groups preceding it. The pulse groups are therefore arranged within the line-synchronizing period in such a way as to reduce variation in their mean level to a minimum. The techniques used rely on the fact that substantial changes in the pulse groups representing consecutive samples of the sound signal are rare, and that the changes that do occur are most likely to affect the least significant digits. First, one of the two pulse groups within each synchronizing pulse is complemented—that is, ones

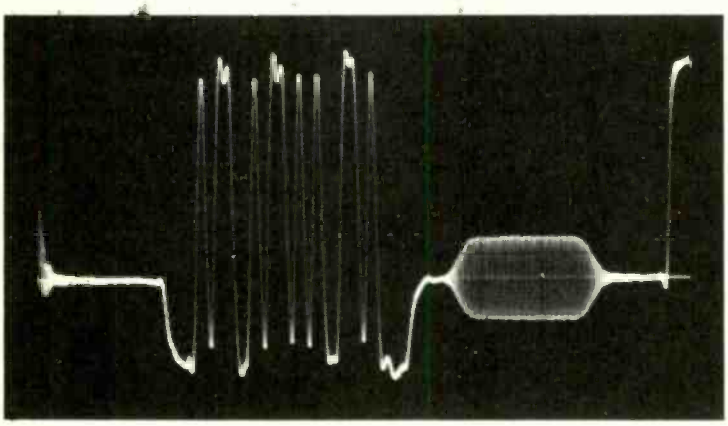

Fig.1. 625-line video waveform during line blanking interval, showing p.c.m. signal—a marker digit and two ten-digit groups—inserted in the line synchronizing pulse, followed by the colour burst.

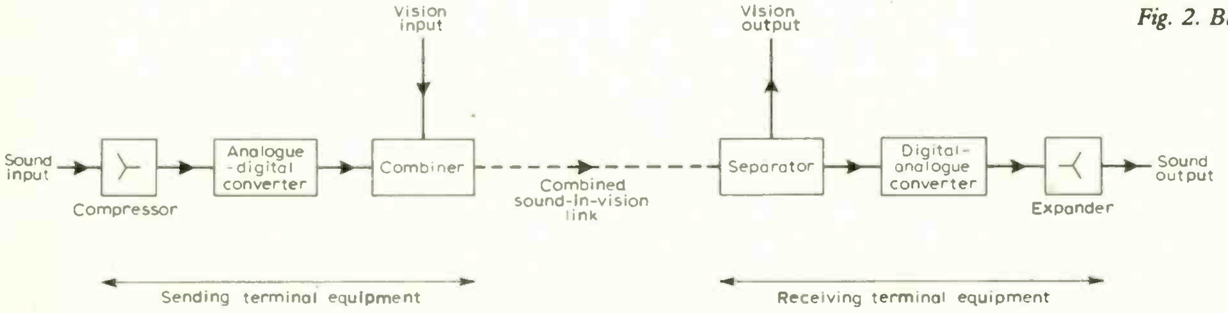

Fig. 2. Block diagram of equipment.

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are exchanged for zeros and vice versa. Secondly, the two pulse groups are interleaved, so that the nth digits from each group appear consecutively. Finally, the digits are arranged in the reverse of the normal order, so that the least significant instead of the most significant digits come first. Thus the complete pulse train is made up as follows: marker pulse, the two least significant digits, one of which is complemented, and so on, ending with the two most significant digits. The complementing and interleaving of digits from alternate groups provides a signal of the form shown in Fig.1, which shows the sound-in-vision waveform with a d.c. input applied to the coder.

The digit train is gated into the television waveform during the 3.8μs interval, and any noise or other irregularities present in the incoming television waveform during this period are therefore removed. The leading edge of the synchronizing pulse is, as already mentioned, left untouched because it is the main timing reference of the composite video waveform.

The Equipment

A block diagram is shown in Fig. 2. The compressor and expander form a syllabic companding system which ensures that the mean signal level into the analogue-to-digital converter is as high as possible. The compandor does not take the usual form, but is actuated only by high frequency components in the signal, which have been boosted in a pre-emphasis unit. It gives an improvement of 13dB in the signal-to-noise ratio of the p.c.m. system and thus renders the 10-digit system slightly better in this respect than one which used 12 digits but no compandor.

The analogue-to-digital converter samples the audio-frequency signal presented to it at twice-line rate, and delivers an output in p.c.m. form to the combiner unit. This unit accepts the vision signal, clamps it during the back porch, and inserts the sound pulses.

The reverse procedure is carried out at the receiving terminal. The combined sound-in-vision signal is fed to the separator unit from which a clamped and restored vision signal is produced. Separated sound pulses are decoded in the digital-to-analogue converter which delivers an audio-frequency signal.

Many picture monitors required at points along the link will not lock if a sound-in-vision signal is connected to them. A cheap and simple pulse code remover has therefore been developed which removes the sound pulses from the inputs to such picture monitors so that they may continue to be used in the normal way.

The input and output terminals of the sound-in-vision equipment handle sound and vision at normal levels and impedances —sound at zero level into 600Ω, vision at 1 volt peak-to-peak into 75Ω. The complete sending and receiving terminal equipments each occupy a height of about 14in within a normal 19in bay. Extensive use is made of integrated circuitry for the digital operations together with discrete transistor circuits for the analogue operations.

Performance

The equipment will accommodate variations in line frequency up to ±1 part in 50 and will operate satisfactorily in the presence of moderate amounts of distortion on the circuit. If the maximum levels of all forms of noise and distortion permitted in two of the longest U.K. vision links in tandem are present simultaneously, the system will tolerate an additional 12dB degradation (to 27dB unweighted) in the signal-to-noise ratio. Provided that the presence or absence of sound pulses can be correctly detected, distortions and noise on the link have no effect at all on the decoded sound signal.

The p.c.m. sound channel has the following characteristics:

Response/frequency characteristic:
±0.5dB 50Hz to 10kHz
±0.7dB 30Hz to 14kHz

Non-linear distortion for full modulation at 1kHz:
0.1% 2nd harmonic
0.07% 3rd harmonic
0.02% 4th harmonic

Signal/noise ratio 70dB (r.m.s. signal/r.m.s. weighted noise)

Announcements

Marconi and Elliott have rationalized their avionic interests and established a new **service depot for London's airports.** For many years Marconi has maintained a depot within the Heathrow airport for the repair of airborne navigation and communication equipment. This will be closed next spring and the service depot moved to the Elliott-Automation establishment at Stanmore from which it will serve other major airports including Gatwick, Luton and Stanstead.

Microwave Systems Ltd., Hunting Gate, Hitchin, Hertfordshire, have been appointed exclusive agents in the U.K. for Frequency Engineering Laboratories of Farmingdale, New Jersey, U.S.A., manufacturers of test and measuring equipment.

As from January 1st, Fluke International Corporation, of Watford, Herts, will become sole distributors for the entire range of **Burr-Brown operational amplifiers** for the U.K. and Eire.

Polymer Consultants Ltd., The Ancient House, Ardleigh, Nr. Colchester, Essex, have been appointed sole U.K. distributors of the **crystals and crystal products** manufactured by Minhorst Kristall Chemie GmbH & Co., Meudt, of West Germany.

An agreement has been concluded between Marconi International Marine Co. Ltd. and the Northrop Corporation, California, U.S.A., under which Marconi Marine have exclusive rights for the marketing of **Omega receivers** in the U.K. and the Republic of Ireland.

Thorn Electrical Industries Ltd. has acquired for Thorn Bendix Ltd., the whole of the share capital of **Greenpar Engineering Ltd.**, manufacturers of coaxial connectors, inter-series adaptor kits, attenuators and probes.

The **Leeds University Television Centre,** at present under construction, has placed orders with EMI Electronics Ltd. for television equipment to the value of £100,000. The new centre will consist of two main studios, demonstration classroom, control rooms, central operations room and a technical equipment area. The equipment includes seven EMI camera channels type 206, and vision mixers.

Storno Ltd., of Camberley, Surrey, have been awarded a £220,000 contract by the Ministry of Defence (Navy), for the supply of v.h.f./f.m. portable radiotelephones.

Plessey Radar has received a £237,000 contract from the Ministry of Technology, for two radio environmental monitors for use with instrument landing systems. These are designed to increase safety levels during aircraft blind-landing by monitoring potential radio interference in the vicinity of aircraft immediately prior to touch-down.

Granger Associates Ltd., announce that their parent company in California has received a $335,000 contract for their high frequency s.s.b. transmitters, receivers and accessories for an inter-island communications network in the western Pacific.

The **Automobile Association** has placed an order with Pye Telecommunications Ltd., valued at £50,000, for additional and new equipment to expand its radio-telephone network. The scheme will now cover the whole of the British Isles.

Decca has been awarded a contract by the United States Coast Guard for the installation of **river radars** in 25 push tow boats operating on the Mississippi and its tributaries, and based in St. Louis, Missouri.

Pye TVT Ltd., of Cambridge, have been awarded a contract to supply equipment for a **new sound broadcasting centre,** by the Government of Gambia. Pye will supply equipment for two general purpose studios, a continuity suite, a talks studio and control rooms associated with these.

Ferranti Ltd., of Edinburgh, have been awarded a contract by the Ministry of Technology for the design and supply of an experimental **airborne laser ranging sensor.**

Plessey Electronics Group have received an order valued at £300,000 from the British Overseas Airways Corporation for the supply of **Plessey "AIDS"** (Aircraft Integrated Data Systems) Type PV 740 for B.O.A.C.'s fleet of Boeing 747 aircraft.

Dynamco Ltd., of Chertsey, Surrey, have received orders to the value of nearly $400,000 from American companies for more than 300 of their 71 Series oscilloscopes.

The Boeing 747 **"Jumbo-Jet"**, is scheduled to make its inaugural flight from Seattle in late December. Nineteen Boeing 747s have been ordered by B.O.A.C., Air France and Lufthansa and all of these aircraft are fitted with dual Marconi AD370, automatic direction finding equipment.

Wayne Kerr is setting-up a **technical advisory service** at its Chessington, Surrey, laboratories. This is in addition to the departments dealing with the normal sales enquiries which remain at New Malden.

Plessey Communications Systems Ltd., have moved from offices at 8 Arundel Street, London W.C.2 to new headquarters at Tolworth Rise, Surbiton, Surrey. Involved in the move are the sales administration offices, service H.Q., and accounts departments as well as the London service depot operating at present from Marshalsea Road, S.E.1.

The London service department of the **Ferrograph Company Ltd,** has been transferred from 84 Blackfriars Road, S.E.1, to Edgware Road, Colindale, N.W.9. (Tel: 01-205 5575)

Dolby Laboratories, of 590 Wandsworth Road, London S.W.8, have moved to new premises at 346 Clapham Road, S.W.9. (Tel: 01-720 1111)

General Instrument (U.K.) Ltd., have moved their London offices to Stonefield Way, South Ruislip, Middx. (Tel: 01-845 1288)

Britimpex Ltd., of 16-22 Great Russell Street, London W.C.1, have moved to 8-12 Rickett Street, London, S.W.6. (Tel: 01-385 0883)

Harmsworth Townley and Co., component distributors, have moved to new premises at Wellington Road, Todmorden, Lancs. (Tel.: Todmorden 2601)

The new address of the **Radio Society of Great Britain** is 35 Doughty Street, London W.C.1. (Tel.: 01-837 8688)

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Personalities

Major-General Eric S. Cole, C.B., C.B.E., has retired from the managing directorship of Granger Associates, of Weybridge, Surrey, which he joined on its formation in 1963. Major-General Cole, who is continuing as a director of the company, retired from the Army in 1961. His last appointment was that of director of telecommunications at the War Office. He is well known in amateur radio circles (his call sign is G2EC) and was president of the Radio Society of Great Britain for 1960/61. Granger Associates' new managing director is **Robert J. F. Whistler,** B.Sc., M.I.E.E., who has also been with the company since it started, initially as a sales engineer. He has been a director since 1965, and deputy managing director for the past year. Mr. Whistler, aged 48, was commissioned in Royal Signals in 1939 and retired with the rank of major in 1962. He received an external London University degree in engineering from the Royal Military College of Science.

R. J. F. Whistler

Luis Alvarez, professor of physics at the University of California Radiation Laboratory and a director of the Hewlett-Packard organization since 1957, has been awarded the 1968 Nobel Prize for physics. In announcing its selection, the Swedish Academy of Science cited Professor Alvarez' "decisive contributions to elementary particle physics, particularly his discovery of a large number of resonance states, made possible through his development of the technique of using hydrogen bubble chamber and data analysis". The prize, created by Alfred Nobel and first awarded in 1901, this year is valued at £29,000.

"For his distinguished contributions to optics, especially by establishing the principles of holography" **Professor D. Gabor,** F.R.S., has received the Rumford Medal of the Royal Society. Dr. Gabor is emeritus professor of applied electron physics in the University of London, senior research fellow at Imperial College of Science & Technology, London, and staff scientist in the C.B.S. Laboratories, Stanford, U.S.A. Dr. Gabor, who is also well known for his original work on the flat "picture frame" television tube, came to this country from Hungary in 1934 and worked in the B.T.H. Research Laboratory, Rugby, until he joined the staff of Imperial College in 1949.

B. W. Manley, B.Sc., D.I.C., F.Inst.P., is appointed commercial product manager for professional valves and tubes in Mullard's Industrial Electronics Division. Mr. Manley joined Mullard Research Laboratories after graduating from London University in 1953. Initially he was concerned with microwave devices and electron-beam focusing systems. In 1957 he was put in charge of a group dealing with storage and camera tubes. Latterly, as a section leader in the Vacuum Physics Division of the Laboratories, he has been associated with research in the field of image intensifiers for military and civil applications and electron multipliers.

J. V. S. Tyndall has become commercial manager of the Industrial Electronics Division of Mullard Ltd. He joined the company's technical service department in 1944 and transferred to the valve measurement and application laboratory in 1949. He went over to the commercial side of the company in 1951 and in 1958 was appointed commercial product manager of the electron optics group. From 1966 until recently Mr. Tyndall was general manager of Mullard Inc. in the United States.

C. B. Charlton, B.Sc., A.R.I.C., has been appointed chief engineer of Advance Filmcap Ltd., the new capacitor subsidiary of Advance Electronics Ltd. He will head the Design Engineering Department of the new plant at Wrexham, Denbighshire. Mr. Charlton was latterly with the Dubilier Condenser Company, prior to which he was research manager with Hunts' Capacitors Ltd. and divisional manager of the T.M.C. Components Division.

B. H. Paren, M.I.E.E., has been appointed director of the Telecommunication Engineering & Manufacturing Association in succession to **R. A. Moir,** O.B.E. Mr. Paren has been engaged in the contract and technical liaison side of the telecommunications industry and in co-ordinating its affairs with the Post Office. He is a founder member of the Joint Electronic Research Committee set up by the Post Office and industry.

B. H. Paren

With the Plessey Electronics Group reorganization of its Radio Systems Division, which will now comprise the Avionics Systems Unit, the Commercial Systems Unit and the Defence Systems Unit together with the Development Laboratories at Ilford, West Leigh (Hants.) and Braxted (Essex), three new appointments have been made. **W. T. Eastwood,** formerly chief engineer at West Leigh, becomes manager of the Avionics Systems Unit, responsible for the Division's activities in airborne communications and electronic equipment. **B. A. Clarke,** formerly general sales manager of the Division, becomes manager of the Commercial Systems Unit with responsibility for civil communications equipment. **D. S. Tatnall,** formerly chief engineer at the Ilford Development Unit, will manage the Defence Systems Unit which handles a wide range of ground and shipborne communications and electronics systems.

I. W. Dick, who joined the seagoing radio officer staff of Marconi Marine in 1949 after service with the Royal Air Force, has become commercial manager. He transferred to the company's shore staff at Liverpool in 1955 and three years later was sent on special missions to Peking and Shanghai before taking over as representative, South-East Asia. In 1962 he joined Norsk Marconikompani A/S., Oslo, as general manager, and later became managing director. Since October, 1967, he has been at Chelmsford in the capacity of management executive.

M. T. Marwood, appointed administration manager of Marconi Marine, joined the company in 1965 as management executive and in 1966 was placed in control of the company's sound systems activity. He served for twenty-two years in the Royal Navy, rising to the rank of lieutenant-commander, and on retirement from the Service in 1958 joined the telecommunications division of A.E.I. From 1961 until he joined Marconi Marine he was sales manager, marine communications department.

Kenneth Finney has been appointed export manager, Western Hemisphere, by British Insulated Callender's Cables Ltd. Mr. Finney served with Automatic Telephone and Electric Company in India from 1946 to 1952, first as managing director of its local trading company and later as liaison officer to the Indian Government. In 1955 he returned to London as export manager of A.T. & E. (now part of Plessey) and since 1959 has been managing director of the Plessey Company's Brazilian subsidiaries.

Vic. Newman, Grad.I.E.R.E., aged 36, has been appointed commercial manager of the newly formed Instrument Division of Coutant Electronics, of Reading. He joined Coutant last year, as regional sales manager, from Plessey Automation where he was assistant sales manager for optical character recognition computer peripherals. Prior to that Mr. Newman was with Advance Electronics Ltd., for four years. Before coming into the electronics industry he served with the Royal Navy and specialized in radar and radio communications.

Max Settelen, manager of S.T.C.'s Aviation Division, has been elected chairman of the steering committee of the European Organization for Civil Aviation Electronics. Set up in Lucerne in 1963 EUROCAE now has member organizations from Belgium, France, Italy, the Netherlands and the U.K. Mr. Settelen joined S.T.C.'s associated company in Switzerland in 1945 on leaving the R.A.F. where he had been a technical signals officer.

OBITUARY

Philip Lever, who died on 7th November at the age of 68, had been joint managing director of E. R. (Factors) Ltd., of Harrow Road, London W.9, since the formation of the company over 35 years ago. He was also managing director of Lasky's Holdings Ltd.

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V_{a2} 100V; V_g (cut-off) −20 to −48V.
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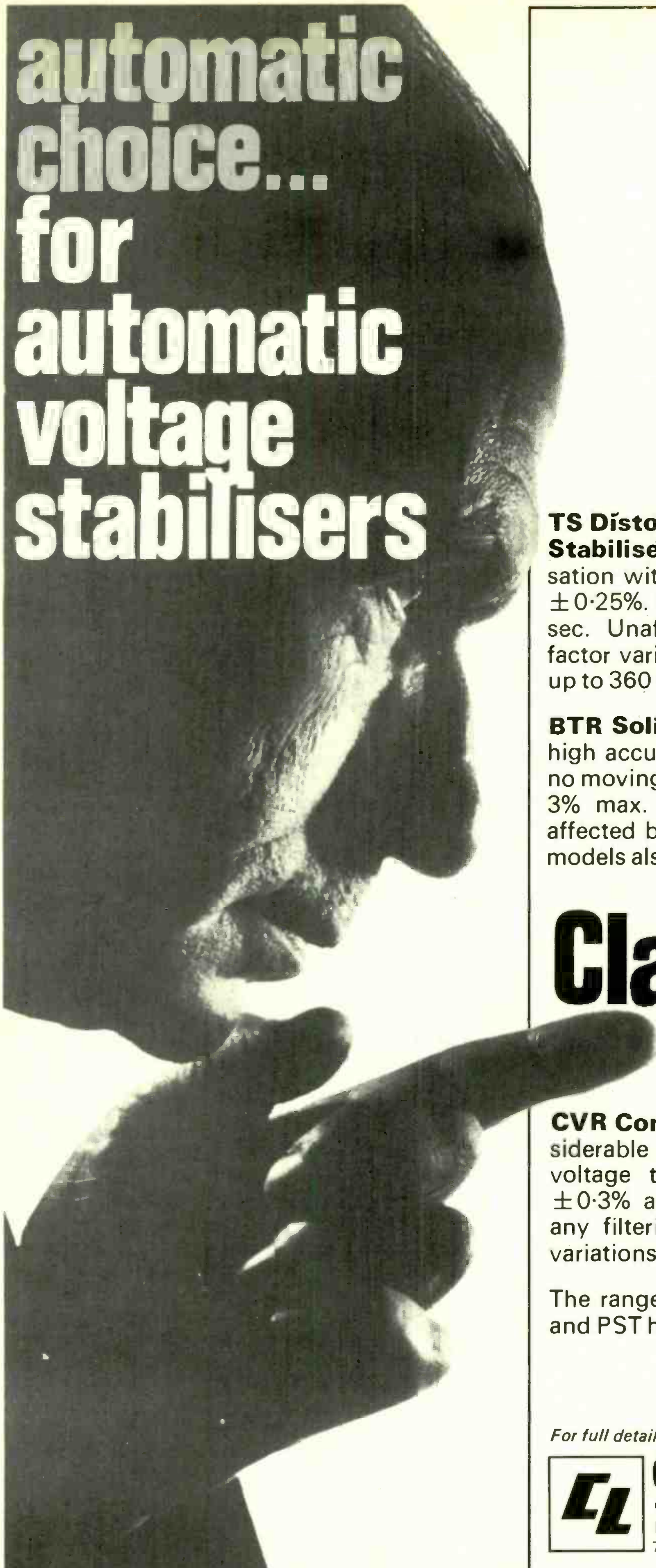

TS Distortionless Servomechanical Stabilisers provide high-speed, accurate stabilisation without distortion of waveform. Accuracy ±0·25%. Correction speed up to 60/100 volts per sec. Unaffected by load, frequency or power factor variations. 1 to 120 kVA single phase and up to 360 kVA three phase.

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Literature Received

"Safety precautions in the use of electrical equipment" is a booklet prepared by the Imperial College of Science and Technology. Its aim is to draw attention to the hazards involved in all kinds of laboratory and workshop activity, and to point out the precautions which must be taken. The booklet is available from The Registrar, Imperial College, London, S.W.7 at 3s per copy.

A leaflet called **"High-gain Horns"** describes a range of nine horn aerials for operation from 1.12 to 12.4GHz that give a nominal 28dB gain. Demornay Bonardi, 1313 N. Lincoln Avenue, Pasadena, CA.91103, U.S.A.
WW401 for further details

"C.C.T.V. and V.T.R. Catalogue" contains details of the services and equipment offered by Holiday Brothers who hold distribution agencies in the north of England for many companies around the world in the closed-circuit television field. Holiday Brothers (Electronic Wholesalers) Ltd, 61B Show Heath, Stockport.
WW402 for further details

A leaflet from Colton Audio Products gives details of a range of **record accessories,** such as styli, pick-up heads, microscopes, wheel and belt dressing, anti-static cloths, pickup lifts and record cases. Colton and Company (Lapidaries) Ltd, The Crescent, London S.W.19.
WW403 for further details

Instrument cases (1) and instrument racking equipment (2) are the subject of two catalogues from Bedco Ltd. The first lists cases from the small bench instrument size to floor standing units in a wide variety of shapes and sizes and also includes aluminium diecast boxes. Similarly the second catalogue contains details of racks of all shapes and sizes and includes information on blower units. Bedco Ltd, Datum Division, Colne Way, Trading Estate, By-Pass, Watford, Herts.
(1) WW404 for further details (2) WW405 for further details

"J259" is the title of a nine-page booklet which describes a **computer operated circuit test system** for multi-terminal electronic circuits—such as integrated and hybrid circuits, and circuit boards. Teradyne U.K. Ltd, Swallow Street, London W.1.
WW406 for further details

"Precision Miniature Motorized Stepattenuators" to remotely control signal level in special purpose test equipments are described in a booklet from Weinschel Engineering. The attenuators will operate from d.c. to 18GHz. Weinschel Engineering, Gaithersburg, Maryland, U.S.A.
WW407 for further details

Bi-directional gate controlled thyristors (Quadracs or Triacs) manufactured by the Electronic Control Corporation are listed with performance data in a leaflet we have received. Quadracs enable efficient power controllers to be made with very few components. The types listed in the leaflet are suitable for voltages up to 700 and currents up to 40A. Claude Lyons Ltd, Valley Works, Hoddesdon, Herts.
WW 408 for further details

Power controllers for a.c. are the subject covered in a product information leaflet from P. Allen Bennett Ltd. Models are available that will handle inputs from 100 to 480V, 50/60Hz and provide outputs from 10 to 400A. Control over the output voltage can be exercised by a potentiometer or an external low power d.c. source. The units employ no moving parts. P. Allen Bennett Ltd, Orgreave Road, Sheffield, S13 9NN.
WW 409 for further details

"Tin in Your Industry" is a 48-page booklet that gives facts and a few figures about the uses of tin (it crops up in the most unexpected places) and about the tin industry in general. Interesting reading. W. T. Duhne, 55/61 Moorgate, London, E.C.2.
WW 410 for further details

"Control Instruments", the catalogue of Ether Ltd, gives details of potentiometric indicating temperature controllers, potentiometric indicators, "scanners", temperature regulators, indicators and controllers, strip-chart recorders, strain gauge indicators, thyristor assemblies and various types of transducers. Ether Ltd, Caxton Way, Stevenage, Herts.
WW 411 for further details

Brief details of the Tektronix S-130 **digital measuring system** are given in a leaflet we have received. It is intended to measure the performance of active devices under simulated operating conditions. A disc storage unit enables details of 1600 measurements, which can be carried out at a rate of 100 per second, to be stored. Tektronix U.K. Ltd, Beaverton House, Harpenden, Herts.
WW 412 for further details

"Loudspeakers for the Perfectionist" is a booklet that gives technical information on the Ditton 10 Mk II and the Ditton 15 and 25 loudspeaker systems. Rola Celestion Ltd, Ferry Works, Thames Ditton, Surrey, England.
WW 413 for further details

The **1968/69 catalogue of Heathkit** is now available. Among the new items are a 30-W f.m. stereo receiver (AR-14) and an f.m. stereo tuner (AR-17). Also introduced is the analogue digital designer (EU-801-A), which is an advanced logic trainer using t.t.l. integrated circuits, and the 805 digital instrument. The 805 is a multi-function instrument with the following operating modes: event counter, frequency meter, digital voltmeter, ratio meter, time interval meter, period meter, and voltage integrator. The logic employed is compatible with the EU-801-A. Daystrom Ltd, Gloucester GL2 6EE.
WW 414 for further details

Stentorian **loudspeaker systems,** types LC/93, /94 and /95, from Whiteley Electrical are described in a leaflet we have received. Also included in the leaflet, in tabular form, is a list of other high-fidelity loudspeakers with technical data and mounting details. Whiteley Electrical Radio Co. Ltd., Mansfield, Notts.
WW 415 for further details

The applications manual for the Sinclair **10-W integrated circuit audio amplifier** shows how the amplifier can also be used as an intercom. amplifier, a d.c. amplifier and siren/burglar alarm. It shows how the tone control circuits are wired and gives instructions for stereo operation. Sinclair Radionics Ltd, 22 Newmarket Road, Cambridge.
WW 416 for further details

An **analogue computer** for teaching purposes that will perform a variety of mathematical functions including third order differential equations manufactured by A. M. Lock & Co. is described in a leaflet produced by them. Two or more computers can be linked together to solve more complex problems. A. M. Lock and Co. Ltd., Prudential Buildings, Union Street, Oldham, Lancs.
WW 417 for further details

Reed relay catalogue. Reed relays in a variety of packages with various contact configurations capable of handling currents up to 1.5A and voltages up to 5kV are covered in this catalogue. Electrothermal Engineering Ltd, 270 Neville Road, London E.7.
WW 418 for further details

Panel mounted **holders for Mallory Batteries** produced in Ireland by the Coleraine Instrument Co., and marketed in this country by H. Tinsley and Co. Ltd, Werndee Hall, South Norwood, London S.E.25, are the subject of a leaflet we have received. The holders, which are made in a variety of sizes for panel thicknesses up to 9.5mm, are made from nickel plated steel (as are the batteries), thereby reducing the danger of corrosion.
WW 419 for further details

"Guide to Modular systems" is a 16 page page booklet produced by Aim Electronics describing a family of modules that cover three branches of measurement technology i.q. signal recovery, pulse generation and waveform sampling. The modules can be fitted into a racking system and interconnected to produce the required test set-up. Aim Electronics Ltd, 71-73 Fitzroy St, Cambridge.
WW 420 for further details

A variety of **test equipment,** the majority of which is for audio, radio and television (including colour television), is described in a new short-form catalogue produced by Grundig (Great Britain) Ltd, London S.E.26.
WW 421 for further details

"Electronic Instruments" describes a range of pulse generators, a d.c. micro-volt/ammeter and an r.f. microvoltmeter manufactured by Lyons Instruments. It also lists other companies and their products for which Lyons have the agency. Lyons Instruments Ltd, Hoddesdon, Herts.
WW 425 for further details

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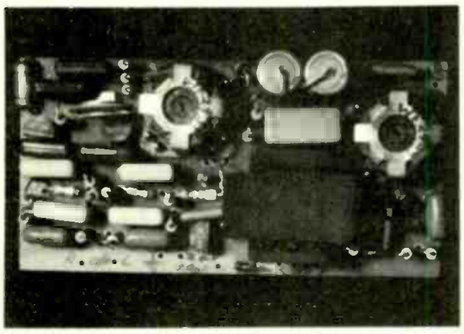
New Products

Stereo Decoder

A stereo decoder unit which contains its own mains power supply and is suitable for use with valve or transistor f.m. tuners has been introduced by Averine Electronics. Constructed on a glass fibre p.c. board the decoder is easily incorporated into a hi-fi system and is fully compatible. Indication of a stereo broadcast is given by a pilot lamp which may be mounted in any convenient position. Hum and noise is said to be −70dB and channel



separation −30dB. Frequency response is 50Hz–18kHz ±1dB. The size of the decoder module is 101×50.5×25.3mm and the price £9 5s. Averine Electronics, P.O. Box 6, Ruislip, Middx.
WW 330 for further details

Frequency Doubler

Specialists in signal recovery equipment, Brookdeal Electronics are now marketing an advanced version of their wideband sinusoidal frequency doubler, type 423. This instrument is regarded by the makers as an essential part of phase-sensitive detection systems and it was developed specifically for use in the reference channel of a "lock-in" small recovery system where the required signal is at twice the frequency of the modulating waveform. Its operation is very simple; when a sinewave is applied at the input, one double the frequency is available at the output. The wideband feature eliminates the risk of phase/frequency errors. Input impedance is 250kΩ and 20pF; output impedance 600Ω at 3V r.m.s. maximum. Frequency range 1Hz to 300kHz. A built-in meter indicates 1-3V r.m.s. The 423 operates from normal mains supplies, weighs 2.5kg and measures

87×218×285mm. Brook-deal Electronics Ltd, 2 Myron Place, Lewisham, London, S.E.13.
WW301 for further details

High-voltage Germanium Power Transistors

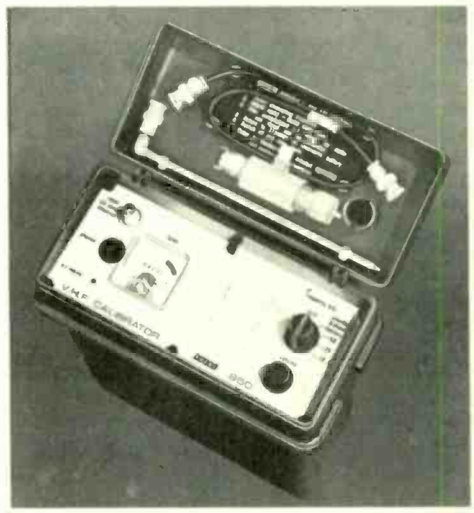
Two epitaxial-base germanium power transistors from Motorola, the 2N5324 and the 2N5325, combine low saturation voltage (typical of germanium transistors) with high voltage capability and fast switching speeds (typical of silicon transistors). The collector cut-off current is only 7mA maximum at the rated V_{CEX} (325V for the 2N5325 and 250V for the 2N5324) along with maximum $V_{CE(sat)}$ of 0.5V and $V_{BE(sat)}$ of 0.75V at 10A collector current. Minimum gain is 20 at 5A, and power dissipation is 50W at a case temperature of 25°C. Minimum f_T for both transistors is 2MHz. Maximum switching speeds at 5A collector current are t_r 15 μs, t_s 10 μs, and t_f 7 μs. The units are packaged in T0-3 cases. The quantity price (100 or more) is £1 13s 1d for the 2N5324 and £2 4s 1d for the 2N5325. Motorola Semiconductors Ltd., York House, Empire Way, Wembley, Middx.
WW310 for further details

White Reference for Colour Television

By fitting a colour matching fluorescent tube in place of the normal high-efficiency tube in their inspection lamp, and using neutral-density filters, Bloctube of Aylesbury, have produced an Illuminant D reference source for the adjustment of colour television receivers. Illuminant D is the new reference white (colour temperature 6,500°K), recently adopted by the B.B.C. in place of Illuminant C, for colour TV transmissions. A neutral density step-wedge film fitted over the tube is compatible with the colour TV test card and allows adjustment of the grey scale. The instrument can be offered-up to the step-wedge pattern on the screen for direct comparison. The instrument is available in 240V 50Hz or 110V 60Hz versions fitted with 4 metres of mains lead. Its price is £10 and delivery is six weeks. Bloctube Controls Ltd., Bicester Road, Aylesbury, Bucks.
WW 325 for further details

Radiotelephone Frequency Calibrator

Although all v.h.f./u.h.f. mobile radiotelephone equipment in this country uses crystal-controlled oscillators to meet the stability specification of the licensing authority, the crystal must be frequently checked against ageing and environmental drift effects, to ensure that the equipment is kept "on channel." To meet this requirement, Racal Instruments have produced a v.h.f./u.h.f. calibrator with an accuracy which is claimed to be better than 1Hz using a zero-beat technique. To achieve this without the use of synthesizers or digital frequency meters, it is fundamentally necessary that in the system under test, the transmitted frequency and the channel spacing should be harmonically related, as is the case in the U.K. It is also necessary to know the approximate frequency of the channel under test. Because the channel frequency is a multiple of the channel spacing frequency, the transmitted waveform of any channel can be sampled at channel spacing frequency. If the channel frequency is correct the sample will always be taken at the same point in the waveform and the calibrator will give a d.c. output. If the frequency being measured is incorrect, successive samples will occur at different points on the waveform and an a.c. component will be generated. The calibrator is called type 850 and is based on the Racal type 840 5-MHz oscillator. This provides a locking signal to a 1-MHz stage, the output being further divided by 10, then by 2, 4 and 8 respectively giving sample rates of 50, 25 and 12.5kHz. A 0.8ns gate pulse is applied to a sampling gate receiving the input signal. The instrument is normally operated using a telescopic aerial, but where high noise level makes operation difficult it can be coupled directly to the v.h.f./u.h.f. equipmment. Available in either bat-



tery- or mains-operated version, the 850 measures 108 × 229 × 298mm and weighs 3.6kg. The cost is about £200. Racal Instruments Ltd., Crowthorne, Berkshire.
WW337 for further details

Industrial Radar

A new industrial tool, in the form of a miniature battery-operated radar, can measure velocities of up to 100 m.p.h., whether a body is travelling in a straight, angled or curved path. In addition it can measure high rotational speeds of the order of 1 million r.p.m. The instrument, called Allscott Mini-Radar type MRJ5, is fully portable (operation is from a 12V battery) and is also provided with facilities for connection to external instruments such as a digital counter or oscilloscope. The basis of the Mini-Radar is a Gunn-effect diode which generates a power output of 5mW maximum c.w. at 13.4GHz. Data recovery circuits include 16 semiconductors, of which 8 are i.cs, all mounted on a printed circuit. Indication of target speed is shown on a moving coil meter at the rear of the case, the range and sensitivity depending largely on the radar cross-section area of the target. Beam width is 28° (3dB) in E plane and 35° in H plane. The unit is in a cast aluminium case measuring approximately 120×95×60mm

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plus the horn aerial projection. James Scott (Electronic Engineering) Ltd., Carntyne Industrial Estate, Glasgow E.2., Scotland.
WW 306 for further details

TV Transmitter Devices

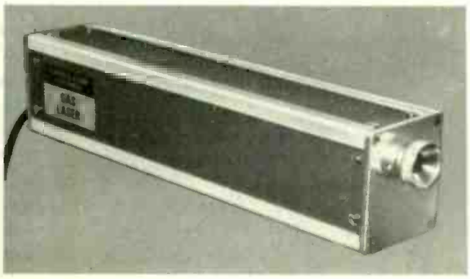
Among new devices shown by Mullard at the last International Broadcasting Convention and Exhibition, were three ceramic-to-metal tetrodes for use in Bands I and III television transmitters. They were types YL1420, YL1430 and YL1440, intended for use in broadband amplifiers and they have maximum anode dissipation of 6, 12 and 1.5kW respectively. All are forced air cooled. Another new device for television transmitters and translators was a multi-cavity air-cooled klystron type YK1005. Under typical operating conditions in a television transmitter it can deliver an output power of 10kW. Permanent magnet focusing and depressed collector operation simplifies cooling problems. Mullard Ltd., Torrington Place, London, W.C.1.
WW 317 for further details

Temperature-stable Reference Diodes

Three reference diodes from SGS-Fairchild have temperature coefficients that are almost zero. Compared with zener diodes, which have a temperature coefficient of greater than 1000 parts per million per degree centigrade, the new diodes, types BZX45, BZX44 and BZX43, have coefficients of 50, 20 and 10 parts per million respectively. Each unit consists of two diodes on one silicon chip in a T0-18 can. One diode is a zener working in the reverse condition, and the other is an ordinary diode working in the forward condition. All three new diodes have a nominal zener voltage of 6.7V $\pm 5\%$, and maintain their temperature coefficient characteristic at a current level of $100\mu A$ over the temperature range 0 to 100°C. Also, the dynamic impedance is low. SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks.
WW 309 for further details

Low-cost Laser

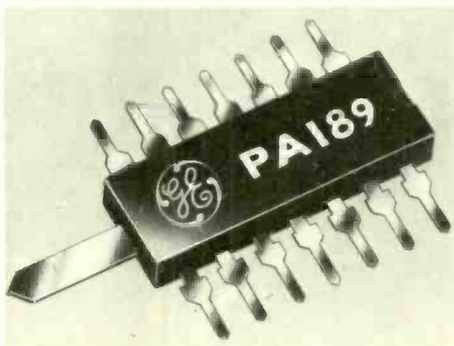
In an effort to beat American competition in the European market for low-priced lasers, Scientifica, London, has produced a new portable model B17/L.



Functionally similar to the existing B17 gas laser range, its special feature is the ease with which the output wavelength can be changed. The wavelength is normally 6328A but it can be changed to 11523A or 33912A if desired. Uniphase power output is approximately 1mW. The laser is normally supplied with one spherical and one plane mirror. Solid-state electronics incorporate the time delay and automatic trigger. The laser tube is a d.c. hot cathode type and the beam width at the exit aperture is 2mm. Dimensions are $90 \times 128 \times 425$mm and weight approximately 4.5kg. It is mains operated. Price £160. Scientifica and Cook Electronics Ltd., 148 St. Dunstan's Avenue, Acton, London, W.3.
WW 305 for further details

I.F. Amp/Discriminator I.C.

Housed in a plastics dual-in-line package, an integrated circuit, type PA189, by General Electric of America performs the function of a high-gain i.f. amplifier and discriminator for use within the consumer market. It may be adapted to meet a wide variety of television and f.m. receiver requirements. These devices are available at £2 1s each



for small quantities from Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW 311 for further details

Counter/Timer

Monsanto model 101A, 12.5MHz counter/timer is a later version of model 100A embodying the additional features of b.c.d. output and provision for an external timebase. It is a half-rack unit employing i.cs and it can measure frequency from 5Hz to 12.5MHz, frequency ratio of $1\text{-}10^5$, and time interval or single period of $10\mu s$ to 10^6 sec. The crystal-controlled clock stability is better than 5 parts in 10^7/day and sensitivity is 50mV r.m.s. A 1MHz internal frequency standard is available at the rear panel and an external frequency standard of 3Hz-5MHz can be applied to the unit. Slave units connected in cascade can be used to extend range or resolution in multiples of 5 digits. Monsanto are in New Jersey, U.S.A. and their British Agents are, G. & E. Bradley Ltd., Electral House, Neasden Lane, London, N.W.10.
WW 303 for further details

Compact Audio Unit

Combining standard hi-fi units into one compact cabinet is a speciality undertaken by Holdings of Blackburn. In the photograph is shown one such combination comprising the Thorens TD150A deck and Shure magnetic cartridge with a Sansui 400 f.m. tuner/amplifier. Different cabinets are available to accommodate the Sansui 2000 and 5000 units. Holdings believe that the satisfactory operation of the units in close proximity can be attributed to the efficient screening on the Sansui unit. Initially, complete systems only will be available but it is expected that cabinets will

shortly be released separately at about 14gn each. Holdings of Blackburn Ltd., Mincing Lane/Darwen Street, Blackburn, Lancs.
WW 308 for further details

Office Intercom System

A new advanced type of intercom system manufactured by Philips and marketed by Pye TVT Ltd.,is claimed to supersede the conventional internal telephone system by offering several advantages. These include simple installation and expansion of the system and instant contact (conversation is possible with any position at the touch of a button). No central exchange is required and facilities for group calling are provided. The Philips intercom system can be supplied in two versions, type M100 and type M30 according to the facilities required. The M100 comprises a control unit and a continuous 8-pair cable which runs through the premises and to which the control unit and up to 100 stations are connected in parallel. The control unit is small and silent in operation and can be mounted in any convenient place, on a wall. Each office has its own output socket into which can be plugged any of the following stations: (1) master station, fitted with the full range of number and function selection keys; (2) executive station, similar to master station but allowing incoming calls to be routed to secretary station; (3) secretary station, similar to master station but with separate line to executive station and (4) substation which can receive and answer calls but from which calls cannot be made.

All stations are available with handsets fitted if it is required to make confidential calls. A station can be moved and plugged in to any socket in the system without changing the number.

The M30 differs from the M100 by being an "all-master" system capable of accommodating up to 30 stations. A 20-core cable is required with a maximum length of approximately 800 metres. Besides enabling any position to call any other position, the M30 also has group calling facilities. When a person is absent, his station can be locked-out and any calling station will then receive a visual "engaged" signal. Both intercom systems use transistors throughout and operate from 110 to 245V, 50 or 60 Hz. Pye TVT Ltd., Addlestone Road, Weybridge, Surrey.
WW 314 for further details

Television Modulator

To convert domestic off-air television receivers to enable them to receive video signals direct from a c.c.t.v. system, General Avionics has produced

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a sound-vision modulator, series 400. The series includes four models designed to cover 625-line v.h.f. and u.h.f., 405-line v.h.f. and the American 525-line standard. The modulator is crystal-controlled at the chosen channel frequency and preset gain controls provide for input levels above those specified. Video input is 0.3V composite minimum and input impedance is 75 Ω video, 5k Ω audio. The r.f. output is sufficient to drive up to 12 receivers. Mains or dry battery driven versions are available. Dimensions are 219 × 51 × 120mm and the price £30 12s 6d. General Avionics Associates Ltd., Victoria House, Victoria Road, Woking, Surrey.
WW 307 for further details

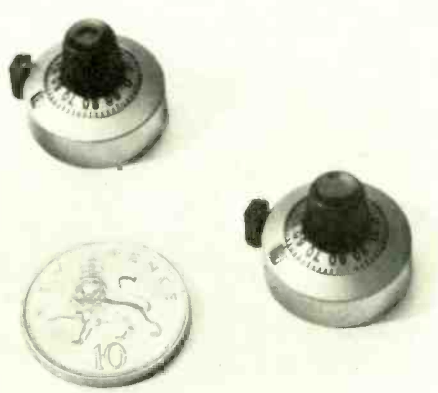
Inverter Series

'S' series inverters by G & R Electronics are 400 Hz, stabilized, sinewave, single- or three-phase modular units in various ratings from 50 to 500

VA, with nominal 24V d.c. input. Compatible units are available to convert the input required to normal a.c. mains. The normal output voltage is 115V, but alternatives are available to order including separate low power 20 or 26V a.c. outputs. Output is stabilized against load and input changes and output power is limited under excess load conditions by means of a re-entrant limiting circuit. This enables the units to be employed for motor starting and other high inrush loads where the initial load presented may be as much as ten times the normal running load. The waveform satisfies the requirements of synchro and servo systems. Synchronization facilities can be provided to lock frequency to an external 400 Hz signal. The illustration shows a three-phase 100 VA unit designated 3S–100. G & R Electronics Ltd., 23 New Street, Salisbury, Wilts.
WW 329 for further details

Turns-counting Dials

Multidials are eleven-turn devices with a total count of 1099, designed for mounting in locations where high precision adjustment is required. The first significant numeral appears in a special



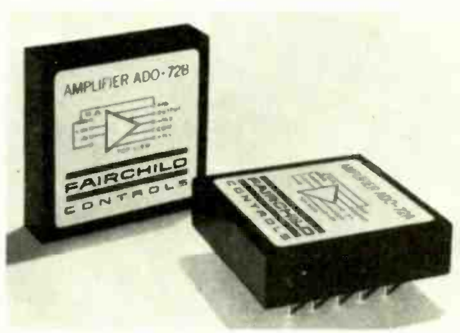
viewing window. The units are designed to fit ¼in diameter shafts but will also fit ⅛in and 3/16in shafts using an adaptor. Torque is 14123μNm and rotation speed can be as high as 1500 r.p.m. There is no backlash and no creep when locked. Finish is in satin chrome with black plastics knobs. Guest Electronics Ltd., Nicholas House, Brigstock Road, Thornton Heath, Surrey, CR4 7JA.
WW 333 for further details

R. F. Switching Diode

A new silicon alloy switching diode, intended for power applications, such as aerial duplexing at base stations and transmitter/receiver isolation in mobile radio telephones, where previously electromechanical devices were used, has been introduced by M.C.P. Electronics. Type PSV100 is a p-n junction device available in a choice of three packages. Sealed in a DO-14 package it has the suffix "L" and is capable of switching 18W of power in a s.p.d.t. circuit between 20 and 250MHz, into a 50-Ω line. Suffixes "D" and "J" will handle 50W. M.C.P. Electronics Ltd. Station Wharf Works, Alperton, Middlesex.
WW 313 for further details

Low-drift Op Amps

Ultra-low drift operational amplifiers types ADO–72A and ADO–72B by Fairchild Controls have guaranteed temperature coefficients of 0.5 and 1μV per deg C respectively. Long term stability is typically 10μV/week. Other features are high gain (500,000 min), high common-mode rejection (250,000:1), high power supply rejection (5μV/V max) and input and output protection. The gain/bandwidth product is typically 800kHz and gain roll-off is typically 6dB/octave. The amplifiers are



designed to operate over a voltage range of −6 to −20V and are housed in low profile, 37 × 10mm packages. Fairchild Controls, 423 National Avenue, Mountain View, California 94040. European office: Seestrasse 233, 8700 Kusnacht, Zurich, Switzerland.
WW 335 for further details

Mobile R/T

A range of new solid-state mobile radio-telephones by Philips is being marketed in the U.K. by FieldTech Ltd. Designed for use in all types of road vehicles and smaller marine craft, the equipment comprises a v.h.f. or u.h.f. transmitter/receiver and built-in loudspeaker in a case measuring 230 × 230 × 65mm. The same case can house 3, 10 or 20W v.h.f. or 5/10W u.h.f. versions with provision in the basic unit for selective calling without requiring add-on units. Channel spacing of 12.5kHz is used, and up to 12 channels can be accommodated. A portable version is available powered by an internal accumulator which is automatically re-charged from the vehicle's battery when the set is placed in the mounting tray. Base stations of the same physical

size and power ratings as the mobile units operate from a.c. mains and can be controlled remotely via land-line if required. FieldTech Ltd., London Airport, Hounslow, Middx.
WW 332 for further details

New Triacs

Three new triacs announced by Quarndon Electronics comprise two 6–A types in a choice of either TO–48 or TO–66 case, and a 10–A version in a TO–48 case. All types are available with voltage ratings of 200, 600 and 800V and feature high triggering sensitivity in the normal operating modes. These devices are suitable for use in power control applications in a.c. circuits. Quandon Electronics (Semiconductors) Ltd., Slack Lane Derby.
WW 336 for further details

Precision Potentiometers

A new range of single-turn precision potentiometers in which the resistive element is of conductive plastics is announced by Pandect of High Wycombe, who claim that this type of track offers virtually infinite resolution coupled with exceptional reliability and long service life. Produced in five of the international frame sizes for synchro servo units (sizes 11, 15, 18, 20 and 30) the potentiometers are intended mainly for instruments and electronic equipment with stringent requirements. In construction, ganging of multiple units on a common axis is provided for, up to a maximum of 8 elements. The range includes standard and special resistance values and linear, non-linear and sine/cosine versions. Resistance values are typically 500Ω to 25kΩ (standard) and 250Ω to 200kΩ (special). Operating torques range from 2471.5 to 6355.3μNm. Ambient temperature range is 55° to + 125°C and

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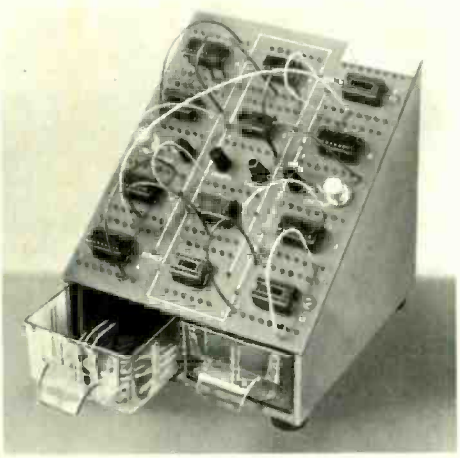
service life 5×10^7 cycles. Pandect Precision Components Ltd., Wellington Road, High Wycombe, Bucks.
WW 334 for further details

I.C. Breadboard

Model ICB727 has been added to the range of i.c. breadboards by Spectrum Electronics giving provision for the connection of 8 sixteen-lead and 4 fourteen-lead dual-in-line circuits. It features solderless inter-connections throughout and is claimed to reduce damage to i.cs to a minimum. Each pin of the 12 i.c. sockets is brought out to a four-way socket which can be connected to any adjacent socket by colour-coded leads. Common power and earth points are available at each socket, terminated in 2mm binding posts. Two storage



drawers are provided for i.cs and leads. The ICB727 measures $160 \times 160 \times 160$mm, weighs 680g, and costs £19 each for small quantities. Spectrum Electronics Ltd., Deneway House, Potters Bar, Herts.
WW 318 for further details

Miniature Terminals

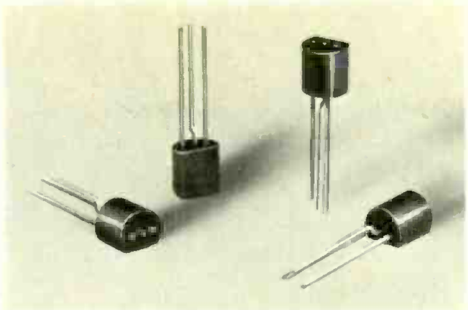
A new series of miniature terminals, type L1726, with a current rating of 10A and a breakdown voltage greater than 4kV d.c. is announced by Belling & Lee. It includes a captive head available in six colours and a socket in the top for plugging-in auxiliary miniature connections. The cross-hole in the clamping gap accepts wires up to 1.9mm diameter, i.e. 15s.w.g. solid wires or 40/.0076 stranded conductors. A 5.3mm mounting hole is required; the stem is terminated in an integral solder spill for rear-of-panel connections. Belling & Lee Ltd., Gt Cambridge Road, Enfield, Middx.
WW 319 for further details

Simple Programming Board

To assist error-free programming, a new 40×20 matrix board with 6.4×12.7mm hole spacing has been developed by Sealectro. The new board provides mechanical separation between each distinct programme function and the extra space between holes makes for easier marking. Silver-plated contacts are used. Sealectro Ltd., Walton Road, Farlington, Portsmouth, Hants.
WW 331 for further details

Epoxy-packaged Complementary Transistors

S.T.C. Semiconductors has extended its range of epoxy-packaged epitaxial transistors with complementary types BSW72–75 (p–n–p) and BSW82–



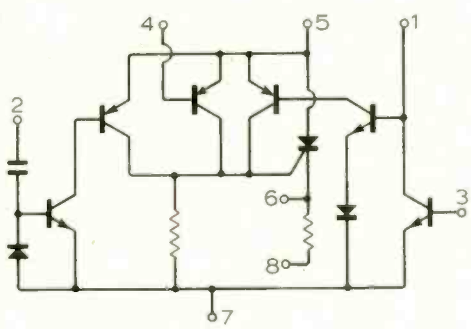
85 (n–p–n), featuring V_{CEO} ratings of up to 40V and a gain specified over the current range 10–500mA. The TO–92 package has lead spacing conforming to TO–18. S.T.C. Semiconductors Ltd., Footscray, Kent.
WW 323 for further details

Tunnel Diodes

Gallium arsenide tunnel diodes which provide microwave oscillator designers with a wide selection of capacitance values are announced by Interplanetric. The thermal characteristics of these devices allow higher output powers than are possible with germanium types. They are inherently stable, thermally, and have a wide voltage swing making them well-suited to switching and logic circuitry. The capacitance range is 1–100pF and cut-off values from 5–25GHz. Storage temperature is from $-65°$ to $+85°$C. Interplanetric, 39–49 Cowleaze Road, Kingston on Thames, Surrey.
WW 321 for further details

Versatile Trigger Circuit

A multiple function trigger circuit, now available from Westinghouse Electric Corporation in an eight-pin dual-in-line package, will operate at low voltage (e.g. 3V) and handle high surge currents (2 amp through the silicon controlled rectifier). Other features of the unit include low standby current, high sensitivity, and a choice



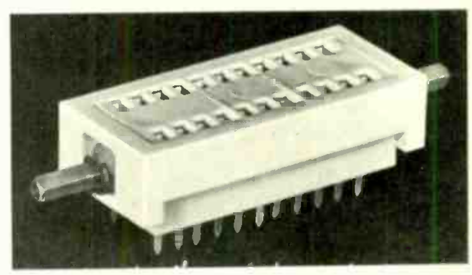
of three input channels to fire the thyristor. Agents: Ultra Electronics (Components) Ltd., Microelectronics Division, 35-37 Park Royal Road, London, N.W.10.
WW 324 for further details

Spectral Analyzer

Among laser equipment shown at the symposium on the "Engineering Uses of Holography," at the University of Strathclyde in Glasgow, in September, was a high-resolution spectroscopic system, designed for use in the analysis of c.w. gas laser mode structure, introduced by Spectra-Physics of America. It comprised an analyzer head and an electronic control unit which provides the driving and display circuitry necessary to produce a trace of laser mode intensity at optical frequency on the screen of a c.r.t. An outstanding feature of the optical spectrum analyzer, designed model 420, is the use of a mode-degenerate, confocal interferometer in the analyzer head. This is aligned at the factory making alignment of the head to the incident beam easy in use. Applications of the 420 include observations of the transverse mode structure of lasers, monitoring the output of "single-frequency" lasers, detection of phase-locking effects and study of the general characteristics of mode structure in lasers. Two alternative analyzer heads are available, models 421 and 422. Model 421 is designed for use with helium-neon 632.8nm lasers and has a free spectral range of 2GHz, while model 422 is designed for use with argon-ion lasers and has a free spectral range of 10GHz. The control unit provides the scanning and bias voltages for the analyzer head as well as the horizontal sweep voltage for a Tektronix 560 series oscilloscope. It can be used with both analyzer heads. An optional optical isolator, comprising a disc of plastics circular polarizing sheet mounted in a rotatable housing, prevents any back-scattered light from feeding back into the laser. Although the analyzer heads do not specularly reflect the laser beam back on itself, the use of an optical isolator is generally desirable. U.K. office: Spectra-Physics S.A., Queensway Estate, Glenrothes, Fife, Scotland.
WW 315 for further details

Lockable I.C. Sockets

Oxley Developments are marketing a socket designed specially for the interconnection of integrated circuits of the d.i.l. type (2×11 con-



tacts). The socket contains a locking device which clamps the male and female contacts together firmly holding the plug-in unit in place and keeping the contact resistance to a minimum. When the socket is in the unlocked position, modules can be inserted or extracted. Oxley Developments Co. Ltd., Priory Park, Ulverston, North Lancs.
WW 322 for further details

Desk-top Calculator

At the recent Electronic Instruments Exhibition, Manchester, Hewlett Packard showed a programmable desk-top electronic calculator, designed to perform complex operations commonly encountered in scientific and engineering problems. It is designated type 9100A. The keyboard includes functions such as logarithms, exponentials, hyperbolic and trigonometric functions and their inverse, as well as co-ordinate transformations. All keys are labelled in English or common mathematical symbols. The 9100A has wide application in the

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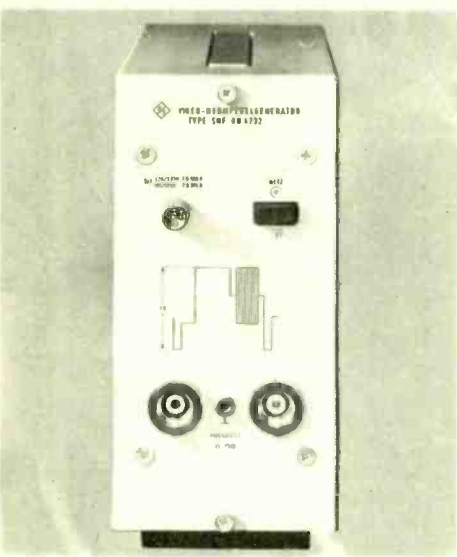
solution of problems in a.c. circuits and in aeronautics, stress analysis and triangulation problems. Hewlett Packard, 224 Bath Road, Slough, Bucks.
WW 328 for further details

Silicon Solar Cells

A range of silicon solar cells now available from Photain Controls have a peak spectral response (560μm) which corresponds with the maximum sensitivity of the human eye. This feature, coupled with their very rapid response times, makes the cells suitable for a wide range of industrial and commercial photo-electric applications. They are sensitive to low illumination levels, require no bias voltage supply and have a stable output. These cells are claimed to have a useful sensitivity in the blue region, the total spectral response range being from 400 to 1100μm. Half-sensitivity spectral width is 440–770μm. Electrical output ranges from 10μA at 32 lux to 300μA at 1076 lux and output is constant over the temperature range —50 to + 132°C. The cells are mounted in acrylic resin cases, metal cans with glass windows or epoxy coated, and can be supplied with effective sensitive areas from 0.123cm^2 to ·2cm^2. Photain Controls Ltd., Randalls Road, Leatherhead, Surrey.
WW 339 for further details

Video Level Generator

A test signal at line frequency, similar to the C.C.I.R. test signal No. 2 but with the front porch and set-up interval omitted, is provided by type SNF video standard level generator made by Rohde & Schwarz. Output voltage is 1V p-p with a stability of ± 1%. A sinewave burst having the same frequency as the colour sub-carrier is included for checking conditions at colour sub-carrier level. The generator is suitable for checking the level of



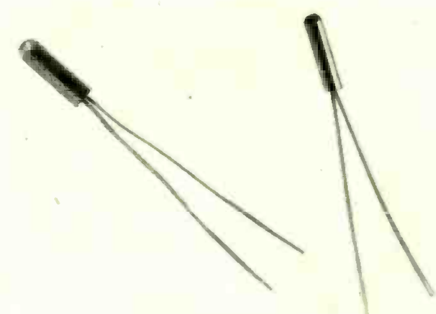
TV transmission paths with PAL, N.T.S.C. and SECAM systems. Rohde & Schwarz, 80 Mühldorfstrasse, Munich, Germany.
WW 327 for further details

M.O.S. Switches

Two m.o.s. multiplex switches, type μM3700 (4-channel switch) and type μM3705 (8-channel switch), produced by SGS-Fairchild to complement their existing devices, are available in two versions to cover different signal ranges of −5V to +5V and 0 to 5V and are suitable for operation over the temperature range −55°C to +85°C. The 3700 is a 14-lead flatpack device and the 3705 is a 16-lead d.i.l. device. Both are intended as basic switching elements for signal routing applications such as airborne or ground instrumentation and can be employed in anologue and digital data transmission. SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks.
WW 320 for further details

New Photodiodes

Two subminiature sensitive photodiodes announced by Mullard are designed for use in high-speed punched card and tape reading machines. Types BPY68 and BPY69, they are symmetrically diffused silicon devices that can operate with a positive or negative bias. Their spectral response extends from 0.6 to 0.97 μm, with a peak occurring at approximately 0.82 μm. The BPY68 is a silicon version of the germanium photodiode type CAP12, which has a similar envelope, but with a sensitivity of 0.3 μA/lux compared with only 0.05 μA/lux for the CAP12. Its diameter is approximately 2.8mm and (excluding



the leads) its length is 9.5mm. The diameter of the BPY69 is only 2.1mm—equal to that of the pitch of the holes in punched tape. The sensitivity of the BPY69 is 0.15 μA/lux. Both diodes are fitted with an integral glass lens. They have a maximum breakdown voltage of 60V and a dark current of not more than 50nA. Mullard Ltd., Torrington Place, London W.C.1.
WW 316 for further details

Portable Soldering Tool

A new departure in soldering tools, the Express 2000 is a battery-operated portable type, powered by a rechargeable nickel-cadmium cell. It is intended for intermittent soldering jobs, the number of joints that can be made on one fully-charged battery being in excess of 100. The battery itself has a working life of 3000 charge cycles and is supplied with the tool. Two bits, of 3mm tip and 1.5mm tip, are supplied. The Express 2000 costs

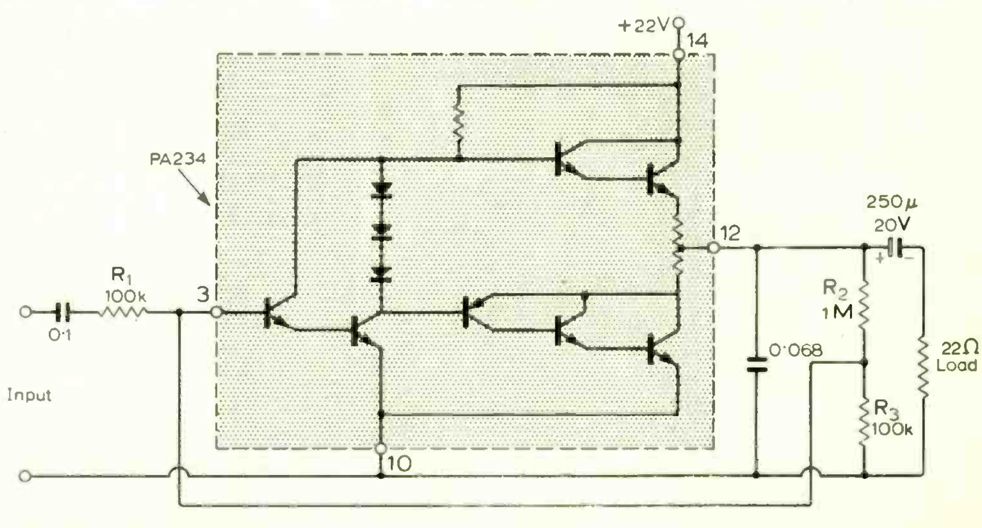
£9 13s 6d, plus £2 16s 6d for an optional charging unit. Henri Picard & Frère Ltd., 34/35 Furnival Street, London, E.C.4.
WW 304 for further details

"Pocketfone" Car Adaptor

Users of Pye u.h.f. "Pocketfone" receivers can now obtain an adaptor which enables the receiver to work inside a car without the disadvantage of screening. When the receiver is clipped into the adaptor it is automatically connected to a trickle charger which charges the internal battery, and an amplifier in the adaptor unit with a separate loudspeaker boosts the output up to 3W via a separate volume control. Pye Telecommunications Ltd., Cambridge, Cambs.
WW 302 for further details

I.C. Audio Amplifier

Recently introduced to the General Electric (U.S.A.) range of i.c. linear amplifiers, type PA234 1W audio amplifier is available from Jermyn Industries in development quantities at 15s 9d each. This new i.c. operates from a supply voltage of 9-25V and is compatible with 8, 16 and 22Ω loads. A cooling tab facilitates heat sink connection, but the package will dissipate 750mW in free air at 25°C. To complete the amplifier circuit the number of external passive components required is only three capacitors and three resistors. The circuit illustrated below has input impedance of 100kΩ, an output impedance of 2Ω and 1W output with an input of 600mV. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW 312 for further details



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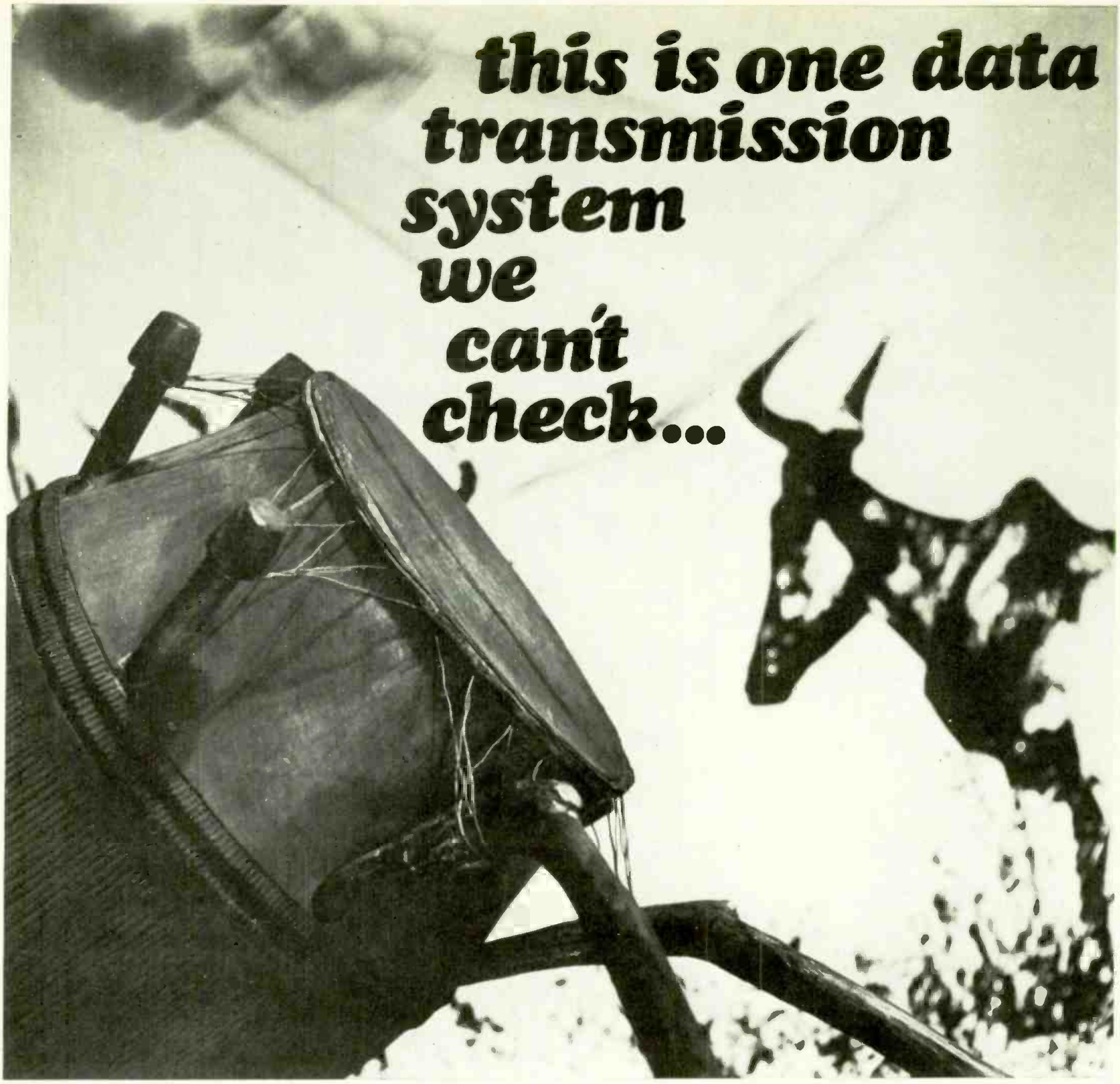

Photograph of Ghanaian 'Talking Drum' by courtesy of The Commonwealth Institute, Kensington High St.

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Test Your Knowledge

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

8. Electromagnetic Radiation

1. One of the following forms of radiation is not electromagnetic:
(a) radiation
(b) α radiation
(c) radiant heat
(d) microwave radiation.

2. A travelling electromagnetic wave in free space has electric and magnetic fields which are:
(a) in phase and in the same direction
(b) in the same direction, but have an arbitrary phase relationship
(c) in phase and at right angles to one another
(d) at right angles, but have an arbitrary phase relationship.

3. The direction of propagation of an electromagnetic wave in free space is:
(a) along the electric field
(b) along the magnetic field
(c) in the plane of the electric and magnetic fields and bisecting the angle between them
(d) perpendicular to the surface containing the electric and magnetic fields.

4. The direction of polarization of a linearly polarized electromagnetic wave is taken as:
(a) the direction of the electric field
(b) the direction of the magnetic field
(c) the direction bisecting the angle between the electric and magnetic fields
(d) the direction of propagation.

5. At a fixed point in a medium in which a circularly polarized plane electromagnetic wave is propagating:
(a) the electric and magnetic fields both rotate and vary in amplitude sinusoidally with time
(b) the electric and magnetic fields both remain constant in amplitude, but rotate in direction with the passage of time
(c) the electric field remains constant in amplitude and rotates while the magnetic field remains fixed in direction but varies in amplitude sinusoidally with time
(d) the magnetic field remains constant in amplitude and rotates while the electric field remains fixed in direction but varies in amplitude sinusoidally with time.

6. With reference to plane electromagnetic waves the relationship between circular polarization and linear polarization is:
(a) none
(b) only that a circularly polarized wave can be formed by combining together two linearly polarized waves
(c) only that a linearly polarized wave can be formed by combining together two circularly polarized waves
(d) a linearly polarized wave can be formed from two circularly polarized waves and a circularly polarized wave can be formed from two linearly polarized waves.

7. 3×10^8 metres per second is the velocity of:
(a) plane electromagnetic waves in free space only
(b) plane electromagnetic waves in any medium
(c) all forms of electromagnetic radiation in free space only
(d) all forms of electromagnetic radiation in any medium.

8. The ratio of peak electric to peak magnetic field strengths in a travelling transverse electromagnetic wave:
(a) is the same in all cases
(b) depends on the shape of the wavefront
(c) depends on the medium in which the wave is propagating
(d) depends on the intensity of the wave.

9. The electric field strength of an electromagnetic spherical wave in a loss-free isotropic medium:
(a) does not vary with distance from the centre
(b) falls off linearly with distance from centre
(c) falls off as the square of the distance from the centre
(d) falls off as the fourth power of the distance from the centre.

10. An isotropic dielectric medium which supports a transverse electromagnetic wave:
(a) is non-dispersive in all cases
(b) is dispersive in all cases
(c) is non-dispersive if the permittivity is proportional to frequency
(d) is dispersive if the permittivity varies with frequency.

11. The total reflection of a plane electromagnetic wave at the boundary between two isotropic media can *only* occur if:
(a) the phase velocity in the medium in which the wave is propagating is less than the phase velocity which the wave would have in the medium beyond the boundary
(b) the permittivity of the medium beyond the boundary is greater than that of the medium in which the wave is propagating
(c) the medium beyond the boundary contains free charges
(d) the boundary between the two media is abrupt.

12. In order that a parallel beam of electromagnetic radiation may propagate:
(a) the diameter of the beam must be very large compared to the wavelength
(b) the radiation must be at light frequencies or above
(c) the radiation must be monochromatic
(d) the medium must be free space.

13. The quantum theory implies that the energy associated with an electromagnetic wave exists in the form of a stream of particles called photons:
(a) in all cases
(b) only if the radiation is incoherent
(c) at optical frequencies and above, but not at lower frequencies
(d) unless the radiation is monochromatic.

14. Electromagnetic radiation is coherent if:
(a) its energy is not quantized
(b) its wave fronts are plane
(c) it is produced by currents flowing in a conductor, not by atomic emission
(d) the phase difference between the oscillations at any two points in the medium does not change with time.

15. The most important difference between light produced by a laser and light produced by any other available source is that the laser light:
(a) is coherent
(b) is at a fixed frequency
(c) is not quantized
(d) can be pulsed.

16. A small generator situated in space far from the earth or any other body emits a parallel beam of electromagnetic radiation. As a result of this the generator will
(a) rotate about a fixed axis
(b) move in the direction of the beam propagation
(c) move in the opposite direction to the beam propagation
(d) move in a direction perpendicular to the beam.

Answers and comments, page 51

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

"Test Your Knowledge—7"

In the set of questions on Valves (December 1968 issue, p.470) some words were accidentally omitted from question 5. The end of the question should read as follows:—
(c) a rise in temperature of the cathode due to ion bombardment
(d) an increase in the anode area due to thermal expansion.

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1969 U.K. Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Jan. 6-11 R.H.S. Halls
Inventions and New Products Exhibition
(Business Conferences & Exhibitions, Mercury House, Waterloo Rd., London S.E.1)

Jan. 13-17 U.S. Trade Center
American Computer Display Equipment
(U.S. Trade Center, 57 St. James's St., London S.W.1)

Mar. 10-13 Alexandra Palace
Physics Exhibition
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Mar. 10-14 Earls Court
Medical Engineering and Automation Exhib.
(Industrial Exhibitions, 9 Argyll St., London W.1)

Mar. 10-14 Earls Court
Electronic Production Equipment Exhib.
(Industrial Exhibitions, 9 Argyll St., London W.1)

Mar. 11-13 Kings Head, Harrow
Public Address Show
(Assoc. of Public Address Engrs, 394 Northolt Rd., Harrow, Middx.)

Mar. 25-29 Earls Court
Laboratory Apparatus & Materials Exhib.
(U.T.P. Exhibitions, Racquet Court, London E.C.4)

Apr. 21-25 Savoy Place
Switching Techniques for Telecom Networks
(I.E.E., Savoy Pl., London W.C.2)

Apr. 22-30 Olympia
Engineering and Marine Exhibition
(F. W. Bridges & Sons, Commonwealth House, New Oxford St., London W.C.1)

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

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

June 10-20 I.M.E., Mark Lane
Marine and Shipping Conference
(Institute of Marine Engineers, 76 Mark Lane, London E.C.3)

July 2-4 Middx. Hosp. Medical Sch.
Lasers in Medicine
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Sept. 2-6 Grosvenor House
Educational & Training Technology
(I.E.E., Savoy Pl., London W.C.2)

Sept. 8-12 Savoy Place
Microwave Conference
(I.E.E., Savoy Pl., London W.C.2)

Sept. 15-17 Savoy Place
Trunk Telecommunications by Guided Waves
(I.E.E., Savoy Pl., London W.C.2)

Oct. 1-4 R.H.S. Hall
R.S.G.B. Radio Communications Exhibition
(P. A. Thorogood, 35 Gibbs Green, Edgware.)

Oct. 16-22 Olympia
Audio Fair
(C. Rex Hassan, 42 Manchester St., London W.1)

BELFAST

Sept. 9-12 Queen's University
Nonlinear Optics
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

BIRMINGHAM

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

BRIGHTON

Feb. 16-21 Hotel Metropole
Oceanology Conference
(G.P.S. Exhibitions, 6 London St., London W.2)

Sept. 24-26 University of Sussex
Nuclear Structure & Elementary Particle Physics
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

CAMBRIDGE

Mar. 26-28 Selwyn College
Elementary Particles
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Sept. 8-12 St. John's College
Man-machine Systems
(D. Whitfield, Applied Psychology Dept., University of Aston, Birmingham 4)

CANTERBURY

July 23-25 University of Kent
Digital Methods of Measurement
(I.E.R.E., 9 Bedford Sq., London W.C.1)

CRANFIELD

Mar. 23-26 College of Aeronautics
Aerospace Instrumentation Symposium
(N. O. Matthews, Department of Flight, College of Aeronautics, Cranfield, Beds.)

DURHAM

Sept. 16-18 The University
Applications of Dynamic Modelling
(I.E.E., Savoy Pl., London W.C.2)

EASTBOURNE

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

June 3-5 Congress Theatre
Microelectronics Conference
(I.E.E., Savoy Pl., London W.C.2)

EXETER

Sept. 16-19 The University
Solid State Devices
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

KINGSTON-ON-THAMES

Apr. 1 & 2 Col. of Technology
Digital Storage Techniques
(Dr. R. V. Sharman, College of Technology, Penrhyn Rd., Kingston-on-Thames)

MANCHESTER

Jan. 7-9 The University
Solid State Physics
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Mar. 31- Apr. 3 The University
Atomic and Molecular Physics
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

June 30- July 3 U.M.I.S.T.
Computer Science & Technology
(I.E.E., Savoy Pl., London W.C.2)

Aug. 25-29 The University
Datafair
(Brit. Computer Soc., 23 Dorset Sq., London N.W.1)

Sept. 29-Oct. 3 Belle Vue
Electronics, Instruments, Controls & Components Show
(Inst. of Electronics, Balderstone, Rochdale, Lancs.)

NORWICH

Apr. 15-18 University of E. Anglia
Physics of Liquids
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

NOTTINGHAM

Mar. 25-27 The University
Interactions among Elementary Excitations in Solids and Liquids
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

PLYMOUTH

Jan. 14 & 15 Col. of Technology
Position Measurement & Instrumentation
(R. T. Macdermott, Dept. of Elec. Eng., College of Technology, Plymouth)

SOUTHAMPTON

Mar. 25-27 The University
Lasers and Opto-Electronics
(I.E.R.E., 9 Bedford Sq., London W.C.1)

Apr. 15-18 The University
Computer Aided Design
(I.E.E., Savoy Pl., London W.C.2)

YORK

Apr. 16-18 The University
Thin Films Conference
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

Overseas Conferences and Exhibitions

JANUARY–MARCH

Jan. 21-23 Chicago
Reliability Symposium
(R. Brewer, Associated Semiconductor Manufacturers Ltd., Millbrook Ind. Est., Southampton, SO9 7BH)

Jan. 28-31 Ellenville, N.Y.
Information Theory
(J. Wolf, Dept. of Elect. Eng., Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, New York 11201)

Feb. 10 & 11 Washington
Transducer Conference
(H. P. Kalmus, Harry Diamond Laboratories, Dept. of the Army, Washington, D.C. 20438)

Feb. 19-21 Philadelphia
Solid-State Circuits Conference
(I.E.E.E., 345 E. 47th St., New York, N.Y. 10017)

Mar. 4-8 Basel
Industrial Electronics Exhibition
(Sekretariat INEL 69, CH-4000, Basel 21)

Mar. 5-7 Washington
Accelerator Engineering & Technology
(E. H. Eisenhower, Center for Radiation Research, National Bureau of Standards, Washington, D.C. 20234)

Mar. 5-16 Sao Paulo
British Industrial Exhibition
(Industrial & Trade Fairs, Commonwealth House, New Oxford St., London W.C.1)

Mar. 6-11 Paris
Festival du Son
(Fed. Nat. des Ind. Electroniques, 16 rue de Presles, Paris 15e)

Mar. 24-27 New York
I.E.E.E. Convention & Exhibition
(I.E.E.E., 345 E. 47th St., New York, N.Y. 10017)

Mar. 24-28 Paris
Remote Data Processing
(Soc. Francaise des Electroniciens et des Radio-électriciens, 10 av. Pierre-Larousse, Malakoff)

Mar. 28-Apr. 2 Paris
Components & Electro-acoustics Show
(Fed. Nat. des Ind. Electroniques, 16 rue de Presles, Paris 15e)

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World of Amateur Radio

United Kingdom Licence Changes

Effective November 1, 1968, United Kingdom amateur sound and television licences were amended in respect of the 4-metre and 70-cm bands. The width of the 4-metre band has been extended downwards by 75kHz to provide a total bandwidth of 675kHz (70.025 to 70.7MHz) while the 70-cm band has been split in two with the lower section falling between 425 and 429MHz and the upper section between 432 and 450MHz. Previously the band extended from 426 to 450MHz. The change has been brought about by the allocation of a band of frequencies between 429 and 432MHz to a new service in the U.K. The amendments to the 70-cm band have led to an alteration in the frequency limits for amateur television which is now permitted between 425 and 429MHz and 432 and 445MHz.

Christoforo Colombo Prize

Charles Newton (G2FKZ) of London, has been awarded the Christoforo Colombo prize in the technical section of the 16th International Communications Conference in Genoa, Italy. The citation reads "For the careful work carried out during the International Geophysical Year, for the study of the phenomenon of radio electrical propagation in the presence of aurora borealis and for the scientific works presented to high level conferences which are a clear mark that the radio amateurs' work has already reached high scientific importance". The award, announced by the president of the Italian Ministers' Council during the closing session of the conference, is the first formal recognition by an international professional body in recent times of the work of United Kingdom radio amateurs.

Canadian Amateur Radio History

"From Spark to Space", is the title of a history of amateur radio in Canada produced by a small group of members of the Saskatoon Amateur Radio Club. Of special interest from the United Kingdom point of view is the account of the early transatlantic tests as seen through the eyes of Canadian participants, particularly Major William Barrett (VE1DD), of Halifax, who also recounts how the Royal Order of Transatlantic Brasspounders came into existence. The ROTAB trophy, donated by the late Gerald Marcuse (G2NM), is the premier award of the Radio Society of Great Britain.

"From Spark to Space" can be obtained from the Saskatoon Amateur Radio Club, Saskatoon, Canada, price $2.00

The September Floods & the R.A.E.N.

Although a full report on the part played by the Radio Amateur Emergency Network during the September floods has not been published, sufficient is known to record that the user services in the badly affected Surrey area failed to call upon the network until a somewhat late hour. When help was sought, no time was lost, and the Surrey group put in a 5-day stint, working from 9 a.m. to 8 p.m. daily, in the flood area.

One unforeseen use of the network was to direct a petrol tanker supplying fuel for the 112 drying machines manned by about 200 R.A.F. personnel who were not equipped with radio. Base stations working on 4 metres were installed at Molesey and Esher and these were supplemented soon afterwards by a further link on 2 metres. With the assistance of G3GOX/G2AVC at Hounslow, acting as mobile control, up to five messages were passing every minute during the peak period. Altogether about 200 messages were accounted for in written form. Out of a total membership of 37 in the Surrey R.A.E.N. group, 20 took an active part in the operation.

New R.S.G.B. Headquarters

After a stay of 25 years at New Ruskin House, Little Russell Street, London, W.C.1, the headquarters of the Radio Society of Great Britain has moved to 35 Doughty Street, W.C.1. The new building was acquired for the sum of £32,500 and a further sum (around £8,000) has been spent on redecorations and the installation of central heating, furnishings, etc. With the change the society has lost its cryptic telephone number "7373", the new one being 837 8688.

Royal Naval Amateur Radio Society

W. Metcalfe (G3TIF), honorary secretary of the Royal Naval Amateur Radio Society, has moved to Edmonton, Canada. The new secretary is radio superintendent R. Malcolmson who may be contacted c/o H.M.S. Mercury, Leydene, Hants. Associate membership of the society has been extended to include members of the Merchant Navy and foreign navies. The next on-the-air Morse code practice run will commence at 1900 hours on January 7, 1969, on 3520kHz.

Christmas Lecture

The education committee of the Radio Society of Great Britain is preparing material for a Christmas lecture dealing with amateur radio to be given at the Science Museum London, on January 4, 1969. The lecture will be delivered once in the morning at 11 a.m. and again in the afternoon at 3 p.m.

Another History Planned

Mrs Louise Moreau (WB9BBO), 1036 East Boston Street, Altadena, California, 91001, is preparing a history of women radio amateurs and is particularly interested in obtaining information and anecdotes about some of the early lady operators. Miss Barbara Dunn (G6YL) (who is still active), was England's first lady amateur with Mrs Dorothy Burns (GM2IA), occupying the same position in Scotland. Both ladies were first licensed about 40 years ago.

Amateur Radio Conference in Brussels

More than 40,000 radio amateurs in Europe, Asia and Africa will be represented by delegates from upwards of 30 members from societies in the International Amateur Radio Union (Region I Division) at a triennial conference to be held at the Hotel Metropole, Brussels, from May 5 to 9, 1969. Papers covering a wide range of subjects are at present being prepared by member societies and will be issued early in the new year as conference documents. The conference is being organised, on behalf of the executive committee of the division, by the Belgian national society (U.B.A.).

Top Band Transatlantic First-timers' Test

European radio amateurs who have not yet succeeded in making a transatlantic two-way contact on Top Band (160 metres) are reminded that a series of tests for their special benefit will take place on February 2, 1969, between 0500 and 0730 g.m.t. Reports of contacts made during the tests should be sent to the organiser Stewart S. Perry (W1BB), 36 Pleasant Street, Winthrop 20152, Mass, U.S.A. Participants should call "CQ DX TEST FT FT".

Northern Radio Societies Association

R. M. Clarke (G8AYD), Hillside, Quickedge Road, Mossley, Ashton-upon-Lyne, Lancs., gives notice that a convention of the ten societies forming the N.R.S.A. will be held in the Cumberland Suite, Belle Vue Gardens, Manchester, on Sunday, April 27, 1969. In the past more than 4,000 people have attended N.R.S. conventions which have become one of the largest events in the amateur radio calendar. Mr. Clarke, who is manager of the convention, will be pleased to hear from any organisation desirous of reserving stand space.

JOHN CLARRICOATS G6CL

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January Meetings

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

LONDON

2nd, I.E.E.—Discussion on "Harmonic generators using varactors and step recovery diodes" at 17.30 at Savoy Pl., W.C.2.

7th. I.E.E.—Colloquium on "Engineering applications of spectral analysis" at 14.30 at Savoy Pl., W.C.2.

7th. S.E.R.T.—"Transistor audio amplifiers" by D. R. Hyde at 19.00 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

8th. I.E.R.E.—"Speech and vocoders" by L. C. Kelly at 18.00 at 9 Bedford Sq., W.C.1.

9th. Inst. of Electronics—"Linear integrated circuits" by J. R. Whitbread at 18.45 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.

13th. I.E.E.T.E.—"Microelectronics—the next decade" by Dr. Ian M. Mackintosh at 18.00 at the I.E.E., Savoy Pl., W.C.2.

15th. Inst. of Navigation—"Marine radar display systems" at 17.00 at the Royal Institution of Naval Architects, 10 Upper Belgrave St., S.W.1.

15th. I.E.R.E.—Discussion on "Auto manual and back-up control problems in plant operation" at 18.00 at 9 Bedford Sq., W.C.1.

17th. R.T.S.—"Electronic equipment for educational and industrial technology—what we have and what we need" by Dr. L. C. Jesty at 19.00 at I.T.A., 70 Brompton Rd., S.W.3.

20th. I.E.E.—"Kirchhoff and after—120 years of network topology" by Dr. G. S. Brayshaw at 17.30 at Savoy Pl., W.C.2.

20th. I.E.E.—"Computer aided instruction" by Capt. G. Huggett, R.N., at 17.30 at Savoy Pl., W.C.2.

22nd. I.E.E.—"Education in electronics" by Prof. J. Brown at 17.30 at Savoy Pl., W.C.2.

22nd. I.E.E. & I.E.R.E. Grads.—"Coaxial in telephone and television transmission" by C. H. Parker at 18.30 at Savoy Pl., W.C.2.

23rd. I.E.E.—Discussion on "Hill climbing—where is it going?" at 17.30 at Savoy Pl., W.C.2.

23rd. R.T.S.—"Colour receiver servicing: a critical appraisal" by B. A. Barnard at 19.00 at I.T.A., 70 Brompton Rd., S.W.3.

27th. I.E.E.—"Beyond the horizon radar" by Prof. E. D. R. Shearman at 17.30 at Savoy Pl., W.C.2.

29th. I.E.R.E.—"Training professional engineers and technicians" by F. Metcalfe at 18.00 at 9 Bedford Sq., W.C.1.

30th. I.E.E.—"Some considerations in the design and operation of a particular real-time system" by W. C. Dunlop at 17.30 at Savoy Pl., W.C.2.

30th. I.E.E.—Discussion on "Linear integrated circuits" at 17.30 at Savoy Pl., W.C.2.

30th. I.P.R.E.—"Ferrites" by E. Adcott at 19.30 at Mullard House, Torrington Pl., W.C.1.

BATH

9th. S.E.R.T.—"Colour television receivers" by B. J. Rogers at 19.45 at the Technical College, James St. West.

BELFAST

21st. I.E.E. Grads.—"Mathematics and engineering" by T. Ambrose at 18.30 at the Ashby Institute, Queen's University, Stranmillis Rd.

28th. I.E.R.E.—"Satellite communication systems and the diverse engineering techniques which they require" by C. F. Davidson at 18.30 at the Ashby Institute, Queen's University, Stranmillis Rd.

BIRMINGHAM

27th. I.E.E. & I.P.O.E.E.—"Electronics in the postal service" at 18.00 at the M.E.B. Offices, Summer Lane.

BRADFORD

9th. I.E.R.E.—"Computer aided electronic circuit design" by P. E. Love at 19.00 at the University.

BRISTOL

15th. I.E.E., I.E.R.E. & R.Ae.S.—"Practical uses of navigational aids" by W. J. Inglefield at 19.00 at the University.

16th. I.E.E.—"Technician courses, examinations and awards" by J. Cotterell at 18.30 at the Technical College.

CAMBRIDGE

30th. I.E.R.E. & I.E.E.—"Inertial navigation" by Prof. A. Stratton at 20.00 at the University Eng'g Labs., Trumpington St.

CARDIFF

6th. I.E.E.—"Concorde" by H. Hill at 18.00 at the Inst. of Science & Technology.

15th. I.E.R.E.—"Linear microelectronics" by S. O. Davidsen at 18.30 at the Inst. of Science & Technology.

15th. I.E.E.T.E.—"The laser beam and its applications" by C. S. Grace & L. G. Penhale at 19.30 at the Inst. of Science & Technology.

17th. S.E.R.T.—"Communications in space" by G. L. Griffiths at 19.30 at the Llandaff Technical College, Western Avenue.

CHELMSFORD

21st. I.E.R.E.—"Underwater telemetry" by G. Pearce at 19.00 at the Civic Centre, Duke St.

CHESTER

6th. I.E.E.—"Computer aided design using light pen techniques" by D. B. Welbourn at 18.30 at the Town Hall.

CHRISTCHURCH

8th. I.E.E.—"Lasers in electronic systems" by D. Briggs at 18.00 at the King's Arms Hotel.

EDINBURGH

7th. I.E.E.—Colloquium on "Metrication in electrical engineering" at 18.00 at the Carlton Hotel.

8th. I.E.R.E."Automatic character recognition by computer" by Dr. A. Coombs at 19.00 at the Napier College of Science & Technology, Colinton Rd.

14th. I.E.E.—"The impact of integrated circuits on the role of circuit designer" by A. G. I. Cressell & R. Towell at 18.00 at the Carlton Hotel.

EVESHAM

14th. I.E.E.—"Electronic telephone exchanges" by V. E. Mann at 19.00 at the B.B.C. Club.

FARNBOROUGH

7th. I.E.E.—"Stereophonic broadcasting by G. J. Phillips at 18.30 at the Technical College.

16th. I.E.R.E.—"Thick film technology" by R. G. Finch at 19.00 at the Technical College.

GLASGOW

9th. I.E.R.E.—"Automatic character recognition by computer" by Dr. A. Coombs at 19.00 at the University of Strathclyde.

13th. I.E.E.—"The impact of integrated circuits on the role of circuit designer" by A. G. I. Cressell & R. Towell at 18.00 at Strathclyde University.

29th. I.E.E. Grads.—"Colour television engineering" by C. B. B. Wood at 19.30 at Strathclyde University.

HULL

30th. I.E.E.—"World communications" by Prof. C. Cherry at 18.30 at Y.E.B. Offices.

LEEDS

28th. I.E.E.—"Microelectronics and the future" by Prof. G. D. Sims at 18.30 at the University.

LEICESTER

21st. I.E.R.E.—"Application of research to industry" by J. Dixon at 18.30 at the University Physics Lecture Theatre.

LIVERPOOL

15th. I.E.R.E.—"Radiometric measurements" by C. Goodwin at 19.00 at the Dept. of Electrical Eng'g and Electronics, the University.

20th. I.E.E.—"Electronics in marine applications" by M. Adams at 18.30 at the University.

29th. I.E.E.—"The technician and his training in modern industry" by H. L. Hazlegrave at 18.00 at the University.

MANCHESTER

6th. I.E.E.—Christmas Holiday Lecture: "Solid state technology" by Prof. E. A. Ash at 11.00 and 15.00 at the Institute of Science & Technology.

29th. I.E.E. Grads.—"Electroluminescence" by A. R. Peaker at 18.45 at U.M.I.S.T.

MIDDLESBROUGH

22nd. I.E.E. Grads.—"The engineer and society" by G. Baker at 18.30 at the Cleveland Scientific Institution.

NEWCASTLE-UPON-TYNE

8th. S.E.R.T.—"Medical Electronics" by E. Chicken at 18.45 at the Charles Trevelyan College.

OXFORD

8th. I.E.E.—"Pulse code modulation" by G. H. Bennett at 19.00 at the College of Technology.

PLYMOUTH

8th. R.T.S.—"The lead oxide vidicon and its use in colour cameras" by B. Pover at 19.30 at the Studios of Westward Television Ltd.

PORTSMOUTH

7th. I.E.E. Grads.—"Colour television" by H. J. Bradley at 18.30 at the College of Technology.

READING

16th. I.E.R.E.—"Modern tools of systems engineering" by G. C. Tarr at the J. J. Thomson Physical Lab., the University.

21st. I.P.R.E.—"Some unusual applications of thyristors" by J. H. Gibbons at 19.30 at the Gt. Western Hotel.

RUGBY

21st. I.E.E. Grads.—"Colour television engineering" by C. B. B. Wood at 18.15 at the College of Engineering Technology.

SHEFFIELD

8th. I.E.E.—"Recent advances in computer aided design service for industry" by E. Wolfendale at 18.30 at the University.

SOUTHAMPTON

21st. I.E.R.E.—"Satellite earth stations" by Dr. G. H. Bryant at 18.30 at the University.

STAFFORD

13th. I.E.E.—"Applications of lasers" by Prof. E. D. R. Shearman at 19.00 at the College of Technology.

STEVENAGE

16th. I.E.E.—"Microelectronics" by K. J. Dean at 19.30 at the College of Further Education.

SUNDERLAND

23rd. I.E.E. Grads.—"Colour television" by P. H. Beards at 18.30 at the Technical College.

SWANSEA

9th. I.E.E.—"Introducing integrated circuits" by P. Cooke at 18.15 at the University College.

SWINDON

7th. I.E.E.—"Benefits and implementation of metrication" by A. J. Gilbert at 18.15 at the College.

WINCHESTER

22nd. I.E.E. & B.C.S.—"A small educational digital computer" by D. M. Taub at 18.30 at I.B.M., Hursley Park.

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Answers to "Test Your Knowledge"–8

Questions on page 47

1. *(a).* α radiation consists of a stream of helium nuclei.

2. *(c).*

3. *(d).* This is the direction of the "Poynting vector".

4. *(a).*

5. *(b).* The electric and magnetic fields remain at right angles and rotate together.

6. *(d).* Two circularly polarized plane waves of equal amplitude and opposite senses of rotation propagating together in the same direction add to form a linearly polarized plane wave. Two linearly polarized plane waves of equal amplitude with their directions of polarization at right angles and their phases differing by $\pi/2$ propagating in the same direction add to form a circularly polarized plane wave.

7. *(c).* For any transverse electromagnetic wave the phase velocity is $1/\sqrt{\epsilon\mu}$. 3×10^8 m/s is the value of $1/\sqrt{\epsilon_0\mu_0}$.

8. *(c).* This is the wave-impedance; its value for transverse electromagnetic waves in a given medium is $\sqrt{\mu/\epsilon}$

9. *(b).* Since the power propagating out through a given solid angle is constant the intensity is inversely proportional to the square of the distance from the centre. The electric field strength is proportional to the square root of the intensity.

10. *(d).* The phase velocity is $1/\sqrt{\epsilon\mu}$. μ is effectively the same as in free space (ferrimagnetic dielectrics are not isotropic) so that if ϵ varies with frequency the phase velocity will also vary with frequency and hence the medium will be dispersive.

11. *(a).* Total reflection occurs at a boundary between two isotropic media when the direction of propagation of the wave makes an angle to the normal to the boundary greater than θ where

$$\sin\theta = \frac{\text{incident phase velocity}}{\text{phase velocity beyond the boundary}}$$

This equation has no solution if the incident phase velocity is greater than the phase velocity beyond the boundary, and reflection does not occur.

The result applies even where the transition from one medium property to the other is gradual provided we define the boundary as the surface at which the transition between medium properties has reached half way.

In a region of space where free electrons occur the phase velocity is greater than that in empty space; this accounts for reflections from the ionosphere.

12. *(a).* The beam spreads owing to the effect of diffraction. If the aperture in wavelengths is very large the amount of spreading can be very small; a searchlight beam is a good example of this.

13. *(a).* Solution *(c)* is a common fallacy.

14. *(d).*

15. *(a).*

16. *(c).* The photons emitted have momentum, hence the law of conservation of momentum indicates that the generator must move in the opposite direction to the photons.

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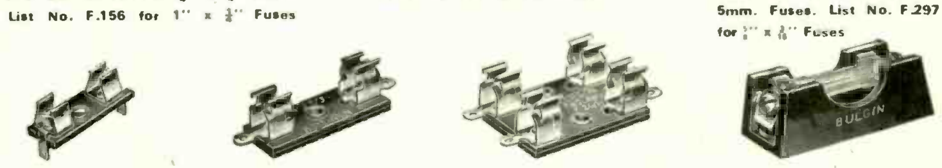
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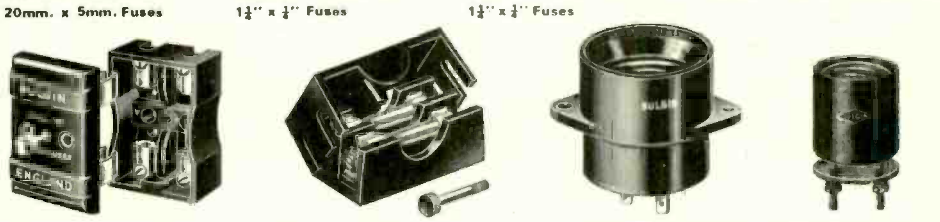
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Real and imaginary

By "Vector"

"All we like sheep . . ."

So help me, I hadn't intended to return to the subject of takeovers (oh, very well, Dr. Stickler, if you insist, takesover) but to judge from correspondence received it's a subject that could do with some more airing.

In the November issue I instanced the case of one Joe Tymebase, a research and development man in his fifties, who got the chopper as a consequence of a financial takeover. Now Joe was fictional in the sense that I had had no one person in mind when I wrote the piece. As they say on the fly-leaf of a novel, any resemblance to persons living or dead is purely coincidental.

Then, a few days after publication, came a letter signed 'Joe Tymebase' and with it four pages of autobiography which followed the fictional Joe's career in every single particular, but with added detail. And this wasn't fiction; it was set down as fact.

So closely did the one tally with the other that it gave me rather a turn. If Rodin, having put the final touches to The Thinker, had been tapped on the shoulder by it and asked for a cigarette, I know how he would have felt. As for me, I'm considering packing in electronics and applying for a job in the Civil Service which appears to be the only area of expansion.

Joe's letter was disturbing; all the more so because it isn't a diatribe against the wicked bosses. Taken at its face value, it's a straightforward bit of reportage, restrained and with a leavening of wry humour (you have the knack, Joe, if I may quote the Editor). Unfortunately Joe didn't give his real name or address so I couldn't contact him for verification. All one can say is that his story has the ring of truth.

Joe, it seems, was 55, in a senior position after 30 years with his firm and regarded by one and all as 'fireproof'. Before the takeover there was a lot of smooth talk about expansion and the additional labour that would be required. Who could blame him for feeling safe?

The takeover completed, a new and amalgamated R and D department was built in another district and Joe's advice was sought and taken regarding the equipment. The new district was described in the Works magazine as 'lying in the heart of the beautiful countryside, with all local amenities' (Joe went house-hunting there and found that the local amenities appeared to consist of used car dumps).

He describes how the crunch came and he and 499 associates of similar age received the copper handshake. The publicity boys, adepts at constructing silk purses out of sows' ears, published numerous pictures of happy employees who had decided to retire.

This done (says Joe) a rumour was circulated around the company "another 500 in two months' time". At this, many of his not-so-old ex-colleagues saw the red light and got out under their own steam. This was exactly what was wanted; it enabled young blood to be recruited (at cheaper rates) in true American tradition.

There is much more, but the ending must suffice. Joe was luckier than most; after a time on the Labour Exchange he got a job, but not in electronics. As he points out, it was a classic example of the Selective Employment Tax in reverse—the transfer of highly skilled personnel from essential industry into a non-essential occupation.

Now, before we get too hot under the collar, we must be fair about all this. There may be another side to the story and I hope Joe will not misunderstand me when I say that for all we know he may be the type who's born with a chip on his shoulder (although I've never known one who lasted 30 years with one firm).

But that is not the real issue. Even if his account is also fiction—and something tells me that it isn't—we all know only too well that there is absolutely nothing to prevent this situation occurring anywhere and at any time if expediency (in the form, perhaps, of share-juggling) dictates. That is the point. That is the essential wrongness of it all.

Vulnerability of R & D

"Takeover" executions are not, of course, exclusive to electronics engineers but, because of the high proportion of R & D in our industry (the second highest of all manufacturing industries), they are more vulnerable. Inevitably, when two major concerns merge the most likely sections to come under the chopper are the duplicated R & Ds. Moreover, ours is a "man power" based industry, with a higher content of personnel per £1000 of output than the large "plant and machinery" based industries like petroleum or detergents for instance.

If we try to find the root cause *within* the electronics industry we shall fail because we are being far too parochial. This evil is a world cancer whose fibres are everywhere. It is aptly summed up in an advertisement I saw the other day which says "Working for money is a poor way of making money". We are all tainted with this philosophy; Mister Average has his football pools and his bingo hall. Mister Tycoon has his stocks and shares to manipulate. There is no fundamental difference. We are all conditioned to it by an educational system which, while paying lip-service to the humanities, has as its yardstick of success the acquisition of money. Some manage to evade the trap; but the Old Boy who is invited to orate on Prize Day is not the one who has become a doctor in a dockland slum but the one who has made a million.

In the days of the dark satanic mills the poor had two things which made life tolerable—the bottle or a faith in a hereafter. In the Welfare State we can't afford the bottle and our faith is confined to material things. Inevitably we have become predatory animals with the business world a natural jungle; so don't blame Mister Tycoon when the chopper falls, Joe. It's just that tycoons happen to have more killer instinct than the rest of us.

The bigger the organization, the easier the executions become, for remoteness is a significant factor. Few of us, I imagine, would enjoy a steak if a daily wallow in a slaughter-house was made obligatory. Similarly, it is easy to sack 500 human beings if they are merely names on a list; not so easy if you know that Jim Smith's wife is crippled with arthritis or that the future of Harry Brown's son at university depends on a stroke of your pen.

So what to do? If the human race was sensible it would reform its educational system to teach tomorrow's children that moral responsibility to their fellows is more important than arithmetic. In short, it should create a situation in which the original Frys and Cadburys and (in our own field) the Frank Murphys, would constitute a norm and not misguided freaks.

But we won't, of course. In the electronics industry we shall probably do nothing at all and continue to be bought and sold at auction like sheep. I don't think rabid trade unionism is the answer, either. Then what?

Protection from the Learned Societies?

If we must deal in palliatives rather than in cures, there is the suggestion I made in the November issue, namely that the Learned Societies should take a hand. After all, the main aim of such is to protect the status of the qualified engineer and there isn't much status attached to being bought and sold is there? There is a precedent in the British Medical Association, which seems to be able to look after its members very effectively.

This isn't asking for the moon. It's just common justice that the men who make the profits for the shareholders should have some say in the fortunes of their company and enjoy a degree of protection which at present is singularly absent.

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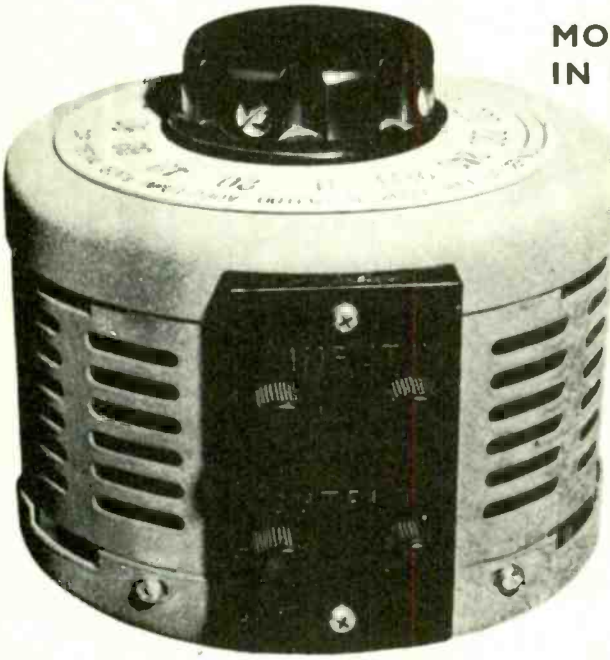

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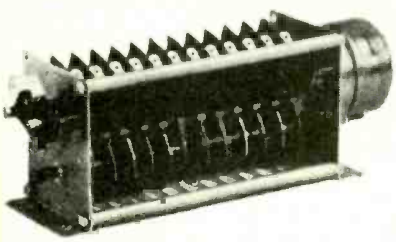

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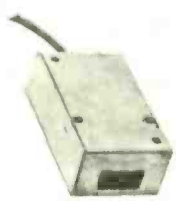

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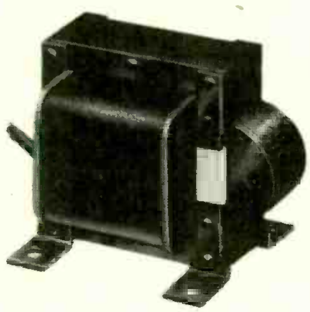

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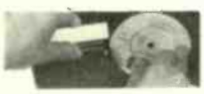

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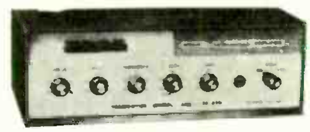

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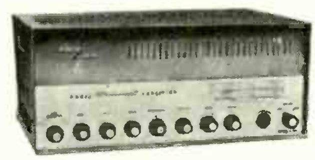

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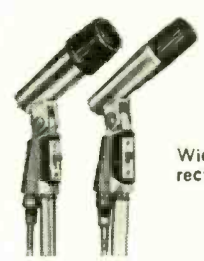

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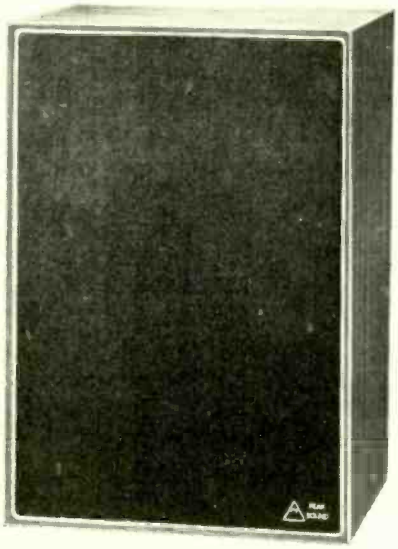
PEAK SOUND

aids to economical hi-fi



ES/10-15 BAXANDALL SPEAKER

"Rolls-Royce standards"
SAYS RALPH WEST,
Hi-Fi News
OCTOBER, 1968

"The immediate impression was of a thoroughbred speaker, smooth and effortless . . . voices both speaking and singing were uncannily real . . . Once again we see the possibility of Rolls-Royce standards from comparatively cheap components . . . when you know how." *Hi-Fi News* Test Report, Pages 1208/1211, Oct. 1968.

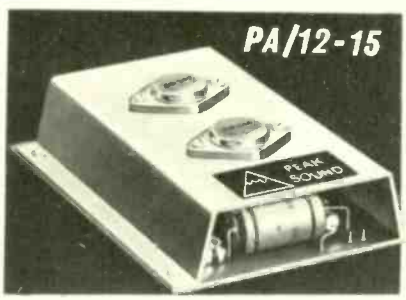
A REVOLUTIONARY ADVANCE IN DESIGN LOGIC

THE PEAK SOUND ES/10-15 is the designer-approved kit of the sensational loudspeaker designed and described by P. J. Baxandall in *Wireless World* (Aug. & Sept. 68). The frequency response extends from 60-14,000 Hz. (100-10,000 Hz. ± 3dB). Everything is supplied to specification—the 18" x 12" x 10" afromosia teak cabinet is cut and drilled for simple assembly: the equalising circuitry is ready-made for immediate installation. The finished product is completely professional. It will astonish and delight you beyond words. See what *Hi-Fi News* says in full in its detailed report in their October issue. It is hard to believe so modestly priced a speaker could get so glowing a report.

Equaliser assembly **—36/-** Speaker Unit—**38/-**: Pur. Tax—8/1d.: Cabinet parts (complete) **£6.15.0.**

TOTAL COST
£10.17.1

X-over for additional bass unit—22/6.



a new Peak Sound hi-fi power amplifier

THE PEAK SOUND PA/12-15 is a new power amplifier of excellent design and performance. Features include Class B output of 12 watts R.M.S. into 15 ohms: 43dB neg. feedback frequency response from 10 Hz to 45 Hz ± 0.5dB; distortion at max. output less than 0.1%; input sensitivity—400mV: power requirement 45V D.C. which can be obtained from the Peak Sound heavy duty power unit (price £5.5.0). Size 5" x 3¾" x 1⅞". Selected high gain closely matched transistors are used throughout. Full instructions are provided. This sensibly designed unit will appeal to all for whom reliability and good design are important. Pre-amp details available.

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Kit. less heat sink (price 6/-) and matrix base board
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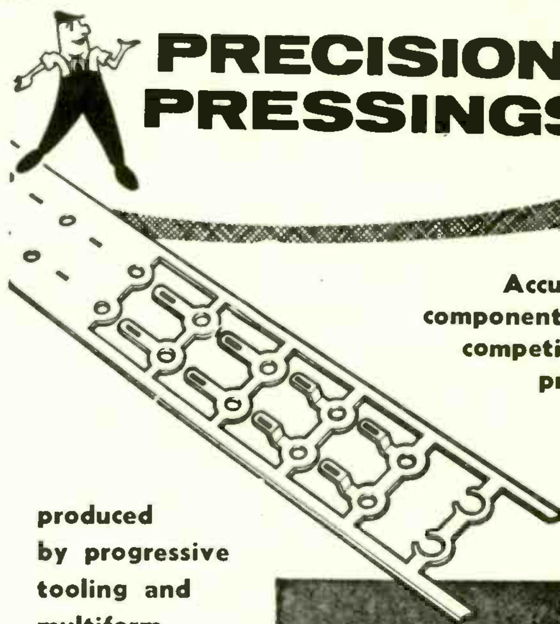

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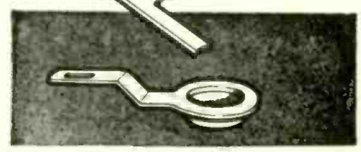

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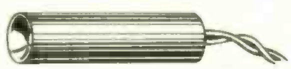

MAX RATINGS

Total dissipation (in free air, T_{amb} = 25°C.).........100mW. Derating Factor.........2mW/°C. Output Current Intensity.........100mA. Voltage.........25V. Operating Temperature.........from —30° to +125°C.

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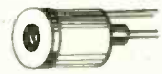
Filamentless, infra-red emitter in a robust, sealed cylinder coaxial with beam to facilitate optical alignment and heat sinking.



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Forward current I_F max. D.C..........400mA. Forward peak current I_F max.* (pk).........6A*
Power dissipation.........600mW. Derating factor for T_{amb} greater than 25°C.........7.5mW/°C.*
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**When mounted on an aluminium heat sink 1 in. x ½ in. x ½ in.*

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Silicon NPN photo-diode of passivated planar construction, suitable for punched card readers, counters, film sound track, etc.

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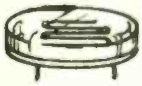
Inexpensive light sensitive resistors which require only simple circuitry to work as light triggering units in a wide range of devices, such as: flashing or breakdown lights, exposure meters, brightness controls, automatic porch lights, etc. Not polarity conscious — use with A.C. or D.C. Spectral response covers whole visible light range.



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Epoxy sealed 1½ in. diam. x ¼ in. thick. Resistance at 100 Lux – 700 to 3,000 ohms. Maximum voltage 200 A.C. or D.C. Maximum current 500 mW.
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Glass sealed with M.E.S. base. Glass envelope $\frac{5}{16}$ in. diam., overall length 1 in. Resistance at 100 Lux – 50 Kohms to 150 Kohms. Maximum voltage 150 A.C. or D.C. Maximum current 75 mW. **8/6** *post free*

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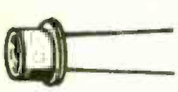
These have a higher dark resistance in a given period than Cadmium Sulphide Cells, indicating much faster response. Suitable for all Cds applications plus applications in chopper, electronic musical instruments, computer and other sophisticated circuitry. Time response shown in megohms is dark resistance measured 10 secs. after 400 Lux light intensity is intercepted.



MKB5H
Hermetically metal sealed. ½ in. diam. x ⅛ in. thick. Time response 100 megohms. Resistance at 1,000 Lux – 1 Kohm to 10 Kohms. Resistance at 10 Lux – 50 Kohms to 1 megohm. Maximum voltage 50 A.C. or D.C. Maximum current 10 mW. Continuous current 5 mW.
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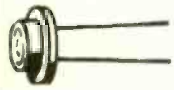

MKB12H
Hermetically metal sealed ⅜ in. diam. x $\frac{3}{16}$ in. thick. Time response 100 megohms. Resistance at 1,000 Lux – 100 ohms to 1,000 ohms. Resistance at 10 Lux – 1 Kohm to 10 Kohms. Maximum voltage 50 A.C. or D.C. Maximum current 80 mW. Continuous 30 mW.
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Selenium cells in which light energy is converted into electricity directly measurable on microammeter or used with amplifier as light trigger for alarm and counting devices, luminous fluxmeters, exposure meters, colorimeters, etc., Spectral response covers visible light range.

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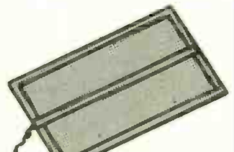

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Highly flexible light guides that transmit light to inaccessible places as easily as electricity is conducted by copper wires. Fibre optics make it possible to control, miniaturize, split, reflect or transfer light from one source to many places at once and to operate photo devices, logic circuits, or illuminate in ways never before possible. Proops offer both glass fibre optics or inexpensive Crofon plastic fibres for hundreds of experiments or serious applications in a fascinating new science.

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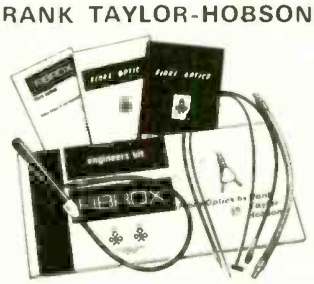

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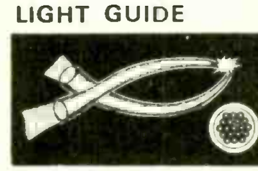

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12 watts R.M.S. continuous sine wave output

This is the recommended amplifier for those requiring greater power and a high degree of versatility. This eight special-transistor amplifier is the most successful of its kind ever designed. It has an excellent power to size ratio and is easily adapted to a wide variety of applications. The Z.12 performs satisfactorily from a wide range of voltages and it can readily be run from car batteries. This true 12 watt amplifier comes to you ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo, when the Sinclair Stereo 25 will be found the ideal control unit for use with it.

Size—3"x1$\frac{3}{4}$"x1$\frac{1}{4}$". Class B Ultralinear Output: Frequency response from 15 to 50,000Hz $\pm$1dB: Output suitable for loudspeakers from 3 to 15 ohms impedance. Two 3 ohms speakers may used in parallel: Input 2 mV into 2Kohms: Output 12 watts R.M.S. continuous sine wave (24 watts peak): 15 watts music power (30 watts peak); Power requirements 6-20V.d.c. from battery or PZ.4 Mains Supply Unit. *Ready built, tested and guaranteed.*

89/6

SINCLAIR STEREO 25

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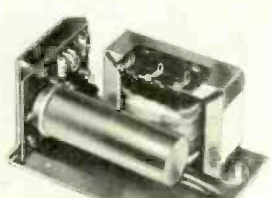

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STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V.d.c. at 1.5A. Designed specially for use with two Z.12 Amplifiers, etc., together with Stereo 25. Built, tested and guaranteed.

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- remarkable range and power
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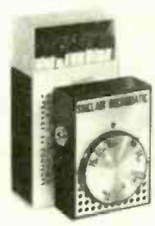

the world's smallest radio

This fantastic little British pocket receiver is available in kit form to build for yourself or ready built, tested and guaranteed. Its range, power and selectivity must be experienced to be believed: its quality everything you could wish for. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier. The neat black case with aluminium front panel and tuning control give the Micromatic elegantly modem appearance.

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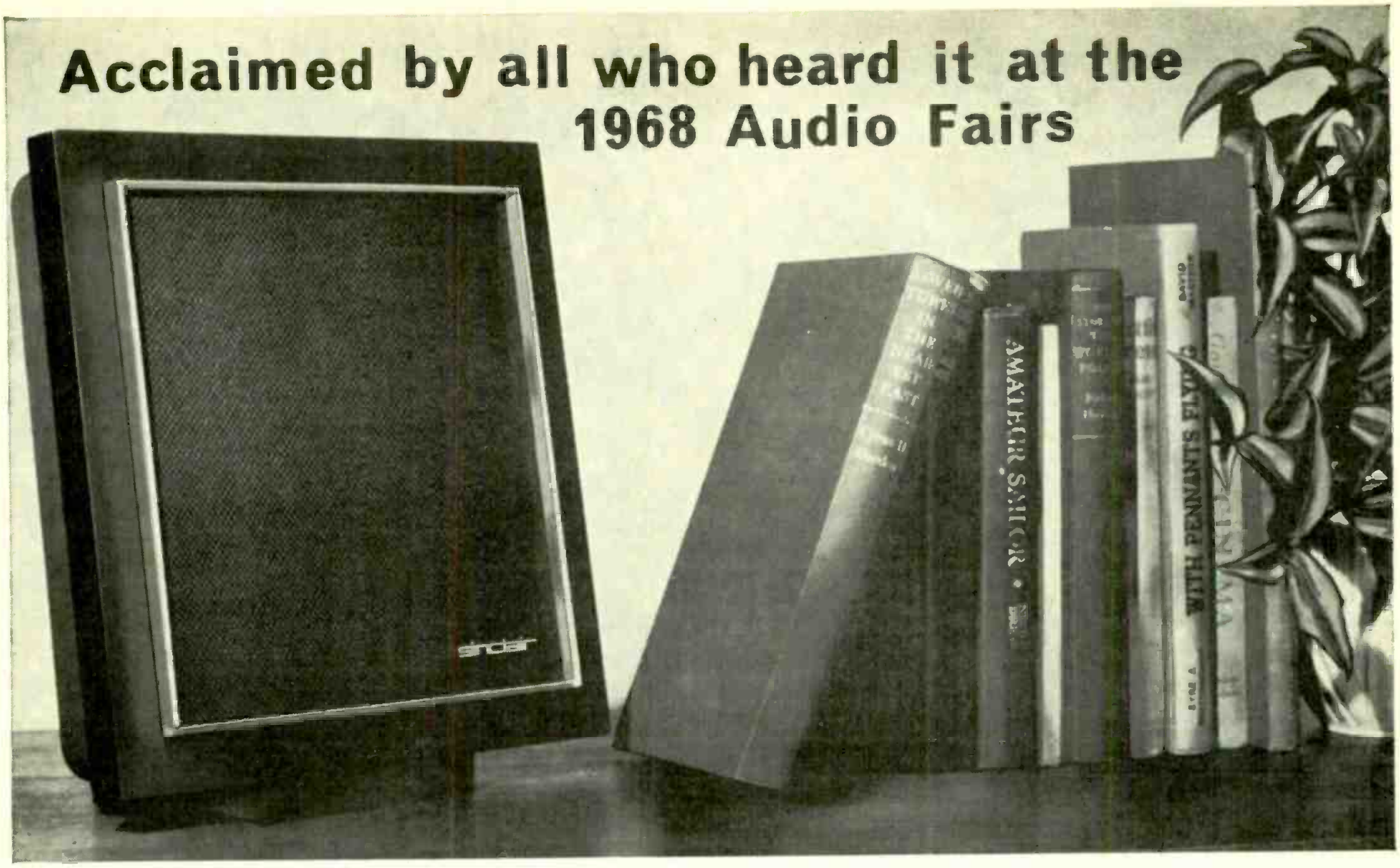

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Price is no longer an obstacle to the enjoyment of high-fidelity loudspeaker reproduction; nor is size a problem either. In the Sinclair Q.14 you will find a loudspeaker of such remarkable quality and so compactly and attractively styled that you will want to change to Sinclair as soon as you hear it. At Trade Exhibitions and both the 1968 Audio Fairs, experts have been greatly impressed on hearing the Q.14 against speakers costing many times more, proving beyond question that good reproduction does not have to be expensive. Tests by an independent laboratory with a Q.14 drawn from stock show exceptionally smooth response between 60 and 15,000Hz and well sustained output beyond both these figures. Its remarkable transient response ensures beautifully defined separation of voices, instruments, etc. Much of the success of this Sinclair design comes from the use of materials quite different from those to be found in conventional speaker manufacture, and the unusual contours of the seamless, sealed pressure chamber allow the Q.14 to be conveniently positioned on shelves, the floor, in wall corners or flush mounted. The Sinclair Q.14 is finished in matt black with solid aluminium bar trim on the front. Size: $9\frac{3}{4}$ in. square × $4\frac{3}{4}$ in. deep. Try it in your own home by sending off the order form today. *If you are not satisfied your money plus the cost of posting the Q.14 back to us will be returned in full.*

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Matched for optimum performance. Compare prices with equipment and cabinets purchased individually.

'Package 3' 30 Watt System
★ Goldring Transcription Turntable on Plinth.
★ Shure Magnetic Pick-up Cartridge.
★ Super 30 Amplifier in Teak veneer housing.
★ Pair of Stanton Loudspeaker Units.

Special inclusive price. Fully wired units ready to "plug-in". **85 Gns.** Really superb performance Carr. 25/-
Send S.A.E. for leaflet.


Illustrated with TFM1 Tuner fitted.

'Package 2' 30 Watt System
★ Garrard SP25 Mk. II Turntable on Plinth.
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★ Super 30 Amplifier in Teak veneer housing.
★ Pair of Stanton Loudspeaker Units.

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EXTREMELY ATTRACTIVE AND VERSATILE PLINTHS finished in Satin Teak veneer. Tinted Perspex "hinged" cover with satin chrome handle.

'Package 1' 13 Watt System
★ Garrard SP25 Mk. II 4-speed Player Unit.
★ Goldring CS90 Ceramic P.U. Cartridge.
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★ Pair of Dorset Loudspeaker Units.

Special inclusive price. **49½ Gns.** Perspex cover 3 gns extra. Or Dep. £10. and 9 mthly. pmts. £5.4.0. Carr. 25/- (Total £56.16.0.)

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AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround giving low fundamental resonance. "D" indicates Tweeter Cone providing extended frequency range 40-15,000 c.p.s. Impedance 3 or 15 ohms. Exceptional performance at low cost.

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HF 102D	10"	8W	59/9			
HF100D	10"	15W	£5/15/0	HF126D	12" 15W	5 Gns.

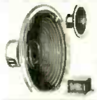
HIGH FIDELITY LOUDSPEAKER UNITS
Cabinets of latest styling Satin Teak veneer. Acoustically lined or filled with woollen damping material. Ported where appropriate. Credit terms available on all units.

DORSET Size 16 × 11 × 9in. Range 45-15,000 c.p.s. Rating 8-10 watts. Fitted High flux 8" Dual cone speaker. Impedance 3 or 15 ohms. **£8.19.9** inc. carr.

STANTON IIIS Size 18 × 11 × 10in. Rating 10 watts. Incorporating Fane 803b speaker with roll rubber cone surround and 15,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 30-20,000 c.p.s. Impdnce. 3 or 15 ohms. Gives smooth realistic sound o'pt. **16 Gns.**

GLOUCESTER Size 25 × 16 × 10in. 12in. High flux 12,000 line speaker. Cross-over unit and Tweeter. Rating 10 watts. Frequency range 40-20,000 c.p.s. Impedance 15 ohms. **12½ Gns.**

AUDIOTRINE HI-FI SPEAKER SYSTEMS



Consisting of matched 12in. 12,000 line 10 watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **5 Gns.**
Or Senior 15 watt inc. HF 126 15,000 line Speaker 6 Gns. Carr. 6/6. Carr. 5/9

HI-FI 'SPEAKER ENCLOSURES

Teak veneer finish. Modern design. Acoustically lined and ported. Prices inc. carr.
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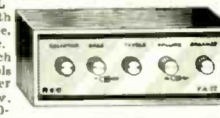
SE12 For excellent performance with 12in. Hi-Fi speaker and Tweeter. Size 25 × 16 × 10½in. **6 Gns.**

THE 'YORK' HIGH FIDELITY 3 'SPEAKER SYSTEM

*Moderate size approx. 25 × 14 × 10 in. *Range 30-20,000 Complete kit. c.p.s. Impedance 15 ohms. *Performance comparable with units costing considerably more. Consists of (1) 12 in. 20 watt Bass unit with cast chassis. Roll rubber cone surround for ultra low resonance, powerful 2in. diam. pole pieces and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Measured weight of woollen acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. HEAR IT AT ANY BRANCH **18 Gns.** Carr. 12/6

R·S·C·TA12 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL

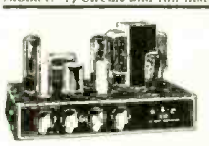


Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3-15 ohms ★ For 200-250 v. A.C. mains ★ Frequency Response 30-20,000 c.p.s. —2dB ★ Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise —70dB ★ Sensitivities (1) 300 mV (2) 50 mV (3) 100 mV (4) 2 mV ★ Handsome brushed silver finish Facia and Knobs. Complete kit of parts with full wiring diagrams and instructions. 12½ GNS. Carr. 7/9 Factory built with 12 mth. gntee. 15 GNS. Or Dep. £4/16/- and 9 mthly. pymts. 29/- (Total 17 Gns.) Or in Teak veneer housing 19 GNS. or Dep. £4/19/- and 9 mthly. pymts. 39/- (Total £22/10/-.)

R.S.C. BATTERY/MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.5 v. and 90 v. where A.C. mains 200/250 v. 50 c/s. is available. Complete kit with diagram 49/11 or, Ready for use, 59/11.

R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



Highly sensitive. Push-Pull high output, with Pre-amp./Tone Control Stages. Performance figures: Hum level —70dB. Frequency response ±3dB 30-20,000c/s. Sectionally wound output transformer. All first grade components. Valves EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls. Sensitivity 12 millivolts so that any kind of Microphone or Pick-up is suitable. Designed for Clubs, Schools, Theatres, Dance Halls or Outdoor Functions, etc. For use with Electronic Organ, Guitar, String Bass, etc. Gram. Radio or Tape. Reserve L.T. and H.T. for Radio Tuner. Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250 v., 50 c/s. A.C. mains. For 3 and 15 ohm speakers. Complete Kit parts wiring diags., instructions. Twin-handled perforated cover 27/6. Supplied factory built with EL34 output valves. 12 months' guarantee for 17 gns. **14 Gns.** Carr. 12/6
TERMS: Deposit £5/14/- and 9 monthly payments of 31/3 (Total £19/15/3). Send S.A.E. for leaflet.

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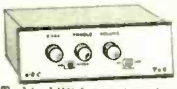
R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER

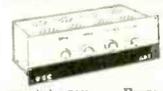


200-250v. A.C. mains operated Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram. Radio or Tape. Input selector switch. Output for 3-15 ohm speakers. Max. sensitivity 5mV. In fully enclosed enamelled case. 9¾ × 2¾ × 5½in. Attractive brushed silver finish facia plate 10¾ × 3¼in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **6 Gns.** Or factory built with 12 months' guarantee. 8 Gns. Carr. 7/6.

R.S.C. COLUMN SPEAKERS

Covered in two-tone Rexine/Vynair. Ideal for vocalists and Public Address. 15 ohm matching. Type C48S, 30 watts. Fitted four 8in. high flux 8 watt speakers. Overall size approx. 42 × 10 × 5in. 16 Gns. Or deposit 65/- and 9 mthly pmts. 34/9 (Total £18/17/9). Carr. 10/-
Type C412s, 50 watts. Fitted four 12in. 11,000 lines 15 watt speakers. Overall size 56 × 14 × 9in. approx. 24Gns. Or Deposit £4/13/6 and 9 monthly payments Carr. 15/- of 52/6 (Total £28/5/-).

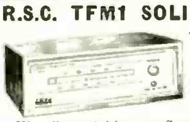
R.S.C. A11T 15 WATT HIGH FIDELITY AMPLIFIER



DUAL PURPOSE P.A. or HI-FI SOLID STATE CIRCUITRY. ★ 3 input sockets. ★ 2 vol. controls for mixing purposes. ★ Input Selector. ★ Output for speakers between 3 and 15 ohms. ★ Separate Bass and Treble Controls. Suitable for Gram. Radio. Tape. Microphone, or Guitar P.U. For Vocal and Instrumental groups. Frequency Response 20-40,000 c.p.s.—3dB. Hum level —80dB. Harmonic Distortion 0.2% at 10 watts R.M.S. Operation on 200-250v. A.C. mains. Size 9¾ × 2¾ × 5½in. Complete Kit of parts with comprehensive wiring diagrams and instructions. **9 Gns.** Carr. 9/6
Or Factory built with 12 mths. guarantee 13 gns. Carr. 9/6. Terms: Deposit £4 and 9 monthly payments 25/6 (Total £15/9/6).

R.S.C. TFM1 SOLID STATE VHF/FM RADIO TUNER

Total cost of parts with detailed wiring diagrams & instructions. **12½ Gns.** Carr. 10/-
Or factory built 16½ gns. Or in Teak finished cabinet as illustrated 19½ gns. Terms: Deposit £5 and 9 monthly payments £2. Total £23.



★ High-sensitivity ★ 200-250v. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Output ample for any amplifier (approx. 500 m.v.). ★ Simple alignment instructions. ★ Output available for feeding tuning meter. ★ Output for feeding Stereo Multiplexer. ★ Tuner head using silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input.
Visually matching our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. The pre-wired tuning head facilitates speed and simplicity of construction. Printed circuitry. Only high grade transistors and components used. A quality product at considerably less than the cost of comparable units. Stereo version. All parts 18 gns. Carr. 10/-. Assembled 22½ gns. Inc. Carr.

12in. High Quality LOUDSPEAKERS

In teak veneered cabinets. 15 Watt Model, Gauss 11,000 lines, 3 or 15 ohms. **£5/15/-** Carr. 7/6
20 Watt Model. 15 ohm. Size 18 × 18 × 10in. Gauss 10,000 lines. Rexine covered 10/- extra. **£8/19/9** Carr. 8/9

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Listen and speak with both hands free. Handsome black case. Battery operated. **59/9**

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300-0-300v. 130mA. 6.3v. 4a., c.t., 6.3v. 1a. For Mullard 510 Amplifier	43/9
350-0-350v. 100mA., 6.3v. 4a., 0-5-6.3v. 3a.	35/9
350-0-350v. 150mA. 6.3v. 4a., 0-5-6.3v. 3a.	45/9
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250-0-250v. 100mA. 6.3v. 2a., 6.3v. 1a.	24/9
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SOLID STATE

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MU12/14	4/-	QS150/15		U31	6/-	AC127	2/-
MX40	12/6		9/6	U33	29/6	AC128	2/-
N78	38/4	QVO4/7	8/-	U35	16/6	AC154	5/-
N339	25/-	R10	15/-	U37	34/11	AC155	6/6
P61	2/6	R11	19/6	U45	15/6	AC156	4/-
PABC80	7/3	R16	34/11	U50	5/6	AC157	5/-
PC86	9/6						
PC88	9/6						
PC95	8/3						
PC97	7/9						
PC900	8/3						
PCC84	6/-						
PCC85	6/6						
PCC88	9/9						

AC165	5/-	BD119	9/-	GET874		OC38	11/6
AC166	5/-	BFY50	4/-		23/6	OC41	10/-
AC167	12/-	BFY51	4/-	GET882	10/-	OC42	6/9
AC168	7/6	BFY52	4/6	GET887	4/6	OC43	12/6
AC169	6/6	BF154	5/-	GET889	4/6	OC44	2/-
AC176	11/-	BF159	5/-	GET890	4/6	OC44PM	8/3
AC177	5/6	BF163	4/-	GET896	4/6	OC45	1/9
ACY17	3/-	BF167	2/6	GET897	4/6	OC45M	8/-
ACY18	3/8	BF173	2/6	GEX13	3/6	OC46	3/-
ACY19	3/9	BF180	12/-	GEX35	4/6	OC65	22/6
ACY20	3/6	BF181	8/-	GEX36	10/-	OC70	2/3
ACY21	3/9	BF185	8/-	GEX45	7/1	OC71	2/-
ACY22	3/6	BTX34/400		GEX55	15/-	OC72	2/-
ACY28	4/-		40/-	GEX66	15/-	OC73	16/-
AD140	7/6	BY100	3/6	GT3	5/-	OC74	2/6
AD149	8/-	BY101	11/6	M1	2/10	OC75	2/-
AD161	9/-	BY105	10/6	M3	2/10	OC76	2/6
AD162	9/-	BY114	6/6	OA5	5/6	OC77	2/6
AF102	18/-	BY126	6/6	OA9	2/6	OC78	3/-
AF114	4/-	BY234	4/-	OA47	2/-	OC78D	3/-
AF115	3/-	BY236	4/-	OA70	3/-	OC79	8/-
AF116	3/-	BY238	4/-	OA73	3/-	OC81	2/-
AF117	2/9	BYY23	20/-	OA79	1/9	OC81D	2/-
AF119	3/-	BYZ10	5/-	OA81	1/9	OC81M	5/-
AF124	6/6	BYZ11	5/-	OA85	1/6	OC82	2/3
AF125	3/6	BYZ12	5/-	OA86	4/-	OC82D	2/3
AF126	5/3	BYZ13	5/-	OA90	2/6	OC83	2/-
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AF139	11/-	CG12E	4/-	OA95	1/9	OC123	4/6
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AF181	14/-	GD5	5/6	OA210	9/6	OC170	2/6
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ASY29	10/-	GD10	4/-	OAZ202	9/-	OC201	5/6
AY100	26/-	GD11	4/-	OAZ203	9/6	OC202	4/6
BA115	2/8	GD12	4/-	OAZ204	9/-	OC203	4/6
BA116	9/-	GD14	10/-	OAZ205	9/-	OC204	5/6
BA129	2/6	GD15	8/-	OAZ206	9/-	OC205	7/6
BA130	2/-	GD16	4/-	OAZ207	10/6	OC206	10/-
BCY10	5/-	GET102	4/-	OAZ210	7/-	OC812	8/-
BCY12	5/-	GET103	4/-	OAZ213	7/-	OCP71	27/6
BCY33	5/-	GET105		OAZ224	16/6	ORP12	15/-
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BC108	3/6	GET116	6/6	OC26	5/-	XA103	15/-
BC109	4/3	GET119	4/-	OC28	5/-	MAT100	7/9
BC113	5/-	GET573	7/6	OC29	16/6	MAT101	8/6
BC115	3/-	GET587	8/6	OC30	5/-	MAT120	7/9
BC116	5/-	GET872	10/-	OC35	5/-	MAT121	8/6
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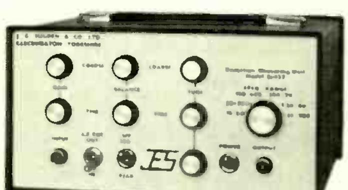

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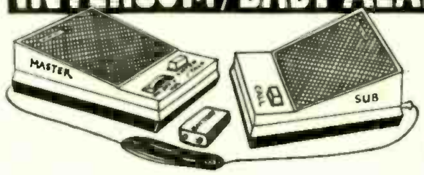

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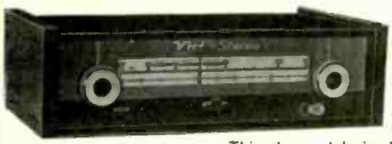

A SUPERB NEW TRS MONO-STEREO F.M TUNER

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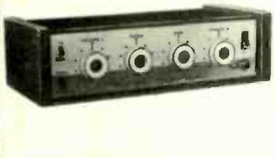

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Complete kit inc. cabinet/power pack/DIN plugs and sockets **£12.10.0** Carr. 7/6

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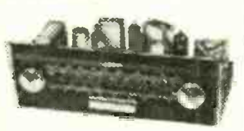
6 VALVE AM/FM TUNER



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2N4291 PNP 40V hFE over 100 at 100mA } complementary driver/
2N3794 NPN 40V hFE over 100 at 100mA } output
2N4294 NPN 30V UHF, N.F. 6dB max at 100MHz fT 570MHz typ
B5001 Power, 14·3W at 100°C base temp. Insulated base, T066 size. 35V hFE over 100 at 0·5A.
Prices: 2N4285 to 2N4292, 2N3794 3/3; B5001 13/6.

RECTIFIERS 100V PIV ½A type TS1, 2/-; 400V PIV ½A type TS4, 2/9. 850V PIV ½A type BY238 3/9; 1000V PIV 1·5A type 1N5054 3/11.
FOR FURTHER DATA on the above semiconductors and many others, see our catalogue price 1/- only, post free.

ZENER DIODES
3V to 27V 5% 400mW all preferred voltages, **4/6** each.

★ PEAK SOUND PRODUCTS
CIR-KIT No. 3 Pack, 12/6: adhesive copper strip, 5ft. × ⅛ or 1/16 in. 2/-: 100ft × ⅛ or 1/16 in., 30/-. Perforated board 0.1in. matrix 5in. × 3¾in., 4/-: 2½in. × 3¾in., 2/6: 2in. × 3¾in., 1/9.
ALL PEAK SOUND PRODUCTS AS ADVERTISED

★ SUPER QUALITY NEW RESISTORS
Carbon film high stab, low noise:
1/8W 10% 1 Ω to 3·3 Ω } **1/10** doz., **14/6** per 100.
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1/6 less per 100 if ordered in complete 100's of one ohmic value.
Please state resistance values required.
QUALITY CARBON SKELETON PRE-SETS: 100 Ω, 250 Ω, 500 Ω, 1K Ω, 2K Ω, 2·5K Ω, 5K Ω, 10K Ω, 20K Ω, 50K Ω, 100K Ω, 200K Ω, 250K Ω, 500K Ω, 1M Ω, 2M Ω, 2·5M Ω, 5M Ω, 10M Ω.
Available in horizontal or vertical mounting **1/-** each.

★ ELECTROLYTICS,
SUB-MIN., C426 RANGE (μF/V): 0.64/64, 1/40, 1.6/25, 2.5/16, 2.5/64, 4/10, 4/40, 5/64, 6.4/6.4, 6.4/25, 8/4, 8/40, 10/2.5, 10/16, 10/64, 12.5/25, 16/10, 16/40, 20/16, 20/64, 25/6.4, 25/25, 32/4, 32/10, 32/40, 32/64, 40/2.5, 40/16, 50/6.4, 50/25, 50/40, 64/4, 64/10, 80/2.5, 80/16, 80/25, 100/6.4, 125/4, 125/10, 125/16, 160/2.5, 200/6.4, 200/10, 250/4, 320/2.5, 320/6.4, 400/4, 500/2.5. **1/4** each.
MINIATURE (μF/V): 5/10, 10/10, 10/25, 25/10, 50/10 **9d.** each. 25/25, 50/25, 100/10, 200/10, **1/-** each. 50/50, **2/-**. 100/50, **2/6**. 250μF 25V **2/6**.

★ POTENTIOMETERS (short spindle): 100Ω to 10MΩ lin, 5KΩ to 5MΩ log 2/3 each. Dual, long spindle; 10K, 25K, 50K, 100K lin or log, **10/6d. each.**

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ZENER DIODES:
1½ watt range from 3·30 Volts @ **4/6.**
Unmarked, untested transistors 60 for **10/-.**
VEROBOARD:
2½in. × 3¾in., **3/6.** 2½in. × 5in., **4/3.** 3¾in. × 3¾in., **4/3.** 3¾in. × 5in. 5/6. 17in. × 3¾in., **16/-.** Cutter, 9/-.
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1MFD-100 MFD, **1/6** each.
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¼ watt, **4d.** ½ watt, 5d. 1 watt, **6d.** 3 watt, **1/6.** 5 watt, **2/-.**
SPEAKERS: 3 OHM
3in., **8/6.** 5in., **14/6.** 8in., **27/6.** 12 in., **39/6.** 7in. × 4in., **16/6.**
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Post and Packing, 1/- per order. Send 6d. stamp for full list.
ALL DEVICES ARE FULLY GUARANTEED

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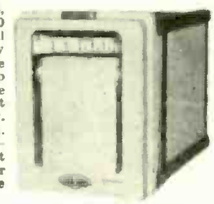
ELECTRONIC BROKERS LIMITED

DIGITAL MAGNETIC DATA STORAGE DECK Seven track record replay heads

These machines originally ex-computers, but lend ideally for use as audio stereo multi-track recording units or data storage. Record and Playback Heads encased in one common unit. This unique close spacing of Record and Playback Head will enable the operator to monitor instantly while recording, crosstalk between tracks absolute minimum. Head Resistance 40 ohms and 7 ohms. Freq. Response approx. 30 c.p.s.—30 Kc/s with a good response to 50 Kc/s. Deck driven by one synchronous capstan motor and two variable-speed rewind motors. Wow and flutter—detect it if you can. Electro-pneumatic capstan take-up mechanism. Speed 37½ i.p.sec. (Note: Capstan Head can be easily removed and/any diameter Capstan Head corresponding to any speed can be fitted.) All deck function push buttons are illuminated and are brought out to separate multi-core leads which can be wired to any deck function or auxiliary equipment. Finished in brush-aluminium and matt-black. Size: 27 × 26 × 8 in. Weight 90 lb. 230v-380v. A.C. Capstan motor speed 1,500 r.p.m. Must have cost £1,000. **Our price £65.** New condition but ex-equipment. **VACUUM ASSEMBLY** required for computer and data use. **£7/10** extra.
Seven Track record replay head, ex-computer, complete with guides, little used. **£12/10/-**
½ in. Tape, 2,400 ft. **£8/10/-** new. Empty reels **25/-**, in cassettes **45/-**.

PORTABLE SINGLE PEN RECORDER BY RECORD ELECTRICAL



(illus.). 3in. chart, sensitivity 500 micro amps. Coil res. 1.53k. Fully interchangeable gears available to make a wide range of chart speeds. 200/250v. Size: 8 × 11 × 6in. Brand new—comp. with chart and ink. List over £100. Our price **£49/10/-.**

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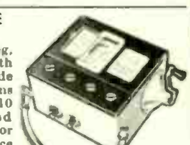

250 volt, 50 meg. Insulation tester with built-in four decade bridges with ratio arms giving ratios of 100-10—1—0.1 + 0.01 and Selector switch for insulation, resistance and variety measurements. **£29/10/-.**

TRIMPOTS 990 GB—Wirewound Micropot Potentiometer. Low noise. Brand new, by well known manufacturer. 1 watt @ 70°C. 100 ohms and above ±5%. Available in the following values: Ohms: 5, 15, 25, 50, 100, 250, 400; 1K, 2K, 2.5K, 10K, 25K. Price, 1-9 = **20/-** each, 10-25 = **15/-** each, 25-50 = **12/6** each, 50 and over **10/-** each.

KELVIN HUGHES FIVE-PEN RECORDER COMPLETE WITH AMPLIFIERS, and offered complete in free standing consul. Fully overhauled and in excellent condition. Cost: £1,200 + when new. Our price: **£450.**

SPEECH INVERTER MI-7181-A
The R.C.A. Speech Inverter is a device intended for use in radiotelephone installations where privacy is a prime consideration. The equipment when used in conjunction with the R.C.A. MI-7182 Hybrid Transformers enables parallel two-way conversations on a single telephone pair line at each terminal of the communications system. With inversion, speech fed into the transmitting inverter circuit will feed the radio transmitter with unintelligible signals. These signals will remain unintelligible until they pass through a receiving inverter circuit at the other end of the communication channel. (Used only under Licence in U.K. P.O.A.).

MAGNETIC FLUX MEASURING SET
TS 13A. Range 1,200-9,600 Gauss—Bold. Pole face diameter of magnets ¾ in.-1 in. Air gap 550 in.-1.51 in. Powered by U2 1.5V cell. Our price **£18/10/-.**

HYSTERESIS REVERSIBLE MOTOR. Incorporating two coils. Each coil when energized will produce opposite rotation of the output shaft. 240 volt 50 cycle, 15 r.p.m., 6 r.p.m., ½ r.p.m., ¼ r.p.m., 1/6 r.p.m., 1/10 r.p.m., 120 volt 60 cycles 1/10 r.p.m. **80/-**, reduced to **30/-**.

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TEL: 01-958 9842

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Lasky's Radio

LASKY'S HI-FI SPECIAL

TRIO Model TK-500E

SOLID STATE FM MULTI-PLEX STEREO TUNER

Another great Lasky's special purchase—the TK-500E is a truly outstanding 21 transistor FM Multiplex Stereo Tuner by TRIO—Japan's foremost producer of transistorised Hi-Fi equipment. The extremely sophisticated circuitry of the TK-500E incorporates many unique TRIO features including ● Automatic electrical switching of FM Multiplex stereo and mono modes with stereo indicator beacon ● Inter-station noise muting circuit ● MPX background noise suppression filter circuit eliminates secondary signal and "beat" interference even in fringe area reception ● Nuvistor cascode front end and 5 IF stages assure the highest sensitivity reception ● Pinpoint meter tuning ● Low impedance stereo, mono and tape outputs. BRIEF SPECIFICATION: 21 transistors, 15 Germanium and 8 Silicon diodes and 1 Zener diode. 3 valves. Frequency range: 88–108 Mc/s. Sensitivity: 0·8µA (20dB quieting with 72Ω antena). Output: 2V. Frequency response: 20-20,000 c/s ± 1dB. Channel separation: better than 35dB. Distortion less than 0·6% at 400 c/s 100% mod. Capture ratio: 2dB. Superbly styled and finished hammer enamel and brushed alloy cabinet, size 15¾ × 12¾ × 5¼in. For 110/240V. AC (50 or 60 c/s) operation. Today's comparative value over £65.

Lasky's Price 38 Gns. Carriage and Packing 12/6.

FOSTER CRITERION HI-FI BOOKSHELF SPEAKER SYSTEM

This extremely high quality bookshelf speaker system by the world famous Foster Co. of Japan incorporates an acoustical suspension woofer and cone tweeter in a sealed infinite baffle enclosure with handsome oiled walnut finish. The performance of the Criterion is superior to many larger and more expensive units and at Lasky's special purchase price is quite without equal!

Spec.: Air suspension type 6½in. bass/mid-range woofer with rolled cloth edge. 2½in. HF cone type tweeter. Frequency range 65-20,000 c/s. Max. power handling 15W. 8Ω impedance. Cabinet constructed from ½in. laminate with oiled walnut veneer finish; size 13¾ × 7½in. square. Dark green woven acoustic gauze. Phono input at rear. List Price £12.10.0

Lasky's Price £8.8.0 2 for £16

Post 1—7/6. 2—12/6.

GARRARD RECORD PLAYERS

AUTOCHANGERS

2025	£7/19/6
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SL95	£45/0/0
3000LM with stereo cart.	£9/19/6
AT60 Mk. II	£13/19/6
A70	£13/19/6
AP75	£22/11/6
A50	£7/7/0

GARRARD BASES

WB1 £3/5/8 WB2 £4/13/8 WB4 £5/6/11

SINGLE PLAYERS

GARRARD SP25 Mk. II Heavy turntable	£11/19/6
GARRARD SRP22	£6/10/6

TRANSCRIPTION DECKS

GARRARD 401	£27/19/0
GARRARD Lab. 80 Mk. II with base	£30/9/0

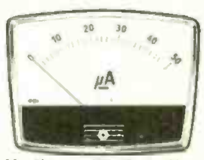
CLEARVIEW PERSPEX COVERS

SPC1 £3/3/10 SPC2 £4/4/4 SPC4 £4/4/11

Postage on all above 5/- extra.

SPECIAL INTEREST ITEMS!

LASKY'S PRECISION PANEL METERS



Precision made in Japan by TTC. Each meter boxed and fully guaranteed with all fixing nuts and washers. Sizes are of front panel.

SPECIAL QUOTATIONS FOR QUANTITIES

Add 1/6 Post on each.

MK-38A 1½in. sq.		MK-45A 2in. sq.		MK-65A 3in. sq.		KR-65 3½ × 3in.		KR-52 3 × 2½ in.	
1mA	29/6	1mA	29/6	1mA	38/6	1mA	38/6	1mA	38/6
5mA	27/6	5mA	28/6	5mA	36/-	5mA	37/6	5mA	38/6
100mA	27/6	100mA	28/6	100mA	38/6	100mA	38/6	100mA	38/6
300v	27/6	300V	28/6	300V	36/-	300V	36/-	300V	35/-
50µA	37/6	50µA	49/6	50µA	59/6	50µA	59/6	50µA	56/-
1mA S mtr	29/6	1mA S mtr	32/6	1mA S mtr	38/6	1mA S mtr	42/-	1mA S mtr	39/6
100µA	37/6	100µA	42/6	100µA	52/6	100µA	56/-	100µA	52/6
500µA	29/6	500µA	35/-	500µA	42/-	500µA	46/-	500µA	45/-

NEW INTERNATIONAL TAPE

FAMOUS AMERICAN MADE TAPE AT RECORD LOW PRICES

3in. Message tape, 150ft.	2/6
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3in Message tape, 300ft.	7/6
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4in. Triple play, 900ft., Mylar	17/6
5in. Double play, 1,200ft. Mylar	15/0
5in. Long play, 900ft. Acetate	10/0
5in. Standard play, 600ft. PVC	8/6
5in. Triple play, 1,800ft. Mylar	35/0
5¾in. Double play, 1,800ft. Mylar	22/6
5¾in. Long play, 1,200ft. Acetate	12/6
5¾in. Standard play, 850ft. PVC	11/6
5¾in. Long play, 1,200ft. Mylar	15/0
5¾in. Triple play, 2,400ft. Mylar	45/0
7in. Standard play, 1,200ft. Acetate	12/6
7in. Standard play, 1,200ft. Mylar	12/6
7in. Long play, 1,800ft. Mylar	19/6
7in. Double play, 2,400ft. Mylar	25/0
7in. Long play, 1,800ft. Acetate	15/0
7in. Triple play, 3,600ft. Mylar	50/0

P. & P. 1/- extra per reel, 4 reels and over Post Free.

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● NEWS FLASH ●

LASKY'S GREAT 36th YEAR AUDIO-TRONICS PICTORIAL

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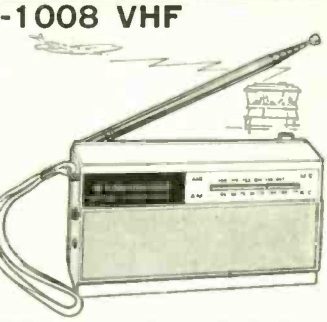
This year we celebrate our 36th anniversary by bringing to you this great new issue of our "AUDIO-TRONICS PICTORIAL". NOW 16 colour pages in large 16" × 11" format, simply packed with 1,000s of items from our vast stocks of EVERY-THING for the Radio and Electronics Hobbyist, Hi-Fi Enthusiast, Serviceman and Radio Ham. Plus 100s of Lasky's exclusive STAR PRICE Bargains.

FREE JUST SEND YOUR NAME, ADDRESS AND 1/- FOR POST ONLY

SPECIAL INTEREST ITEMS!

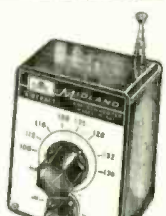
FANTAVOX Model TV-1008 VHF AIRCRAFT BAND AND AM RECEIVER



The first pocket size Receiver of its type allowing you to "tune-in" anywhere to the entire air-to-ground, ground-to-air communications band covered by 108–137 Mc/s in addition to full AM medium wave band cover of 535–1605 Kc/s. An extremely sensitive 10 transistor and 2 diode, superhet circuit, plus 1 variable capacitor and 1 thermister. Intermediate frequencies: AM-455 Kc/s; VHF-10·7 Mc/s. Output power: 200 mW. 2¼ Permanent Dynamic 8 ohm speaker, earphone also provided for "silent" listening. A built-in ferrite rod aerial is provided for AM reception and a fully directional telescopic antenna for VHF reception—the latter when collapsed neatly clips across the top of the set. Power is from 4–1·5V. penlight cells and a jack socket for connection to a suitable AC converter is also provided. The Model TV-1008 is extremely well made and finished in grey plastic with metallic blue speaker baffle, chrome telescopic antenna; attached wrist strap is also provided. Size 6¼ × 3¾ × 1¼in. Complete with batteries, magnetic earphone, instructions and circuit data.

Lasky's Price £8.7.6 P. & P. 5/-

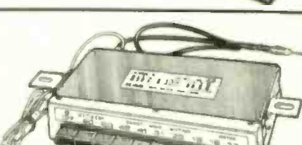
MIDLAND Model 10-502 VHF AIRCRAFT BAND CONVERTER



An entirely new item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535 to 1,605 Kc/s, 88 to 108 Mc/s respectively—with no electrical conversion or connection required. The Model 10–502 (self-powered by one 9V. (PP3 type) battery) is merely placed close to the receiving set and then tuned over 110 to 135 Mc/s which covers the whole aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position and balancing the volume controls of each accordingly. The Model 10–502 has a smartly designed black plastic cabinet with brushed metal front panel and 18in. chrome telescopic antenna, size only 4 × 2¾ × 2¾in. (inc. knobs). Complete with battery and full instructions.

Lasky's Price 79/6 Post 3/6

HITACHI SHORT WAVE ADAPTOR—Model WM-20



New from Hitachi—world famous for high quality transistor radios—a push-button Short Wave adaptor enabling you to receive all foreign broadcasts in the 3–22 Mc/s waveband. The WM-20 adaptor is suitable for use with any make or model of AM car radio (covering the usual 535–1605 Kc/s) in any make or model of car (6 or 12V., positive or negative ground). The WM-20 as will be seen has 10 push buttons which cover meter bands: 13, 16, 19, 25, 31, 41, 49, 60 and 90 plus Off button. Having selected the required band by pushing the appropriate button—fine station tuning is effected by use of the parent radios tuning system—detailed instructions provided with the adaptor show corresponding centres for each short wave band on your radio dial. The double superhet IFM circuit is extremely sensitive and the use of a Zenor diode and compensating condenser, provides great stability. Switched adjustment is provided for 6 or 12V and positive or negative ground; external aerial trimmer is also provided. Connection to the parent radio is via the aerial jack, power is taken direct from the car AUX. supply with separate line fuse. All necessary mounting brackets, leads and jacks are provided with instruction manual for installation and operating. The WM-20 is very smartly styled with brushed and bright chrome front panel and black push buttons. Size 8-1/16in. wide × 1¾in. high × 3½in. deep. Weight approximately 1½ lbs. Current consumption 6mA. List Price 14 gns.

Lasky's Price £9.19.6 P. & P. 5/-

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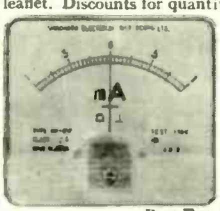

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Accurate wide range signal generator covering 120 kc/s-260 Mc/s. on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Brand new with instructions. £15.

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Sine: 20 cps to 200 kc/s. on 4 bands. Square 20 cps to 30 kc/s. Output impedance 5,000 ohms, 200/250 v. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £16.10.0. Carr. 7/6.

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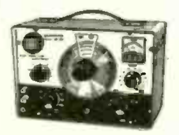
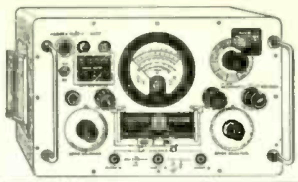


2 pf-2,000 mfd. 2 ohms-200 megohms. Also checks impedance turns ratio insulation. 200/250 v. A.C. Brand New, £17-10 Carr. 7/6.

AVO CT.38 ELECTRONIC MULTIMETERS



High quality 97 range instrument which measures A.C. and D.C. Voltage: Current, Resistance and Power output. Ranges D.C. volts 250mV-10,000 v. (10 meg Ω-110meg Ω input). D.C. current 10µA 25 amps. Ohms: 0-1,000 meg Ω. A.C. volt 100 mV-250 v. (with R.F. measuring head up to 250 Mc/s). A.C. current 10µA-25 amps. Power output 50 micro-watts-5 watts. Operation 0/110/200/250 v. A.C Supplied in perfect condition, complete with circuit lead and R.F. probe, £25. Carr. 15/-.

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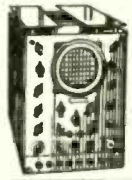
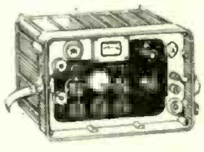


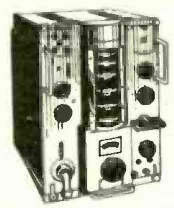
An excellent general purpose D/B oscilloscope. T.B. 2 cps-750 Kc/s. Bandwidth 5.5 Mc/s Sensitivity 33 Mv/cm. Operating voltage 0/110/200/250 v. A.C. Supplied in excellent working condition. £22/10/-. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.

AM/FM SIGNAL GENERATORS



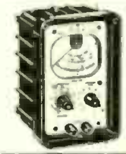
Oscillator Test No. 2. A high quality precision instrument made for the Ministry by Airmec. Frequency coverage 20-80 Mc/s. AM/CW/FM. Incorporates precision dial, level meter, precision attenuator 1µV-100Mv. Operation from 12 volt D.C. or 0/110/200/250 v. A.C. Size 12 x 8½ x 9in. Supplied in brand new condition complete with all connectors, fully tested. £45. Carr. 20/-.

ADMIRALTY B.40 RECEIVERS



Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 Kc/s-30 Mc/s. I.F. 500/Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19½ × 13½ × 16in. Weight 114lb. Offered in good working condition. £22/10/-, carr. 30/-. A few available brand new Carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17/10/-. Carr. 30/-.

MARCONI CT44 TF956 AF ABSORPTION WATTMETER

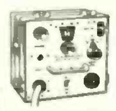


1 µ/watt to 6 watts. £20. Carr. 20/-.

TE-16A TRANSISTORISED SIGNAL GENERATOR

5 Ranges 400 KHZ-30 MHZ. An inexpensive instrument for the handyman. Operates on 9v. battery. Wide easy to read scale. 800 KHZ modulation. 5½: × 5½: × 3½:. Complete with instructions and leads. £7/19/6. P/P 4/-.

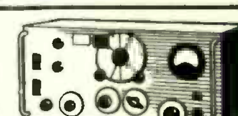
CLASS D. WAVEMETERS



A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 6 v. D.C. Ideal for amateur use. Available in good used condition £5-19-6 Carr. 7/6. Or brand new with accessories £7-19-6 Carr. 7/6.

FIELD TELEPHONES TYPE L. Generator ringing, metal cases. Operate on 2 1.5 v. batteries (not supplied.) Excellent condition. £4.10.0 per pair. Carr. 10/-.

MARCONI TEST EQUIPMENT



EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS, 85 Kc/s-25 Mc/s, £25. Carr. 30/-.
TF 885 VIDEO OSCILLATOR 0-5 m/cs £45 Carr 30/-.
T.F.195M. BEAT FREQUENCY OSCILLATOR. 0-40 kc/s, 200/250 v. A.C. £20. Carr. 30/-.
TF 142E DISTORTION FACTOR METER £20. Carr. 20/-
All above offered in excellent condition, fully tested and checked.
TF 1100 VALVE VOLTMETER, Brand New, £50. TF 1267 TRANSMISSION TEST SET, Brand New, £75. TF1371 WIDE BAND MILLIVOLT METER, Brand New, £50.

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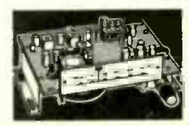
Brand new, guaranteed and carriage paid.
High quality construction. Input 230 v. 50-60 cycles.
Output full variable from 0-260 volts. Bulk quantities available.
1 amp.—£5/10/-; 2.5 amp.—£6/15/-; 5 amp.—£9/15/-;
8 amp.—£14/10/-; 10 amp.—£18/10/-; 12 amp.—£21; 20 amp.—£37

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: .01/.03/.1/.3/1/3/10/30/100/300 v. R.M.S. 4 cps.-1,2 Mc/s. Decibels—40 to +50 dB. Supplied brand new complete with leads and instructions. Operation 230 v. A.C. £17/10/-. Carr. 5/-.

★ TRANSISTOR FM TUNER ★



6 TRANSISTOR HIGH QUALITY TUNER SIZE ONLY 6in. × 4in. × 2½in. 3 I.F. stages. Double tuned discriminator, ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money, £6/7/6. P. & P. 2/6.
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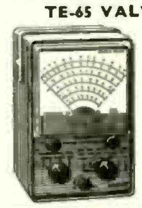
TT1S. TRANSISTOR TESTER. £37/10/-.
Carriage 10/- per item.

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.C. volts 1.5-1,500 v. A.C. volts 1.5-1,500 v. Resistance up to 1,000 megohms. 220/240v. A.C. operation. Complete with probe and instructions £17/10/0. P. & P. 6/-. Additional Probes available; R.F. 35/- H.V. 42/6.

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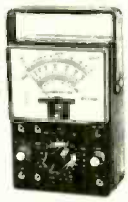

MODEL AS-100D. 100KΩ/Volt. 5in., mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/200MΩ. —20 to +17dB. **£12/10/-.** P. & P. 3/6.

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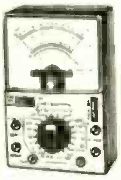

MODEL AF-105. 50KΩ/Volt. Mirror scale, built-in meter protection. 0/.3/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600/1,200 v. A.C. 0/30μA/6/60/300MA/12 Amp. 0/10K/1M/10M/100 MΩ. —20 to +17 dB. **£8/10/-.** P. & P. 3/6.

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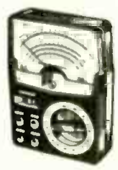
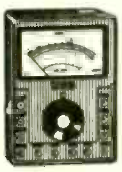
MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000 v. A.C. 0/5/25/50/250/500/1,000 v. D.C. 0-50μA. 5/50/500mA. 0/6K/60K/600K/6 meg. **£4/17/6.** P. & P. 3/-.

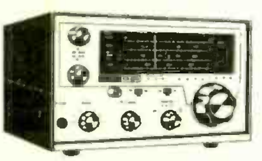


TE-51. NEW 20,000Ω/VOLT MULTIMETER, with overload protection and mirror scale, 0/6/60/120, 1,200 v. A.C. 0/3/30/60/300/600/3,000v. D.C. 0/60μA/12/300m A.D.C. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.



MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 v. D.C. 0/10/50/500/2,500 v. A.C. 0/2 Meg.Ω. 0/250 mA. —20 to + 36 dB. **49/6.** P. & P. 2/6.

MODEL TE-10A. 200kΩ/Volt 5/25/50/250/500/2,500 v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2.5 mA/250 mA D.C. 0/6K/6 meg. ohm. —20 to +22 dB. 10-0. 100 mfd. 0.100-0.1 mfd. **69/6.** P. & P. 2/6.



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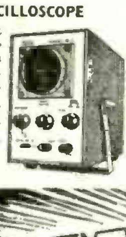

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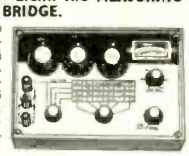

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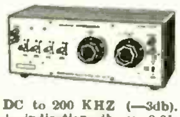

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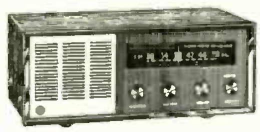

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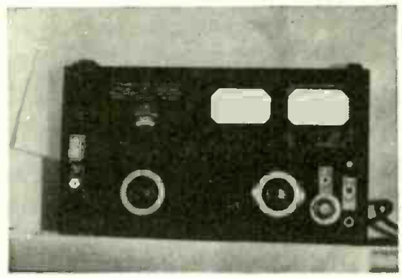

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1C	25-33-40-50	6	£5 19 6	8/6
1D	25-33-40-50	3	£3 12 6	7/6
2A	4-16-24-32	12	£6 10 0	7/6
2B	4-16-24-32	8	£4 17 6	7/6
2C	4-16-24-32	4	£3 5 0	6/–
2D	4-16-24-32	2	£2 2 6	5/–
3A*	25-30-35	40	£14 17 6	15/–
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3C	25-30-35	10	£6 10 0	7/6
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3E	25-30-35	2	£2 15 0	6/6
4A*	12-20-24	30	£11 15 0	10/–
4B	12-20-24	20	£7 10 0	8/6
4C	12-20-24	10	£4 15 0	7/6
4D	12-20-24	5	£3 5 0	6/6
5A	3-12-18	30	£8 15 0	7/6
5B	3-12-18	20	£6 10 0	7/6
5C	3-12-18	10	£3 17 6	6/6
5D	3-12-18	5	£2 12 6	6/6
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7A*	6-12	50	£9 7 6	9/6
7B	6-12	20	£5 10 0	7/6
7C	6-12	10	£3 10 0	6/6
7D	6-12	5	£2 10 0	5/6
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Note: By using the intermediate taps many other voltages can be obtained.

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" 2. 4-8-12-16-20-24-32V.
" 5. 3-6-9-12-15-18V.

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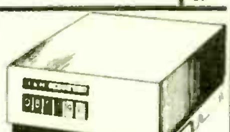

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8 "	750V " "	12/6	3/6 "
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"	8 "	500V " "	6/6	2/6
"	4 "	600V " " Sub chassis mtg.	5/-	2/-
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"	0.5 "	600V " "	1/6	9d.
"	8 "	250V " "	3/6	1/6
"	4 "	800V " "	8/6	3/-
"	2 "	4000V " "	35/-	5/-
"	1 "	5000V " "	35/-	5/6
"	0.25 "	7500V " "	17/6	4/6
"	0.1 "	7500V " "	15/-	3/-
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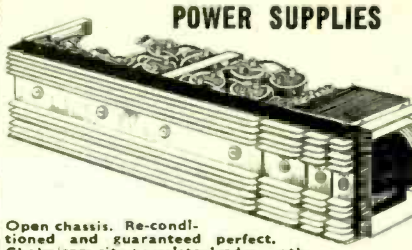

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All 12/6 carriage.

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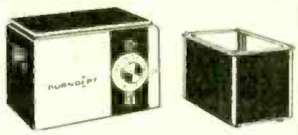

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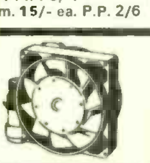

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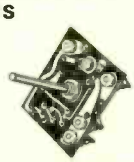

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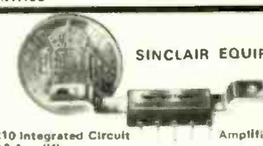

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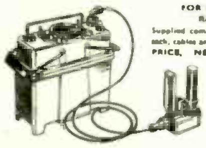

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30	Audio Generator	19	10	0	24
31	R.F. Generator	12	10	0	25
32	C.R. Bridge	10	10	0	26
33	Inductance Bridge	20	0	0	29

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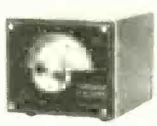

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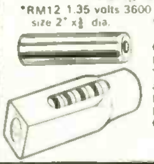

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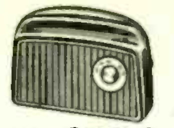

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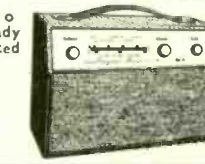

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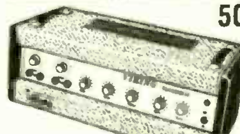

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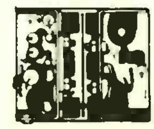

Specifications: RMS Power Output (into 3 ohms speaker) 10 watts.
Sensitivity (for rated output): 1mV into 3 Kohms (0.33 microamp). Total Distortion (at 1 KHz): At 5 watts 0.35%; At rated output 1.5%. Frequency Response: Minus 3 db points 20 Hz and 40 Khz. Speaker: 3-4 ohms. (3-15 ohms may be used). Supply voltage: 24v D.C. at 800 mA. (6-24V. may be used).

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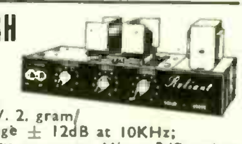

Specifications: Output: 10 watts. Output Impedance: 3 to 4 ohms. Inputs: 1. xtal mic 10mV. 2. gram/radio 250mV. Tone Controls: Treble control range ± 12dB at 10KHz; Bass control range ± 13dB at 100Hz. Frequency response: Minus 3dB points are 20Hz and 40KHz. Signal to Noise Ratio: better than —60dB. Transistors: 4 silicon Planar type and 3 Germanium type. Mains input: 220-250V. A.C. Size of chassis: 10" × 3½" × 2". A.C. Mains, 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Two inputs with control for gram. and mike. Built and tested. 8" × 5" speaker to suit. **Price 14/6** plus 1/6 p. & p. Crystal mike to suit 12/6 plus 1/6 p. & p.

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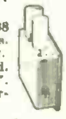

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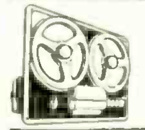

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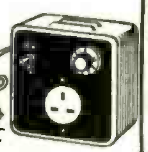

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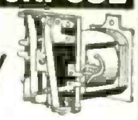

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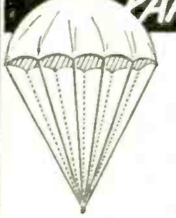


We have a large quantity of SUPPLY PARACHUTES for sale. Brand new and direct from the WarDept. Highest quality manufacture. 11ft. dia. Complete with full cords. Available in lots of 500 at **£1,000** per lot. Samples available at **50/-** each.

Listen to the thrills of Aircraft, Pilots and airports at work. Also Police, Fire, Ambulance, Taxis and Civil Depts. Ideal 2 metre Ham Bands. A fully transistorised receiver covering 97-150 Mc/s V.H.F. broadcasts. Robust louvred steel stove enamelled cabinet of hammer finish. Size 6×4×4in. Operates from a 9 volt battery that fits inside. Speaker or headphone output. Simple to use. Worth over £15. Our Price **£8/10/0** carriage and insurance 10/-, C.W.O. or C.O.D.

RUN TELEVISION-LIGHTING DRILLS ETC-ETC from a 12 Volt CAR BATTERY

A Superbly designed POWER CONVERTER (de-luxe model). A 12-volt INPUT gives a 200/240 volt OUTPUT. Enables you to run up to 220 watt AC/DC TELEVISION lighting and equipment. Thousands of uses. Indispensable to caravanners, Workshops and Garages. The unit is contained in a compact louvred steel case. Complete with connecting leads, battery clips and full instructions. Ready to connect up and use. List Price over £30. Our price while stocks last **£6/19/6.** carriage 12/6. C.O.D. 3/6 extra.

RECEIVE MORSE C.W/SSB. ON ANY RECEIVER

This miniature fully transistorised tunable B.F.O. will be a valuable addition to any receiver. A compact unit with single hole fixing that will fit anywhere. Ideal for all Ex-Govt. and commercial receivers. Complete with installation instructions. **49/6** post free.

VALVE SALE

807—**6/-** each, three for **16/-**. 6V6—**3/-** each, three for **7/-**. 6K7—**2/-** each, three for **5/-**. 6K8—**5/-** each, three for **12/6**. EF50—**1/6** each, three for **5/-**. 6H6—**2/6** each, three for **6/-**. OZ4—**9d.** each, three for **2/-**. Three valves post free, otherwise 9d. P. & P. All Valves guaranteed and insured in transit.

HANDY POWER PACK KIT

Consists of Mains, Transformer, Silicon Rectifier, Electrolytics, and choke etc. Also Robust chassis and full circuit and instructions. Input 200/250v. AC. Output 250v. 75mA. 6.3v. at 2 amps. Only **22/6.** p. & p. 7/6. Assembled **32/6** p. & p. 7/6.

GOVT. SURPLUS WIRELESS EQUIPMENT HANDBOOK

This useful handbook gives detailed information and circuits for British and American Government Surplus Receivers, Transmitters, and Test equipment, etc., plus suggested modification details and improvements for the equipment. Also a Surplus/commercial cross reference valve guide and Government component codings and references. Invaluable to Radio enthusiasts, Universities and Laboratories.

Instal YOUR OWN TELEPHONE System

Now available direct to the general public. Brand new telephones to high G.P.O. specification. Absolutely complete with bell, standard connecting cables and junction boxes. Ideal for use in home, office, shop or factories. Provides an efficient intercommunicating system. Special offer **17/6** each, 2 sets for **30/-**. Please add 5/- per phone. 4 sets for **55/-** post free. Ordinary telephone receivers less dial and extras **£1** each, p.p. 5/-. Two sets **35/-** post free.

PLUG-IN TX/RX MAINS POWER SUPPLY UNIT FOR No. 19 SET AND OTHER SURPLUS EQUIPMENT

RECEIVER POWER SUPPLIES

No. 19 Rec. **£3/10/0** carriage 10/-.
H.R.O. Receiver **£4** carriage 10/-.
R.1132 Receiver **£3/10/0** carriage 10/-.
R.1155 Receiver **£3/15/0** carriage 10/-.
1475 Receiver **£3/15/0** carriage 10/-.
P.C.R. Receivers **£3/10/0** carriage 10/-.

We can provide brand new power supply units as above in louvred steel case complete with connectors, plugs, sockets and full instructions for most Ex-Govt. Receivers.

No. 19 SET. Trans./Rec. Power supply for AC mains operation. Ideal for licensed amateur. Brand new in louvred steel case with full connecting leads and instructions. Price **£6/10/0** carriage 10/-.

UNIVERSAL BATTERY ELIMINATOR

Run all your transistor equipment direct from A.C. mains. The most economical way of running Transistor Radios, Hi-Fi Equipment, Record-Players, amplifiers etc. No more expensive batteries to buy. All the units are contained in an attractive case with a full set of accessories. Mk. 1 Model—replaces all 9 volt batteries, i.e. PP3, PP4, PP5, PP6, PP7, PP9 and all equivalents, or all 6 volt batteries, i.e. PP1 and PP8. (Please state which voltage). Now only **30/-**, p.p. 7/6. Mk. 2 Model. This unique model has three outputs—6 volts, 7½ volts and 9 volts and is ideal for cassette tape-recorders, price only **55/-**, p.p. 5/-. Extra lead with DIN plug for Cassettes **6/6.** Mark III. This unit is the same as the Mk. 2 version above with the added refinement that all the outputs are **STABILISED** making the unit most suitable for running Hi-Fi and Test Gear direct from the mains. Only **75/-**, p.p. 5/-. All units available.

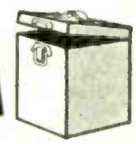
ONE WATT TRANSISTOR AMPS

For 3-5 ohm speakers. Miniature Brand new and British made. 9 volt operation. Only **37/6** p.p. 2/6

BREAST MICROPHONES

15/- each. Ideal for mobile use. p.p. 5/-.

ROBUST METAL BOXES



These Superb 20 SWG steel cases are complete with hinged lid and clasp. Made to rigid Govt. specifications. Cost over £3 each to make. Size approx. 7×7×6in. Hammer finished. Complete with carrying handle. Ideal for Bait Boxes. Tool Boxes. Instrument Cases. Lunch Boxes. Huge purchase of 7,500 enables us to offer them at only **8/6** each, carriage 3/6. Three for **25/-** post free. Six for **£2** carriage 5/-. One dozen **£4** carriage free. Special prices

TRANSFORMER & RECTIFIER SALE (All fully tested)

OC44 **1/6** each, p.p. 4d. Three for **5/-** post free.
OC72 **1/6** each, p.p. 4d. Three for **5/-** post free.
OC71 **1/3** each, p.p. 4d. Three for **4/6** post free.
OC45 **1/3** each, p.p. 4d. Three for **3/6** post free.
OC81 **2/-** each, p.p. 4d. Three for **5/-** post free.
AC128 **2/-** each, p.p. 4d. Three for **5/-** post free.
BSY 95a **3/6** each, p.p. 6d. Three for **10/-** post free.
BC108/107 **4/6** each, p.p. 4d. Three for **12/6** post free.
2N706 **2/6** each, p.p. 4d. Three for **6/6** post free.
2N2926 **2/-** each, p.p. 4d. Three for **5/-** post free.
BSY27 300 mc/s silicon **7/6** each, p.p. 4d. Three for **£1** post free.

IMPEDANCE MATCHING UNITS

These unique pieces of equipment will match a high impedance output to a low impedance load such as speaker or headphones. Also will match a low impedance output to a high impedance load. Ideal for all types of matching radios, microphones, pickups, guitars etc. In a compact plastic case. Only **17/6** each p. & p. 2/6. Two units for **30/-** post free.

BATTERY CHARGER RECTIFIERS

(Selenium) F.W. Bridge. 6 & 12 volts. 2 amp **5/-** each, p.p. 1/-; 4 amp **10/-** each, p.p. 1/-.

SILICON RECTIFIERS BY100 or Genuine tested equiv. **4/11** each 3 for **12/6** post free.

GLOBE SCIENTIFIC LTD
Dept. W.W., 24 Cawoods Yard, Mill Street, Marsh Lane, Leeds, 9
Callers welcome for a demonstration.

www.americanradiohistory.com

BECKASTAT

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season. 19/6. P. & In. 2/9.

DRY JOINT TESTER

The most reliable way of testing for a dry joint is to measure the resistance between the component lead and the printed circuit board. Our kit for doing this comprises a large-scale (3in.) moving-coil meter, a variable resistance for adjusting zero setting, and a wiring diagram with instructions. The only additional items you will need are a battery, some wire, a pair of test rods. Price 19/6. Postage and Insurance 2/6.

REED-SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor-belt switching. These are simply glass-encased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at 2/6 each, or 24/- a dozen. Suitable magnets are 1/- each.

BLANKET SIMMERSTAT

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching the blanket on for varying time periods, thus giving a complete control from off to full heat. Also suitable for controlling the temperature of any other appliances using up to 1 amp. Listed at 27/6 each, we offer these while our stock lasts at only 12/6 each.

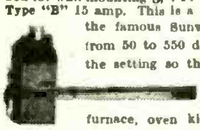
16 R.P.M. GEARED MOTOR

Made by Smiths Electrics, these are almost silent running, but are very powerful. They operate from normal 240 V. mains and the final-shaft speeds 16 R.P.M. 15/-. P.& In. 2/9.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob. Quickly adjustable from 30-80 deg. F. 9/6 plus 1/- post. Suitable box for wall mounting 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50 to 550 deg. F. Internal screw alters the setting so this could be adjustable over 30 deg. to 1000 deg. F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm. 8/6 plus 2/6 post and insurance.

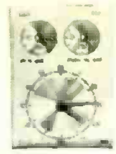


Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yds., 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperatures. 7/6. plus 1/- post.

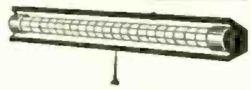
Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50 deg. to 150 deg. F. Price 18/-, plus 2/- post and insurance.

ELECTRIC CLOCK WITH 25 AMP. SWITCH



Made by Smith's these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only 39/6, less than the value of the clock alone—post and insurance 2/9.

INFRA-RED HEATERS



Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions uses silica enclosed elements designed for the correct infra-red wave length (3 microns). Price for 750 watts element, all parts metal casing as illustrated. 19/6, plus 4/6 post and ins. Pull switch 3/- extra.

DRILL CONTROLLER

CONTROL DRILL SPEEDS

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions 19/6, plus 2/6 post and insurance. Or available made up 29/6. Plus 2/6 post.

THIS MONTH'S SNIP

Electric Clock with 3 amp switch

made by Smiths for Dreamland. These are mains driven and frequency controlled so are extremely accurate. The dial enables "switch-on" time to be accurately set. Switch off is 3 hours later or by manual control. Intended for switching electric blankets this needs only one setting for the season. Suitable also to control tape recorder, radio and lamp etc. In neat plastic case with mains lead and two outlet plugs. New and unused, 39/6. post and insurance 3/6.

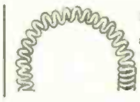
VARYLITE

Will dim fluorescent or incandescent lighting up to 600 W. from full brilliance to out. Fitted on M.K. Flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob. £3.19.6.

INDICATOR LAMP

Panel mounting, consists of neon lamp in red Plastic lens with resistor in leads for mains operation 2/6d. each 24/- dozen.

SPRING COIL LEADS



as fitted to telephones, 4 core 2/6d. each, 3 core 2/- each.

Multi Purpose Neon Test Unit. Robust, useful and instructive, tests insulation, capacity, continuity, resistor, volume controls, also acts as signal injector and L.T. fault finder, kit comprises neon indicator, 4-way wafer switch, ebonite tubes, resistors, condensers, terminals, etc., with diagram, only 9/6. plus 2/- post and insurance.

5 Push Switch. One push operates mains on/off switch, the other four operate various on/off and change-over switches, 2/6.

A.E.I. Fractional H.P. Motor. 200/250 v. 50/60 c.p.s. enclosed, continuous rating 1/40 h.p., ex. equip. Perfect order, 19/6. plus 4/6.

Experimenting with ultra violet? Philips U.V. lamp, 16/6; holder and control gear 19/6.

G.E.C. Black Light Tube for experiments and special lighting effects—40 watt 2ft. tubes only, 14/6 each; holders and control gear, 19/6. plus 4/6 post.

Clock Motor. 230v. 50 cps synchronous—self starting, 6/6.

Pentode Output Transformer. Standard size, 40-1, ex-equipment but OK, 4/3 each. 48/- doz. Post paid.

E.H.T. Condenser. 0·1 mfd. 5 kV, 8/6 each.

Neon Mains Tester, 1/3 each, 12/- doz.

Rotary Cam Operated Switch. 12 positions each of which close a separate pair of contacts except the last which leaves them all open. Contacts rated at 250V 16 amps, 15/- each.

Rotary Cam Operated Switch. 4 positions: 1st position all contacts open; 2nd contact 1 closed; 3rd contacts 1 and 2 closed; 4th contact 1, 2 and 3 closed. Contact rated 250V 16 amps, 8/6 each.

Breast Microphone. Fine American made dynamic type, adjustable on breast plate with neck straps, 7/6. post 4/6.

Circular Fluorescent. 22 watt, 9in. diam. tube complete wth choke, starter, holders and chrome clips, 29/6, post, etc. 4/6.

Midget Relay twin 250 ohm coils, size approx. 1¼in. × 1in. × 1in. 4 pairs changeover contacts, 7/6 each.

P.O. Type Relay. Twin 200 ohm coils, size approx. 3in. 2in. × ¾in. 4 pairs changeover contacts, 8/6 each.

Printed Circuit Board, Edge Connector, solder terminations, 32 contacts, standard spacing for veroboard, etc. 6in. long but easily cut. 7/6 each. 80/- doz.

1,000W Fire Spiral, replacement for most fires. 1/3 each. 12/- doz.

Sub-Miniature Silicon Diodes. General purpose type with gold-plated leads, 1/- each or 7/6 per dozen.

Message Tapes. 225ft. Tape on 3in. spools, normally 4/6 each, we offer 4 tapes for 12/6.

White Circular Flex. Ideal for lighting drops, twin made by BICC. Usually 8d. yd., 100 yd. coil for 30/-, plus 6/- postage.

Edgewise Control. Morganite, as fitted many transistor radios, 2K or 5K with switch, 2/6 each or 24/- per dozen.

12V Inverter. Full transistorised for operating a 20-watt fluorescent tube, size 6in. long × 1½ × 1½. £3.10.0. Post and insurance 3/-.

Silicon Rectifier. Equiv. BY100 750mA 400V., 10 for 20/-.

Miniature Pickup for 7in. records made by Cosmocode, crystal cartridge with sapphire stylus only 3/9 or 36/- dozen.

Telescopic Aerial for radio or transmitter, chrome plated 6 section extends from 7½in. to 47in., 7/6 each, £4 per dozen.

Midget Neons for mains indicators, etc., 1/3 each or 12/- dozen.

Compression Trimmers. Twin 100pF, 1/- each; 9/- per dozen.

3in PM Loudspeaker. 3 ohm, 12/6; 80 ohm 13/6.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

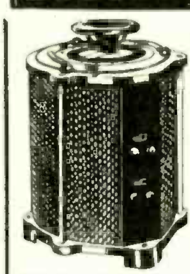
ELECTRONICS (CROYDON) LTD

Dept. WW, 266 London Road, Croydon CRO-2TH

NO EXCUSES! NO DELAYS! FROM STOCK!

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230 v. A.C. 50/60



BRAND NEW. Keenest prices in the country. All Types (and spares) from ½ to 50 amp. available from stock.

0–260 v. at 1 amp.	£5 10 0
0–260 v. at 2.5 amps. ..	£6 15 0
0–260 v. at 4 amps.	£9 0 0
0–260 v. at 5 amps.	£9 15 0
0–260 v. at 8 amps.	£14 10 0
0–260 v. at 10 amps. ...	£18 10 0
0–260 v. at 12 amps. ...	£21 0 0
0–260 v. at 15 amps. ...	£25 0 0
0–260 v. at 20 amps. ...	£37 0 0
0–260 v. at 37.5 amps. .	£72 0 0
0–260 v. at 50 amps. ...	£92 0 0

50 AMPS

1 AMP.

20 DIFFERENT TYPES AVAILABLE FOR IMMEDIATE DELIVERY.

Double Wound Variable Transformers

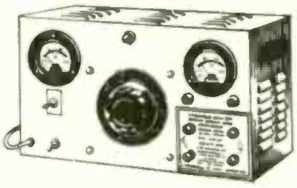
Fully isolated, low tension Secondary winding. Input 230 v. A.C. OUTPUT CONTINUOUSLY VARIABLE 0-36 v. A.C.

0-36 v. at 5 amp. £9.12.6—p. & p. 8/6

0-36 v. at 20 amp. £21.0.0—15/- p. & c.

These fully shrouded Transformers, designed to our specifications, are ideally suited for Educational, Industrial and Laboratory use.

5 Amp. AC/DC VARIABLE VOLTAGE OUTPUT UNIT



Input 230 v. A.C. Output 0-260 v. A.C. Output 0-240 v. D.C. Fitted large scale ammeter and voltmeter. Neon indicator, fully fused. Strong attractive metal case 15in. × 8¾in. × 6in. Weight 24 lb. Infinitely variable, smooth stepless voltage variation over range. Price **£30** P. & C. £2.

7 Amp. A.C./D.C. Mk. II 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, voltmeter and ammeter. Size 17in. × 12in. × 7in. Weight 36 lb. Price £39/10/-. Carriage 40/-.

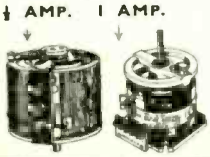
OPEN TYPES

Designed for Panel Mounting. Input 230 v. A.C. 50/60 Output variable. 0-260 v.

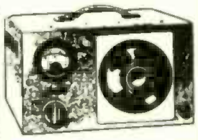
½ amp	£3 10 0
1 amp.	£5 10 0
2½ amp.	£6 12 6

P. & P. 7/6

½ AMP. 1 AMP.

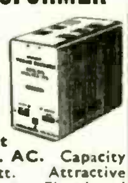


PORTABLE



Input 230 v. A.C. Output variable 0-260 v. A.C. at 1.5 amp. Fitted in beautifully finished steel case. Complete with voltmeter, pilot lamp, fuse, switch, carrying handle. **£9/5/-.** P. & C. 10/-. Also 2.5 amp. as above. £11/7/6. P. & C. 10/-.

CONSTANT VOLTAGE TRANSFORMER



Input 185-250 v. A.C. Output constant at 230 v. AC. Capacity 250 watt. Attractive metal case. Fitted red signal lamp. Rubber feet. Weight 17lbs. Price **£11/10/-**, P. & P. 10/-.

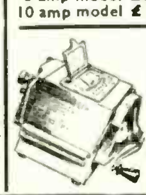
LATEST TYPE SOLID STATE VARIABLE CONTROLLER

Ideal for lighting and heating circuits, compact panel mounting. Built in fuse protection. CONTINUOUSLY VARIABLE. Input 230v AC output 25-230v AC

5 amp model **£8. 7. 6**

10 amp model **£13. 5. 0**

INSULATION TESTERS (NEW)



Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8in., W. 4in., H. 6in. Weight 6lb. 500 volts, 500 megohms. Price £22 carriage paid. 1,000 volts, 1,000 megohms, £28 carriage paid.

36 volt 30 amp. A.C. or D.C. Variable L.T. Supply Unit

INPUT 220/240 v. A.C. OUTPUT CONTINUOUSLY VARIABLE 0-36 v.

Fully isolated. Fitted in robust metal case with Voltmeter, Ammeter, Panel Indicator and chrome handles. Input and Output fully fused. Ideally suited for Lab. or Industrial use. **£55** plus 40/- p. & c. Similar in appearance to above illustration.

SERVICE TRADING COMPANY →

SERVICE TRADING CO

Postage and Carriage shown below are inland only. For Overseas please ask for quotation. We do not issue a catalogue or list.

LIGHT SENSITIVE SWITCHES

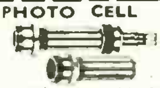
Kit and parts including ORP.12 Cadmium Sulphide Photocell. Relay Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operations. Price 25/-, plus 2/6 P. & P. **ORP 12 and Circuit 10/- post paid.**

220/240 A.C. MAINS MODEL incorporates mains transformer rectifier and special relay with 3 × 5 amp. mains c/o contacts. Price inc. circuit 47/6, plus 2/6 P. & P.

PHOTO ELECTRONIC COUNTER

Can be set for counts of up to 500 per minute. 210-250 v. A.C. powered. Kit of Components, including photo cell, high speed non-resettable counter, transformer, relay, etc., together with clear circuit diagram, £3/2/6, plus 3/6 P. & P. With resettable counter, £4/2/6, P. & P. 3/6.

LIGHT SOURCE AND PHOTO CELL MOUNTING

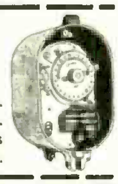


Precision engineered light source with adjustable lens assembly and ventilated lamp housing to take MBC bulb. Separate photo cell mounting assembly for ORP.12 or similar cell with optic window. Both units are single hole fixing. Price per pair £2/15/0 plus 3/6 P. & P.

ULTRA VIOLET BULBS

Easy to use source of U.V. for dozens of practical and experimental uses.
12 volt 36 watt A.C./D.C. SBC, 6/6. P. & P. 1/-
12 volt 60 watt A.C./D.C. SBC 8/6. P. & P. 1/-.
Transformer to suit the above. Input 200-240 v. A.C. 12 volt 36 watt, 21/-. P. & P. 2/6. Input 200-240 v. A.C. 12 volt 60 watt, 27/-. P. & P. 3/6. **Set of 4 Colours FLUORESCENT PAINT.** Red, yellow, green and cerise. In 1 oz. jars. Ideal for use with the above Ultra Violet Bulbs, 11/- plus 2/6 P. & P.

200/250 v. AC HORSTMAN 20AMP TIME SWITCH



2 on/off every 24 hrs. at any pre-set time. Fitted in metal case 36 hr. spring reserve. Used but fully tested. Fraction of maker's price. £3.19.6 plus 4/6d. post and pack.

COPPER LAMINATE PRINTED CIRCUIT BOARD. Large sheet 15½ × 5½in. Price 3/9, 3 for 10/- post paid.

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. £19 plus 15/- carr. Leaflet on request.

INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New 17/- per doz. P. & P. 2/-.

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type, £3 each. P. & P. 4/6. 500 watt type, £4/2/6 each. P. & P. 6/6. 1,000 watt type, £5/5/- each. P. & P. 7/6.

230 VOLT A.C. GEARED MOTORS

Type D15G 5 r.p.m. 1.7lb. inch, £2/9/6. P. & P. 3/-
Type B16G 80 r.p.m. .26lb. inch, £2/2/-, P. & P. 3/-
Type D16G 13 r.p.m. 1.45lb. inch, £2/17/6. P. & P. 3/-.

DRY REED SWITCHES

New special offer of Dry Reed Switches, ½ amp. contact, 1¼ × 1⅛in., 4 for 10/-, post paid.

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.

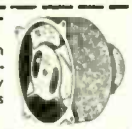
A.C. CONTACTOR

2 make and 2 break (or 2 c/o) 15 amp. contacts. 230/240 v. A.C. operation. Brand new. 22/6 plus 1/- P. & P.

CONDENSERS

New at a fraction of maker's price.
2,500 mfd. 100 v... 12/6   4,000 mfd. 25 v... 10/-
10,000 mfd. 35 v... 15/-   4,000 mfd. 50 v... 15/-

220/240v. A.C. COOLING UNIT



2,300 r.p.m. 6in. blade size. Smooth powerful motor. All metal construction. Continuously rated. Individually tested. Offered at fraction of maker's price, £2/15/-. P. & P. 7/6.

100 WATT POWER RHEOSTATS

(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty.
AVAILABLE FROM STOCK IN THE FOLLOWING 11 VALUES:
1 ohm 10a., 5 ohm 4.7a., 10 ohm 3a., 25 ohm 2a., 50 ohm 1.4a., 100 ohm 1a., 250 ohm 7a., 500 ohm 45a., 1,000 ohm 280mA., 1,500 ohm 230mA., 2,500 ohm .2a. Diameter 3½in. Shaft length ⅜in. dia. ⅜in., 27/6. P. & P. 1/6.
50 WATT 1/5/10/25/50/100/250/500/1,000/1,500/2,500 ohm, 21/-, P. & P. 1/6.
25 WATT 10/25/50/100/250/500/1,000/1,500/2,500 ohm, 14/6, P. & P. 1/6.
Black Silver Skirted knob calibrated in Nos. 1-9. 1½ in. dia. brass bush. Ideal for above Rheostats, 3/6 each.

STROBE! STROBE! STROBE!

TWO EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES. SOLID STATE TIMING + TRIGGERING CIRCUITS. PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION.
The Strobe is one of the most useful and interesting instruments in the laboratory or workshop. It is invaluable for the study of movement and checking of speeds. Many uses can be found in the psychiatric and photographic fields, also in the entertainment business. It is used a great deal in the motor industry and is a real tool as well as an interesting scientific device.
EXPERIMENTERS "ECONOMY" KIT. 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube + instructions £5.5.0 plus 5/- P. & P.
INDUSTRIAL "ADVANCED" KIT. 1 to 80 Flash per sec. IDEAL FOR LABORATORY OR SCHOOL USE. Fully isolated from the mains supply by specially wound transformer. 500v. FLASH CIRCUIT and stabilised timing circuit. Higher output flash tube. Price £8.8.0 plus 7/6 P. & P.
6½ INCH POLISHED REFLECTOR. Ideally suited for above Strobe Kits. Price 8/6 post paid.
Regret not sold separately.

PARVALUX TYPE SD19 230/250 VOLT AC REVERSIBLE GEARED MOTOR

30 r.p.m. 40 lb. Ins. Position of dry spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. 6gns. P. & P. 10/-.

Latest American. New. Plastic THYRISTOR 400 P.I.V. 8 amp. Complete with data sheet. 19/6 post paid.

"AVO MODEL 7X" PANCLIMATIC

Offered fully tested and in excellent condition. Complete with carrying case, leads and instructions. £14, plus 10/- Reg. Post.

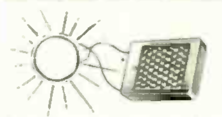
"AVO" 25,000 VOLT D.C. MULTIPLIER

For CT38 Valve voltmeter. Complete with leads. New and boxed, 21/-. P. & P. 6/6.

NICKEL CADMIUM BATTERY

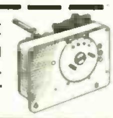
Sintered Cadmium Type 1.2 v. 7AH. Size: height 3½in., width 2¼in. × 1⅛in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6. P. & P. 2/6.

34R SILICON SOLAR CELL



4 × .5 volt unit series connected, output up to 2 v. at 20 mA. in sunlight, 30 times the efficiency of selenium. As used in power Earth Satellites, 45/-. P. & P. 1/6d.

PRECISION INTERVAL TIMER



From 0-30 seconds (repetitive). Jewelled balanced movement. Lever re-set. Operates 230 v. A.C. 5 amp. c/o microswitch. Brand New 17/6 plus 2/6 P. & P.

50k 45 TURN PRECISION WIREWOUND CONTROL

Fly leads. 1¼ × ¼ × ⅜in. made by M.E.C. Ltd. 10/- post paid.

LATEST TYPE SELENIUM BRIDGE RECTIFIERS

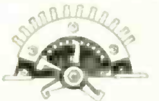
30 volt 3 amp., 11/-, plus 2/6 P. & P.
30 volt 5 amp., 16/-, plus 2/6 P. & P.

MOVING COIL HEADPHONE AND MIKE

Soft rubber ear-pieces with M/C Mike fitted 5-way plug as on No. 19 set. New, in maker's packing, 16/6, plus 3/6 C. & P.

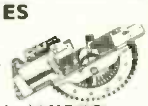
A.C. AMMETERS 0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at 21/- each.
A.C. VOLTMETERS 0-25 v., 0-50 v., 0-150 v. M.I 2½in. Flush round all at 21/- each. P. & P. extra.
0-300 v. A.C. Rect. M-Coil 2½in. 29/-
0-300 v. A.C. Rect. M-Coil 3½in. Type W23 ...... 55/-

MINIATURE UNISELECTOR



3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. 22/6, plus 2/6 P. & P.

UNISELECTOR SWITCHES NEW 4 BANK 25 WAY

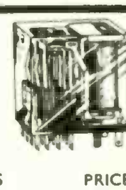


25 ohm coil, 24 v. D.C. operation. £5/17/6, plus 2/6. P. & P.

8-BANK 25-WAY FULL WIPER

24 v. D.C. operation, £7/12/6. Plus 4/- P. & P.

RELAYS



BULK PURCHASE ENABLES US TO OFFER THE FOLLOWING NEW SIEMENS PLESSEY, etc. MINIATURE PLUG IN RELAYS COMPLETE WITH BASE, AT A FRACTION OF MAKER'S PRICE

COIL Ω	WORKING VOLTAGE	CONTACTS	PRICE
280	6—12	2 c/o	14/6
280	9—18	4 c/o	15/6
700	12—24	2 c/o	12/6
700	16—24	4 c/o	15/6
700	16—24	4M 2B	12/6
1250	20—40	2 c/o Heavy Duty	12/6
2500	30—50	2 c/o Heavy Duty	12/6
5800	50—70	4 c/o	10/-
9000	40—70	2 c/o	10/-

POST PAID

SEALED RELAY

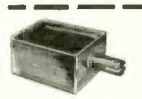
230 VOLT AC COIL
Two change over 5 amp contacts. Plug-in I.O. Base.
Price 14/6d. incl. base. Post Paid.

SANGAMO WESTON

Dual range voltmeter. 0-5 and 0-100 v. D.C. FSD 1 mA. In carrying case with tests prods and leads. 32/6. P. & P. 3/6.

GALVANOMETER

300-0-300 microamp. Calibrated 30-0-30. Mounted in sloping front case £2/10/-. P. & P. 3/6 **D.C. Voltmeter** 0-3 V and 0-15. V £2 plus 3/6 P. & P. **D.C. Ammeter.** 0-6 amp. and 0-3 amp. £2, 3/6 P. & P. The set of 3 matching instruments £6, P. & P. 6/6.



230/250 v. A.C. SOLENOID

Heavy duty type. Approx. 3lb. pull. 17/6 plus 2/6 P. & P.

12/24 v. D.C. SOLENOID

Approx. 8 oz. push, 8/6 plus 1/6 P. & P.

VAN DE GRAAF ELECTROSTATIC GENERATOR, fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price £7/7/-, plus 4/- P. & P. L't. on req.

L.T. TRANSFORMERS

All primaries 220-240 volts.

Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36 v. at 5 amps.	£4 5 0	6/-
2	30, 40, 50 v. at 5 amps.	£6 5 0	6/6
3	10, 17, 18 v. at 10 amps.	£4 10 0	4/6
4	6, 12 v. at 20 amps.	£5 17 6	6/6
5	17, 18, 20 v. at 20 amps.	£6 12 6	6/6
6	6, 12, 20 v. at 20 amps.	£6 5 0	7/6
7	24 v. at 10 amps.	£4 15 0	5/6
8	4, 6, 24, 32 v. at 12 amps.	£6 10 0	6/6

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SHOWROOMS NOW OPEN
Many Bargains for the caller.
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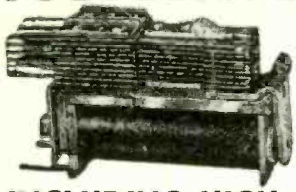
Wilkinsons FOR RELAYS



P.O. TYPE 3000 AND 600

BUILT TO YOUR REQUIREMENTS—QUICK DELIVERY
COMPETITIVE PRICES — VARIOUS CONTACTS
DUST COVERS — QUOTATIONS BY RETURN
LARGE STOCKS HELD OF MINIATURE SEALED RELAYS
INCLUDING HIGH SPEED G.E.C. • SIEMENS • S.T.C. • ERICSSON • E.M.I. • BEST MAKES
25,000 IN STOCK DETAILED LIST ON REQUEST

CONNECTING WIRE 1/024; 7/0076; or 14/0048 PVC covered in various colours 100 & 200 yard reels. £4 per 1,000 yds. post 6/-

LEDEX SOLENOID DRIVENWAFER SWITCHES SIZE 58. From 90/-. 11 Way and off. 3 to 24 Pole; also 4 Pole 12 Way and 54 Pole on/off.

SOLENOIDS type 3E in stock at 17/6 each.

CERAMIC AND PAXOLIN WAFER SWITCHES available from stock at keen prices. send for list.

P.O. STANDARD RACKS 6ft U channel sides drilled for 19in. panels heavy angle base. 150/-, cge 20/-. Desk Units for Racks 30/-, cge 7/6.

HYGROMETER. reading humidity. 4in. round by Negretti and Zambra. scaled 0/100. 65/-, post 3/-.

MINIATURE BUZZERS. 12v. with tone adjuster. 7/6.

SPECIAL OFFER
43.500 Condensers 0.1 mfd 150 volts T.M.C. wire ended £15 per 1.000 or offer to clear lot.

PLASTIC-FILM CONDENSERS TMC S125017LM 0·9 + 0·1 mfd 500V also 1 mfd. 1%. 150V. TCC 20/- each.

AIR BLOWERS. 200/250 volt. A.C. cylindrical 7in. — 7in. suitable for intake or extraction. 1/50th h.p. £10. 1/15th h.p. £11. 1/10th h.p. £14.

ELCOM STUD SWITCHES. 12 pole 2 way or 3 way types on 3 Banks. break before make action 50/- ea.

GEARED MOTORS. 3 r.p.m. or 1 r.p.m. 4 watts very powerful. reversible 24 v. AC 35/-. post 2/6. can be operated from 230v with our 20/- Transformer.

SUB-MINIATURE LAMPS. Flying leads 0.75 volts 50/- 100.

DOUBLE HEADPHONES. Balanced armature. Sound powered type DHR. 17/6. Post 3/-.

MICRO SWITCH. Burgess MK4BR. robust die cast casing. 8/6 each. Post 1/-. Others available.

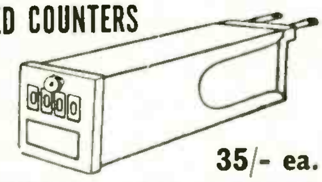
BATTERY CHARGERS at special price made by Westinghouse. worth £35. Input 200/250v AC. output 6v 15 amps DC. with ammeter. fuses; regulated by a 4-position switch and sliding resistance. **OUR PRICE 170/-.**

TRANSISTORS	DIODES	SCR'S	ZENNERS	VALVES
ASZ20 4/6	2N698 5/-		SX68 4/6	1S131 2/-
OC45 3/6	2N1305 2/6		SX645 15/-	OA10 3/-
OC71 3/6	2N1997 5/-		SX641 3/-	OAZ242 4/6
OC200 4/6	2N1613 3/-		ZS10A 3/-	VR525A-B 6/-
2S002 15/-	2N1596 29/-		ZT83 11/6	ECC81 4/-
GET875 6/-	(low gain selection)		E88CC 12/-	12BH7 7/6

LAMP HOUSES with pair of 6in. lenses mounted in a 9in. square case, ideal spotlight 70/- each, post 10/-.

HIGH SPEED COUNTERS

3¼ × 1in., 10 counts per second with 4 figures. The following D.C. voltages are available, 6 v., 12 v., 24 v., 50 v. or 100 v.



35/- ea.

SUB-MINIATURE Microswitch Honeywell S.P.D.T. type 11 SM1 TN 13 size ½" × ⅜" × ¼" 6/6 ea. or mounted in fives for 22/6 post free.

DIGITAL INDICATOR. KGM M5 28 vt. 0 to 9. 50/- ea.

SPEAKERS ELAC 5in. ROUND. 9700 Gauss. 3Ω 12/6. Post 2/6.

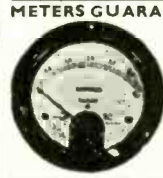
JACK PLUGS. 2 Point with screw-on cover. 2/6. post 9d. PO 201 on headphone cord 3/-. post 1/6.

PLUG-IN RELAYS. Londex 4 change-over HD contacts 28 v. D.C. or 240 v. A.C. with base and cover. 35/- ea.

RELAYS. 24 v. D.C. 4 make 4 break HD 12/6 each.

ROBUST AIRCRAFT PUSH 5C/898 of bakelite barrel type construction. with 1 ¼" square 4 hole fixing top with actual push below the level of a 1" bakelite circle to prevent it being used accidentally. Samples 5/6 each large quantities available.

METERS GUARANTEED. Complete list available.



Microamps 0/100 2½in. MC	40/-
Microamps 0/500 2in. MC	25/-
Microamps 0/500 2½in. MC	37/6
Milliamps 0/50 2½in. MC. .	35/-
Milliamps 0/500 3½in. MC	54/-
Amps 50-0-50 2in. MC. . . .	17/6
Amps 0/5 2in. MC.	37/6
Volts 5/0/5 2½in. MC.	25/-
Volts 0/20 2in. MC.	37/6
Volts 0/10 A.C. 3½in. MCR	70/-

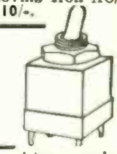
MICROAMPS 0/50 scaled in Rontgens 2½in. MC 45/-.

LEAK DETECTOR A.E.I. mains powered £35 ea.

PORTABLE VOLTMETERS 0/250 Moving Iron AC/DC, 6in. scale. in polished wood case. £7/10/-.

ONE HOLE FIXING SWITCHES

SINGLE POLE. Double Throw. 3 amp. 250 v. A.C. can be used as on/OFF or CHANGE-OVER switch. 18/- per dozen. post 2/-. 130/- per 100. post 5/-.



CLOCKWORK MECHANISM. Precision made. Contacts making and breaking twice per second in sound-proof case with thermostat controlled heating. 12 or 24v. 18/6 post 6/-.

"VISCONOL-CATHODRAY" CONDENSERS. .001 mfd. 10 kV. 5/-; .002 mf. 15 kV. 9/-; .02 mf. 10 kV. 10/-; .025 mf. 2.5 kV. 5/-; .05 mf. 5 kV. 9/-; 0.1 mf 4 kV. 9/-; 6 kV. 17/6; 0.5 mf. 2.5 kV. 17/6; 1 mfd. 2 kV. 17/6.

RESISTORS. wire wound or carbon, potentiometers, condensers, quantities ex-stock at low prices.

BRIDGE MEGGERS SERIES I. With resistance box and leads. 1,000 v., 0-100 megohms. £60 ea.

L. WILKINSON (CROYDON) LTD.
LONGLEY HOUSE LONGLEY RD. CROYDON SURREY
Phone: THO 0236 Grams: WILCO CROYDON

LATEST RELEASE OF

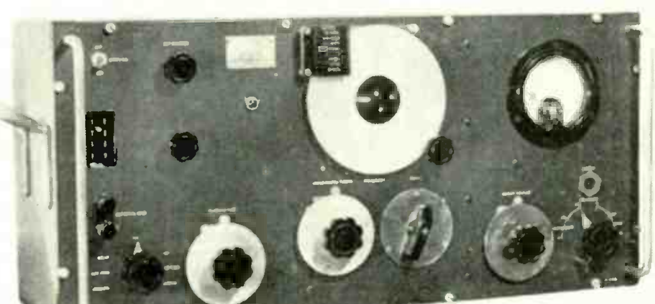
RCA COMMUNICATION RECEIVERS AR88

BRAND NEW and in original cases—A.C. mains input. 110V or 250V. Freq. in 6 bands 535 Kc/s-32 Mc/s. Output impedance 2.5-600 ohms. Complete with crystal filter, noise limiter, B.F.O., H.F. tone control; R.F. & A.F. variable controls. Price £87/10/- each, carr. £2.

Same model as above in secondhand cond. (guaranteed working order), from £45 to £60, carr. £2.

SET OF VALVES: new, £3/10/- a set, post 7/6; available with Receiver only. **SPEAKER:** new, £3 each, post 10/-. **HEADPHONES:** new, £1/5/- a pair, 600 ohms impedance. Post 5/-.

AR88 SPARES. Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L55. Price 10/- each, post 2/6. RF Coils 13 & 14; 17 & 18; 23 & 24; and 27 and 28. Price 12/6 each. 2/6 post. By-pass Capacitor K.98034-1, 3×0.05 mfd. and M.980344, 3×0.1 mfd., 3 for 10/-, post 2/6. Trimmers 95534-502, 2-20 p.f. Box of 3, 10/-, post 2/6. Block Condenser, 3×4 mfd., 600 v., £2 each, 4/- post. Output transformers 901666-501 27/6 each, 4/- post.



MARCONI SIGNAL GENERATORS

TYPE TF-144G

Freq. 85Kc/s-25Mc/s in 8 ranges. Incremental: +/— 1% at 1Mc/s. Output: continuously variable 1 microvolt to 1 volt. Output Impedance: 1 microvolt to 100 millivolts, 10 ohms 100mV-1 volt-52.5 ohms. Internal Modulation: 400 c/s sinewave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100 c/s. Consumption approx. 40 watts. Measurements: 19¼ × 12¼ × 10 in. The above come complete with Mains Leads, Dummy Aerial with screened lead, and plugs. As New, in Manufacturer's cases, £40 each. Carr. 30/-. DISCOUNT OF 10% FOR SCHOOLS, TECHNICAL COLLEGES, etc.

S.A.E. for all enquiries. If wishing to call at Stores, please telephone for appointment.

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HRO RECEIVER. Model 5T. This is a famous American High Frequency superhet, suitable for CW, and MCW, reception crystal filter, with phasing control. AVC and signal strength meter. Freq. range 50 kc/s. to 30 mc/s., with set of nine coils. Complete HRO 5T SET (Receiver, Coils and Power Unit) for **£30**, plus 30/- carr.

COMMAND RECEIVERS; Model 6-9 Mc/s., as new, price **£5/10/-** each, post 5/-.

COMMAND TRANSMITTERS, BC-458: 5.3-7 Mc/s., approx. 25W output, directly calibrated. Valves 2 × 1625 PA; 1 × 1626 osc.; 1 × 1629 Tuning Indicator; Crystal 6,200 Kc/s. New condition—£3/10/- each, 10/- post.
(Conversion as per "Surplus Radio Conversion Manual, Vol. No. 2," by R. C. Evenson and O. R. Beach.)

BC-433G COMPASS RECEIVER; Freq. 200-1,750 Kc/s. in 3 bands, suitable for aircraft, boats, etc. Complete with 15 valves, power supply input 24 v. D.C. at 2 amps. Receiver only £5 each, carr. 15/-.

ROTARY CONVERTERS: Type 8a, 24 v D.C., 115 v A.C. @ 1.8 amps, 400 c/s 3 phase, **£6/10/-** each, 8/- post. Converter 12 v D.C. input, 110 v A.C., 60 c/s @ 2.73 amps. 0.300 Kva, **£15** each, carr. £1. Converter 230 v D.C. input, 115 v. output 60 c/s @ 2.73 amps. 0.300 Kva, **£15** each, carr. £1. 24 v D.C. input, 175 v D.C. @ 40mA output, 25/- each, post 2/-.

CONDENSERS: 150 mfd, 300 v A.C., **£7/10/-** each, carr. 15/-. 40 mfd, 440 v A.C. wkg., **£5** each, 10/- post. 30 mfd, 600 v wkg. D.C., **£3/10/-** each, post 10/-. 15 mfd, 330 v A.C. wkg., **15/-** each, post 5/-. 10 mfd, 1000 v, **12/6** each, post 2/6. 10 mfd, 600 v, **8/6** each, post 5/-. 8 mfd, 1200 v, **12/6** each, post 3/-. 8 mfd, 600 v, **8/6** each, post 2/6. 4 mfd, 3000 v wkg., **£3** each, post 7/6. 2 mfd, 3000 v wkg., **£2** each, post 7/6. 0.25 mfd, 32,000 v, **£7/10/-** each, carr. 15/-. 0.25 mfd, 2Kv, **4/-** each, 1/6 post.

AERIAL MASTS: 40 ft., complete with base, **£10** each. Carr. £2.

RACK CABINETS: 6 ft. by 19 in., and 16 in. depth, with rear door and safety switch, **£5**, carr. £2.

AVO MULTIRANGE No. 1 ELECTRONIC TEST SET: £25 each, carr. **£1**.

AVOMETERS: Model 47A, **£9/19/6** each, 10/- post. Model 7x, **£13/10/-** each, 10/- post. Excellent secondhand cond. (Meters only). (Batteries and Leads extra—at cost).

OSCILLOSCOPE Type 13A, 100/250 v. A.C. Time base 2 c/s.-750 Kc/s. Bandwidth up to 5 Mc/s. Calibration markers 100 Kc/s. and 1 Mc/s. Double Beam tube. Reliable general purpose scope, £22/10/- each, 30/- carr.
COSSAR 1035 OSCILLOSCOPE, £30 each, 30/- carr.

RELAYS: Relay Unit (with 9 American relays) 24 v. D.C., 250 ohm coils, heavy duty, M. & B. 30/- each, 4/- post. GPO Type 600, 10 relays @ 300 ohms with 2M and 10 relays @ 50 ohms with 1M., £2 each, 6/- post.
12 Small American Relays, mixed types £2, post 4/-.

CALIBRATION TACHOMETER Mk. II: Maxwell Bridge Type 6C/869 **£25** each, **£2** carr.

ROTAX VARIAC & METER UNIT: Type 5G.3281. Reading 0-40 v., 0-40 mA and 0.5 amps., all on 275 deg. scales, **£30** each, **£2** carr.

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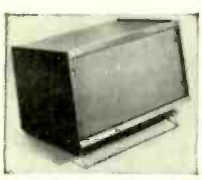
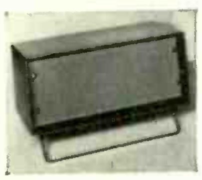
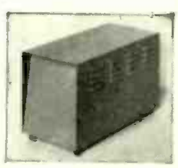

Type	Width Dim. A	Height Dim. B	Depth Dim. C	Type	Width Dim. A	Height Dim. B	Depth Dim. C
	inches	inches	inches		inches	inches	inches
25A	6½	4½	4½	61	15½	7½	9½
25B	6½	4½	6¼	62	17½	8½	9½
26A	8¾	5¾	6¼	63	16½	9½	9½
26B	8¾	5¾	8¼	64	15½	7½	12½
27A	12¼	7½	5½	65	17½	8½	12½
27B	12¼	7½	8	66	16½	9½	12½
28A	14	10½	6½	75A	12⅜	5⅜	6½
28B	14	10½	8½	75B	12⅜	5⅜	9
29A	10	4	6	76A	12⅝	7⅞	6
29B	10	4	8	76B	12⅝	7⅞	9
30A	12	5	6	77A	14⅝	6⅜	6½
30B	12	5	8	77B	14⅝	6⅜	9
31A	14	6	6	81	4	4	6⅛
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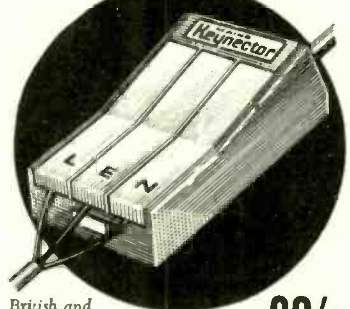

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4V	800	1,250	2,000	3,200
6·4V	640	1,000	1,600	2,500
10V	400	640	1,000	1,600
16V	250	400	640	1,000
25V	160	250	400	640
40V	100	160	250	400
64V	64	100	160	250
Price	**1/6**	**2/-**	**2/6**	**3/-**

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Tubular, 10%, 160V: 0·01, 0·015, 0·022µF, **7d.** 0·033, 0·047µF, **8d.** 0·068, 0·1µF, **9d.** 0·15µF, **11d.** 0·22µF, **1/-.** 0·33µF, **1/3.** 0·47µF, **1/6.** 0·68µF, **2/3.** 1µF, **2/8.**
400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, **6d.** 6,800pF, 0·01, 0·015, 0·022µF, **7d.** 0·033µF, **8d.** 0·047µF, **9d.** 0·068, 0·1µF, **11d.** 0·15µF, **1/2.** 0·22µF, **1/6.** 0·33µF, **2/3.** 0·47µF, **2/8.**
Modular, metallised, P.C. mounting, 20%, 250V: 0·01, 0·015, 0·022µF, **7d.** 0·033, 0·047µF, **8d.** 0·068, 0·1µF, **9d.** 0·15µF, **11d.** 0·22µF, **1/-.** 0·33µF, **1/5.** 0·47µF, **1/8.** 0·68µF, **2/3.** 1µF, **2/9.**

POLYSTYRENE CAPACITORS: 5%, 160V (unencapsulated): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, **5d.** 1,000, 1,500, 2,200pF, **6d.** 3,300, 4,700, 5,600pF, **7d.** 6,800, 8,200, 10,000pF, **8d.** 15,000, 22,000pF, **9d.**
1%, 100V (encapsulated): 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820pF, **1/-.** 1,000, 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900pF, **1/3.** 4,700, 5,000, 5,600, 6,800, 8,200, 10,000, 12,000, 15,000pF, **1/6.** 18,000, 22,000, 27,000, 33,000, 39,000pF, **1/9.** 0·047, 5,000, 0·056µF, **2/-.** 0·068, 0·082, 0·1µF, **2/3.** 0·12µF, **2/9.** 0·15, 0·18µF, **3/-.** 0·22µF, **4/-.** 0·27, 0·33µF, **5/-.** 0·39µF, **5/9.** 0·47, 0·5µF, **6/3.**

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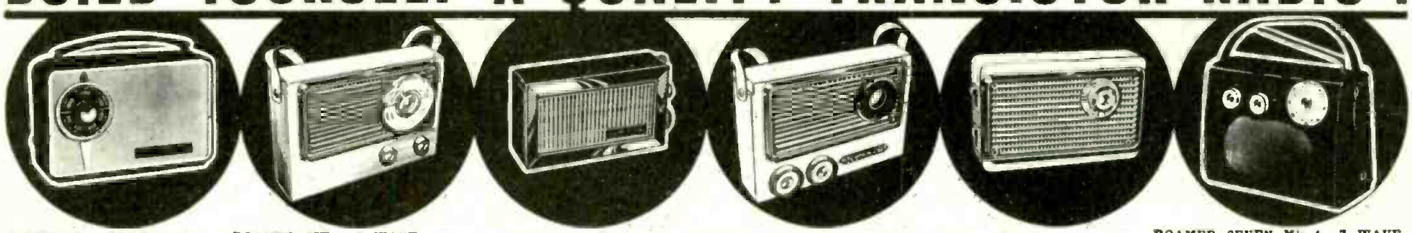

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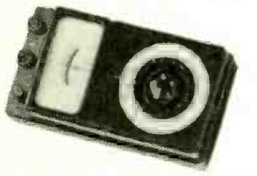

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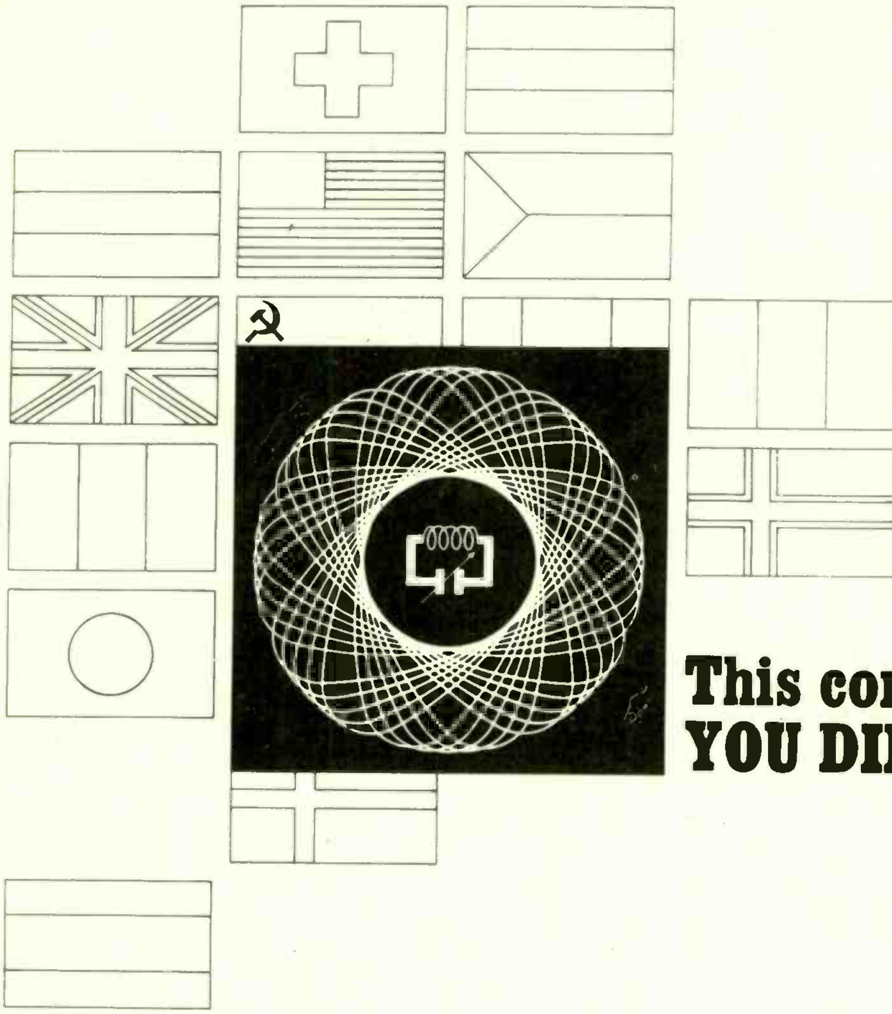

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Working environment and conditions of service are attractive and include an excellent pension scheme and free life assurance. Some assistance may be given with re-location in appropriate cases.

Please apply in writing, stating experience, salary, age and qualifications to:—

The Recruitment Manager (WW 2890J),
Marconi Instruments Limited,
Longacres, St. Albans, Herts.

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SWITZERLAND

SERVICE ENGINEER

Service Engineer, single, wishes work in Switzerland. 20 years' experience Radio, TV, etc. 14 years self-employed. Teetotal, clean licence. Willing to train for specialised equipment. J. BATEMAN, 22 Sutherland Avenue, Burnham-on-Sea, Somerset.

UNIVERSITY OF EAST ANGLIA

Applications are invited for the post of

LANGUAGE LABORATORY TECHNICIAN

in the Language Centre. Candidates should have some knowledge of radio and experience with tape recorders and preferably also experience of recording. Salary will be at a point on scale £722-£1007 or £692-£977 per annum.

Applications should be sent to The Director, Language Laboratory, University of East Anglia, University Plain, Norwich, NOR 88C, as soon as possible.

TECALEMIT (ENGINEERING) LIMITED
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ELECTRONICS ELECTRICIAN

Preferably within the age range of 25-35 for the maintenance and development of electronic equipment and controls.
A working knowledge of transistor techniques is essential and previous experience in Industrial Electronics an advantage.
Academic qualifications are desirable but the primary requirement is for a man of good practical experience and ability.
Please apply in writing stating career to date and present salary to:

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RADIO SYSTEMS DIVISION

The work in the Development Unit at West Leigh is expanding and covers the whole spectrum of electronic equipment design.

If you are working in any field of

Design & Development of Electronic Equipment

and are looking for

New Opportunities

we would like to hear from you

If you are between 25 and 35 years old and qualified to HNC and/or degree standard then write, or post the coupon, please, in confidence to The Personnel Officer, The Plessey Company Limited, West Leigh, Havant, Hants, quoting HAV/145/E.

The laboratories are located in the grounds of West Leigh House. The site is close to the sea and to the South Downs, and is well placed for housing, shops, schools, recreational and cultural facilities.

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Specification :-
Wide general experience
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OPERATE A
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and require a

TELEVISION ENGINEER

for operation and maintenance of the MCR.

QUALIFICATIONS
- ★ HNC, City & Guilds or equivalent
- ★ Experience in operation and maintenance of high grade television equipment
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OPPORTUNITIES
- ★ The Company is planning further expansion in the fields of television and electronics
- ★ Good salary and prospects
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Applications stating age and experience should be sent to:—
RACECOURSE TECHNICAL SERVICES LTD.,
88 Bushey Road, Raynes Park, London, S.W.20.

Government of ZAMBIA

REQUIRES

POSTAL ENGINEERS

TELECOMMUNICATIONS, PLANNING and EVALUATION

Professional Engineers required for telecommunications by the GOVERNMENT OF ZAMBIA, General Post Office on contract for one tour of 36 months in the first instance. Commencing salary according to experience in scale. Kwacha 2784 rising to Kwacha 4464 a year (£Stg.1624–£Stg.2605) plus inducement allowance of £Stg.348–£Stg.429 a year. Gratuity 25% of total salary drawn. A direct payment of £Stg.233–£Stg.350 is also payable direct to an officer's home bank account. Both gratuity and supplement are normally TAX FREE. Free passages. Quarters at low rental. Children's education allowances. Liberal leave on full salary or terminal payment in lieu. Special terms of service apply to serving civil servants including employees of the General Post Office.

Candidates should have a recognised degree in telecommunications or electrical engineering or equivalent qualification. This should be followed by several years of experience with a telecommunications organisation. The duties of the posts are varied. They include planning of trunk and telegraph multiplex systems and radio systems, also the technical and economic evaluation of local and trunk line development policy in the field of underground cables and open wire lines.

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 M2K/61610/WF.

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Westrex Co. Ltd., famous for their Telecommunications, Public Address and Cinema Projection and Recording Equipment, offer new opportunities to help meet their rapid expansion.

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for specialised work associated with motion picture and public address equipment including audio frequency amplifiers, power units, filters, network, etc.
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for specialised electro-mechanical, telegraphic apparatus associated with data processing and computer peripheral units including logic circuitry and sophisticated mechanical devices. Location: Cricklewood

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Excellent salary and prospects to the right applicants.

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telephone 01-452 5401 Extension 12.

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There are opportunities in the National Air Traffic Control Service, a Department of the Board of Trade, for you to play a vital part in the safety of Civil Aviation. You'll work on the latest equipment including Computers, Radar and Data Extraction, Automatic Landing Systems and Closed-Circuit Television, at Civil Airports, Air Traffic Control Centres, Radar Stations and other engineering establishments, including Heathrow, Gatwick and Stansted.

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Write for details to: Mr. T. H. Mallett, B.Sc. (Eng.), C.Eng., M.I.E.E., Room 705, The Adelphi, John Adam Street, London W.C.2, marking your envelope 'Recruitment'.

Name ______________________

Address ______________________

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RWW 7

NATCS National Air Traffic Control Service

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Computer Engineering

NCR requires additional ELECTRONIC, ELECTRO-MECHANICAL ENGINEERS and TECHNICIANS to maintain medium to large scale digital computing systems in London and provincial towns.

Training courses will be arranged for successful applicants, 21 years of age and over, who have a good technical background to ONC/HNC level, City and Guilds or radio/radar experience in the Forces.

Starting salary will be in the range of £900/£1150 per annum, plus bonus. Shift allowances are payable, after training, where applicable. Opportunities also exist for Trainees, not less than 19 years of age, with a good standard of education, an aptitude towards and an interest in, mechanics, electronics and computers.

Excellent holiday, pension and sick pay arrangements. Please write for Application Form to Assistant Personnel Officer NCR, 1,000 North Circular Road, London, N.W.2, quoting publication and month of issue.

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Ampex Quality Control Department now has vacancies for electronics technicians. Successful applicants will be responsible for fault finding and testing a complete range of sophisticated magnetic recording equipment.

Experience gained in the electronic industry or radio or television servicing would be an advantage or a qualification of O.N.C. standard.

Attractive salary based on qualifications and experience will be paid and the company operates an excellent range of Life Assurance and Pension Schemes, etc.

Please write or telephone for application form to the Personnel Officer, Ampex Electronics Limited, Acre Road, Reading, (Tel.: Reading 84411).

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GOVERNMENT OF THE GAMBIA

REQUIRES

BROADCASTING ENGINEER

to serve on contract for one tour of twenty four months in the first instance. Salary in scale up to £2424 a year (point of entry according to experience) which includes an allowance normally tax free, of £672-£900 a year paid direct to officer's bank account in U.K. by British Government. Gratuity of 25% of aggregate emoluments drawn. Low income tax. Generous paid leave. Education and Outfit Allowances. Furnished accommodation at reasonable rental. Free passages. Contributory pension scheme available in certain circumstances.

Candidates, 25-45 years, must possess City and Guilds Intermediate Certificate, O.N.C. in Telecommunications or B.B.C. Grade 'C', and should preferably have experience of medium and short wave transmitters and in operating and maintaining sound broadcast studio equipment in a tropical country. The engineer will be responsible for the operation and maintenance of all the technical equipment in the studio building, which will include three studios, a main control room, outside broadcast and recording equipment, the air conditioning plant and an emergency diesel generator. He will also be required to undertake extensive technical staff training.

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SERVICE ENGINEERS

With the ability to service the complete range of the Company's instruments. Applicants should be of O.N.C. standard and have at least three years experience in the electronics industry, some knowledge of digital transistorised instruments would be an advantage. An engineer with extensive Radio and T.V. servicing experience would be considered. Salary commensurate with age and experience.

Please apply to:
Personnel Officer, DAWE INSTRUMENTS LIMITED, Concord Road, Western Avenue, Acton, W.3
Tel: 01-992 6751

MINISTRY OF DEFENCE
(Air Force Department)
require

CIVILIAN INSTRUCTORS

(Male)

In the trades of RADAR AND COMMUNICATIONS at RAF Cosford, Wolverhampton, Staffs, and RAF Sealand, Deeside, Flints. Candidates must be BRITISH SUBJECTS. Trade training, practical experience and ability to teach essential. Salary £1,158 at age 26 rising to £1,462 (£1,235 to £1,565 from 1st January, 1969). 5 day week and 3 weeks and 3 days annual leave. Appointments unestablished but prospects of becoming pensionable. Write (preferably on postcard) for application forms to Ministry of Defence, CE3h (Air), London, W.C.1, and quote (CIV INST RC/C). Completed application forms must be returned by 10th January, 1969.

PROFESSIONAL APPOINTMENTS

ELECTRONICS

We are one of the World's leading designers and manufacturers of Flight and Radar Simulators and we export a high proportion of our products. Ours is a highly sophisticated complex product, incorporating both digital and analogue computers, which provides a fascinating challenge to Engineers of all grades.

We have vacancies for:

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SYSTEMS ANALYSTS (TECHNICAL)
SERVICE ENGINEERS
SYSTEMS TEST ENGINEERS
TECHNICAL AUTHORS
DRAUGHTSMEN
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We are based in Crawley, 26 miles from the sea and 31miles from London.
We have a contributory Pension Scheme coupled with free Life Assurance, and a good sick pay scheme. Canteen and Social Club facilities are available.
If you are interested in joining us, write immediately giving brief details of career and quoting reference WW169 to:

H. C. Hall, Personnel Manager
REDIFON LIMITED
THE QUEEN'S AWARD TO INDUSTRY
Gatwick Road, Crawley, Sussex
Telephone: Crawley 28811

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This private College provides efficient theoretical and practical training in the above subjects. One-year day courses are available for beginners and shortened courses for men who have had previous training.

Write for details to: The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. Tel.: 01-373 8721.

STAVELEY-SMITH CONTROLS LIMITED

SERVICE ENGINEERS

Vacancies exist for Marine and Industrial Electronic Service Engineers in our London (Barking), Manchester, Liverpool, Birmingham and Glasgow Depot areas.

Applicants must be either ex-seagoing personnel and/or experienced Industrial Service Engineers, residential within ten miles of above depots.

All applicants must hold clean driving licence, be willing to travel and be of British birth.

All positions are Staff, with contributory Superannuation.

Apply in writing, stating experience to:—

68 Grosvenor Street, MANCHESTER, 1.

ADMIRALTY CABLE SHIPS "BULLFINCH" and "St. MARGARETS"

(each 1511 tons gross) based at Plymouth

require:

RADIO OFFICER (man only) aged at least 20 and normally under 35 with at least 2nd Class PMG Certificate.

SALARY: £1,239-£1,892 plus free victualling. Non-contributory pension.

WRITE to Civil Service Commission, Savile Row, London, W1X 2AA, or telephone 01-734 6010, ext. 229 (after 4.30 p.m. 01-734 6464 "Ansafone" Service), for application form, quoting S/370. Closing date 3rd January, 1969.

Test Engineers

AT MARCONI WEMBLEY

Due to a further expansion of the Test Department, applications are invited from ELECTRONICS and TELECOMMUNICATIONS ENGINEERS to fill positions at the Company's Wembley establishment.

Applicants are expected to have a knowledge of Circuitry and be able to undertake testing and fault finding of a wide range of Communications Transmitters and Receivers, Data Handling Equipment, Radar, and a variety of Electronic Aids. Domestic Radio/TV service engineering experience is unsuitable.

We are looking for Engineers with several years' production test experience in these fields or for ex-Regular Service Technicians with appropriate Forces' training and experience.

A 37-hour, five-day week is worked (8.30am-4.24pm) with occasional paid overtime. We are well served by frequent rail and road transport services from most areas.

Marconi

Please apply by letter giving age, education, experience and present salary, quoting reference WW/V/2 to: D. M. McPhail, Personnel Officer, The Marconi Company Limited, Wembley Works, Lancelot Road, Wembley, Middlesex. Tel: 01-902 9421

AN ENGLISH ELECTRIC COMPANY

SITUATIONS VACANT

A FULL-TIME technical experienced salesman required for retail sales: write giving details of age, previous experience, salary required to—The Manager, Henry's Radio, Ltd., 303 Edgware Rd., London, W.2. [67

CITY & COUNTY OF BRISTOL, Bristol Technical College. Applications invited for following post: Senior Technician T.3. (Ref. T686/49/2). Salary Scale: £895—£1,055. Starting salary dependent upon age, qualifications and experience. An additional £50 or £30 will be paid to a candidate with appropriate National Certificate or C. & G. qualifications. Applicants should be over 21 and hold Intermediate City & Guilds in Electronics or Radio Communications, or other appropriate qualifications. Duties include servicing and maintenance of electronic and electrical equipment as used in Merchant Ships and Civil Aircraft. 38-hour, 5-day week with usual holiday and sick pay schemes. Permanent superanuable post. Further particulars and application forms (to be returned within 14 days of this advertisement) from Registrar, Bristol Technical College, Ashley Down, Bristol, BS7 9BU. Please quote reference number T686/49/2 in all communications. [2105

DESIGN DEVELOPMENT ENGINEER for laboratory work in the design of audio amplifiers, V.H.F. tuners and quality tape recorders. Only persons holding a similar position need apply. Salary according to experience. Apply to Elizabethan Electronics Ltd., Ref: W.W.1, Crow Lane, Romford, Essex. Tel. Romford 64101. [2108

DOLBY LABORATORIES require another TEST ENGINEER for professional audio equipment. We are an expanding organisation who require the services of a test engineer of H.N.C. standard who is experienced in the acurate testing and fault finding of transistorised printed circuit equipment. We have recently moved to a modern building in Clapham Road, with excellent working conditions and the position offers a good salary and prospects to the right man. Please contact:— **Mr. P E. Lindsley, Production Manager, Dolby Laboratories Inc. Tel. 01-720 1111, 346 Clapham Road, London, S.W.9** (near Clapham North and Stockwell Underground Stations). 2121

EXPERIENCED TV Engineer required. Permanent position, good salary. Transport available if required. This is an addition to staff to cope with expanding TV service. REM RADIO, 79 Church Road, Ashford. Tel. Ashford 5336 (Middlesex). [79

GUATEMALA: Small radio station requires volunteer radio technician to assist in establishing relay stations and radio schools. Interesting post concerning the development of remote areas. Volunteer terms: board, lodging, pocket-money, fares, allowances.—Write: CIIR/OV, 38 King St., London, W.C.2. [74

PHOTO-STAFF CONSULTANTS LTD. require a Senior Audio Visual Mechanic for S.W. London and Liverpool areas. This post carries a high salary for a man experienced in 16 m/m sound equipment, i.e. Optical, Mechanical, Audio, etc. (Selling ability an advantage). Please phone ref. "M", PHOTO-STAFF, REG 1918, or call at 25 Oxford Street, London, W.1. [2110

PRINTED CIRCUITS—An experienced Screen Printer Photographer is offered interesting work in Devon. Good prospects for advancement. Company house available. Full personal details to Box WW 2112 Wireless World.

PRODUCTION MANAGER—Electronics. An experienced and adaptable Radio Production Engineer is required in Devon by an expanding company. Accommodation available and every prospect for advancement. Full personal details to Box W.W. 2111 Wireless World.

RADIO AND TAPE RECORDER TESTERS AND TROUBLE-SHOOTERS required. Excellent rates of pay; 8 a.m. to 5 p.m. Five-day week. Elizabethan Electronics Ltd., Crow Lane, Romford, Essex. Tel.: Romford 64101. [78

REDIFON LTD. require fully experienced TELECOMMUNICATIONS TEST ENGINEERS. Good commencing salaries. We would particularly welcome enquiries from ex-Service personnel or personnel about to leave the Services. Please write giving full details to—The Personnel Manager, Redifon Ltd., Broomhill Rd., Wandsworth, S.W.18. [26

ST. BARTHOLOMEW'S HOSPITAL, London, E.C.1. Electronic Technician required to operate, maintain and assist in development on two Linear Accelerators. Salary on scale £801 to £1,140 p.a., including L.Wtg. according to qualifications and experience. Write to the Clerk to the Governors quoting Ref. No. ASC/1674 and naming two referees. [2106

TESTERS and Trouble-Shooters required by manufacturers of car radios, tape recorders, record players, etc. Good rates of pay. Apply to Elizabethan Electronics Ltd. Ref: W.W.2, Crow Lane, Romford, Essex. Tel. Romford 64101. [2109

TV RETAIL BUSINESS of the highest standing, established over 40 years N.W. London. Owner requires PERSONAL ASSISTANT with servicing experience. Good position and prospects for keen and capable man. State age and details of experience. Box W.W. 2119 Wireless World.

WE HAVE VACANCIES for Four Experienced Test Engineers in our Production Test Department. Applicants are preferred who have Experience of Fault Finding and Testing of Mobile VHF and UHF Mobil Equipment. Excellent Opportunities for promotion due to Expansion Programme. Please apply to Personnel Manager, Pye Telecommunications Ltd., Cambridge Works, Haig Road, Cambridge. Tel. Cambridge 51351, Extn. 327 [77

WEST London Aero Club invite "A" and "B" licensed engineers with capital and/or necessary equipment to commence Radio Workshop. Alternative propositions may be considered. Write full details to—White Waltham Airfield, near Maidenhead, Berks. [68

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ARTICLES FOR SALE

BBC2 KITS and T.V. SERVICE SPARES. Suitable for Colour:—Leading British makers dual 405/625 six position push button transistorised tuners £5.5.0. 405/625 transistorised sound & vision IF panels £2.15.0. incl. circuits and data, P/P 4/6. Basic dual purpose 405/625 transistorised tuners incl. circuit £2.10.0, P/P 4/6. New UHF tuners incl. valves, slow motion drive assy, knobs, leads, fittings £5.12.6 P/P 4/6. Sobell/GEC 405/625 IF & output chassis incl circuit 45/- P/P 4/6. Ferguson 625 IF amplifier chassis incl. circuit 19/6, Ultra 625 IF amplifier plus 405/625 switch assy incl circuit 25/- P/P 4/6. New VHF turret tuners:—Cyldon C 20/-, Pye CTM 13 ch. incremental 27/6, P/P 4/6. Many others available incl. large selection channel coils. New fireball tuners 58/6, used good condition 30/-, salvaged 15/-. P/P 4/6. LOPTs, Scan coils, Frame output transformers, Mains droppers etc. available for most popular makes. TV signal boosters transistorised Pye/Labgear B1/B3, or UHF battery operated 75/-, UHF mains operated 97/6, UHF masthead 95/- post free. Enquiries invited, COD despatch available.
MANOR SUPPLIES, 64 GOLDERS MANOR DRIVE, LONDON N.W.11. CALLERS 589B HIGH RD., N. FINCHLEY N.12. (near GRANVILLE RD.) TEL. 01-445 9118.

BUILD IT in a DEWBOX quality plastics cabinet. 2 in. x 2½ in. x any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76

ELEKON STAR BARGAIN OFFERS. Assorted wire-wound resistors 12/6 per 100; Japanese miniature tuning capacitors for medium/long wavebands 5/-; 3 in loudspeakers 8 ohms high-flux magnet rated 500 milli-watts output 10/-; a real scoop in Mullard pot cores LAI, LA1019, LA1117, LA1118, LA1153, LA1158, LA2402 7/6 each; LA5, LA6, LA7, LA1221, LA1247, LA2000, LA2303, LA2503 12/6 each; FX1653 15/-, FX2240 7/6, FX2575 12/6, Siemens pot cores 57T5N22, 56T6-200T26 12/6. Special quotations for bulk quantities of any of above. A wide range of precision ball-bearings is offered for disposal, details on request. We thank our many customers for their patronage in 1968 and we welcome all your enquiries in 1969. Elekon Enterprises, 30 Baker Street, London, WIM 2DS 01-486 5353 (24 hours a day).

NEW, genuine, Mullard OC75 Transistors 1/9d. each or 18/- per doz. Add 6d. p. & p. for orders less than 12. Same day service. Television Maintenance, 1a Barras Lane, Coventry, CVI 3BU. [304

OFFERS for Creed Perforator Type 7P/N3. Brand new, unused. Reynolds, 5 Headland Way, Lingfield, Surrey. [2113

ONE 12-channel Oscillograph Type 1200A, manufactured by Southern Instruments Ltd. Price £250. **(Suitable for vibration investigation.)** One A.F. Panoramic Analyser Model 1950/2 manufactured by Industrial Electronics. Price £25. J. Black, 44 Green Lane, Hendon, N.W.4. Tel. 203 1855 or 203 3033. [2114

SMITHS MOTORS, 230-250 volts, 2 watts, ½ rev per minute, brand new, 22/6. Phillips Tape Cassette Motors, 9 volts, manufacturer's price approx. 40/-, our price 20/-. Computer Boards contains 5 Mullard or OC24 transistors, diodes, etc., 12/6 each. Elekon Enterprises, 30 Baker Street, London, W.1. M2DS. Telephone 01-486 5353.

STOPWATCHES? Before you buy send 8d. in stamps for our illustrated catalogue and save money. Lenses and prisms catalogue also available. Lind-Air (Optronics) Ltd., Dept. CWW, 18 and 53 Tottenham Court Road, London, W.1. Tel. 01-580 1116. [2107

THE IDEAL PANEL Mounting Meter Movement for any Sensitive Test Meter, etc. 200 Micro Amp F.S.D. 4⅛"X4⅜" in clear plastic case. Our special price only 39/6. P. & P. Free. Limited number only. Walton's Wireless Stores, 55A Worcester Street, Wolverhampton, Staffs. [71

TRANSFORMERS. Range of outputs up to 1KVA. Quotations by return. SOLENOIDS, ac or dc, substantial range in stock. Quotations by return. Magnatrol (Farnborough) Ltd., 28 Alexandra Road, Farnborough, Hants. Tel. 42590. [301

TRANSISTOR stabilised modular power supplies, output 5-30V preset. 1A-3A-5A units. Made to sell at £26 to £49 each. Unused over-production run. Approx. qty. 60 pcs. Exceptional bargain at £9/19/6 each nett. Descriptive information and specification from Box W.W. 309 Wireless World.

VIDEO TAPE. A wide range of ½ in, ¾ in and 1 in tape at very keen prices. Write for details. Elekon Enterprises, 30 Baker Street, London W1M 2DS 01-486 5353.

22 REELS unused Scotch 1in recording tape. Any reasonable offer. Marquee Studios 437-6601. [2117

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A LONDON RETAIL TELEVISION and Electrical Business of the highest standing requires Executive Director. Eventual complete take-over of business envisaged on retirement of present managing director. This is an exceptional opportunity to acquire a sound profitable business established over 40 years. Principals only should write in confidence, stating age and details of background and experience, indicating amount of capital available. Box W.W. 2120 Wireless World.

HAS ANYONE DESIGNED/DEVELOPED a compact 2 Mc/s Radio Telephone suitable for use on the Marine Band and are short of capital to manufacture/market their design. If so, please write Box W.W. 2102. Wireless World.

TEST EQUIPMENT — SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [64

TEST EQUIPMENT: Solartron Storage Oscilliscope, Type QD910. Reconditioned, £150. Solartron Oscilliscope, Type CD711S.2. Reconditioned, £65. General Purpose Signal Generator. Working, £12/10/0. Advance

TECHNICIAN

Progressive Electronic Component Manufacturers, situated in the Lake District, require a Technician to work in close conjunction with Electronics Engineers and Physicists, in the development, and subsequent production, of precision glass components.

The successful applicant should be capable of working on his own initiative.

A knowledge of laboratory workshop practice, and basic physics, would be advantageous.

Assistance given in finding local accommodation.

Applications, stating age, experience etc., to be sent to:

THE PERSONNEL MANAGER,
OXLEY DEVELOPMENTS COMPANY LIMITED,
PRIORY PARK, ULVERSTON, NORTH LANCASHIRE

ELECTRONIC TEST ENGINEERS

PYE TVT LIMITED, WEYBRIDGE DIVISION wish to appoint Engineers to work on a wide range of professional television equipment for a world wide market.

Engineers appointed would be required to work on colour and monochrome equipment incorporating the latest transistor/pulse circuitry techniques.

Previous experience of professional television equipment is not essential, but applicants must have a sound technical knowledge of transistor circuitry, plus experience of equipment testing.

We offer attractive salaries and conditions, making this a worthwhile career opportunity.

Apply to:
Personnel Officer
PYE TVT LIMITED
WEYBRIDGE DIVISION
Addlestone Road
Weybridge, Surrey

REDIFFUSION

COLOUR and MONOCHROME TELEVISION RECEIVER DESIGN

Two senior engineering appointments are to be made in our new and well-equipped Engineering Laboratories conveniently situated SW of London near to Kingston-upon-Thames. These opportunities are created by the expansion of our activities, including colour television, and applications are invited from engineers experienced in the following fields:

1. TELEVISION RECEIVER DESIGN AND DEVELOPMENT
2. MECHANICAL DESIGN OF TELEVISION AND TEST EQUIPMENT

These positions will be particularly attractive to engineers intent on taking on a high degree of responsibility and establishing themselves in key positions in the Company.
Salaries will recognise ability and experience and assistance with re-housing will be given. Applications should state brief details of experience, qualifications and age and will be treated in strict confidence.
Two further vacancies exist for younger engineers who wish to gain experience in design for production. Day release for studies will be granted.

Chief Engineer:
REDIFFUSION VISION LIMITED
Fullers Way South, Chessington, Surrey. Telephone No. 397 5411

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SERVICE TECHNICIANS

Experienced electronic engineers, minimum qualifications ONC/City & Guilds, to service and repair a wide range of electro-acoustic instruments. Driving experience essential.

Excellent salary and opportunities for advancement. Write or telephone for immediate interview.

Personnel Department, Amplivox Ltd., Beresford Avenue, Wembley. Tel.: 01-902 8991

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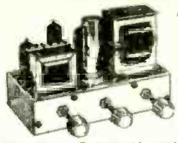

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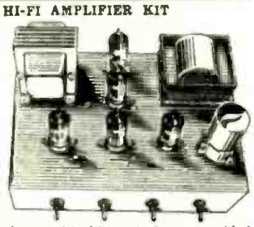

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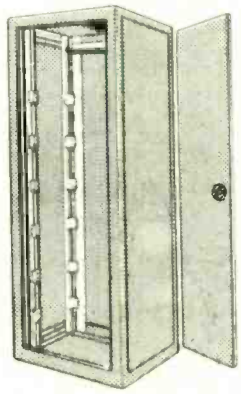

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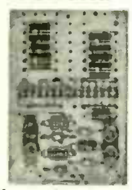

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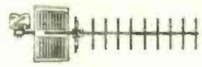

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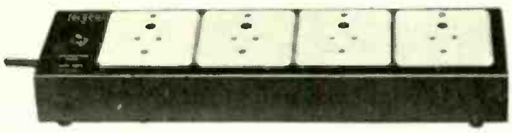

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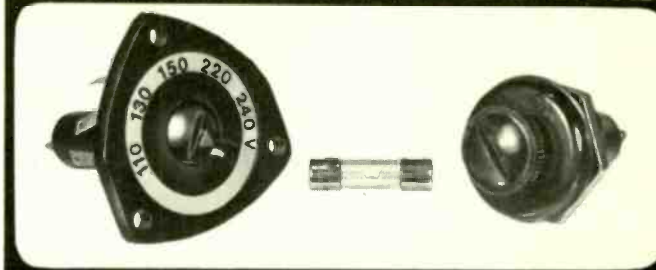

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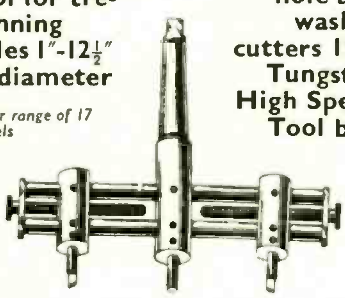

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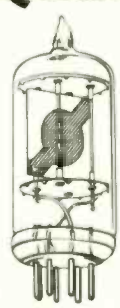

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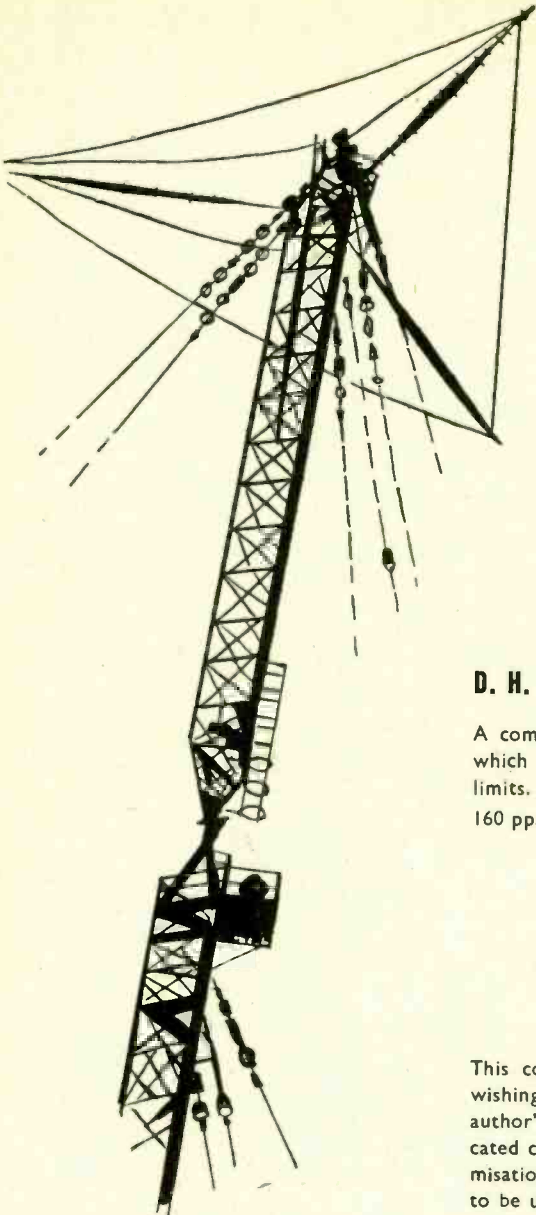

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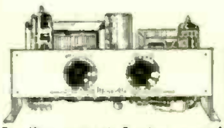

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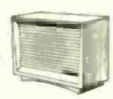

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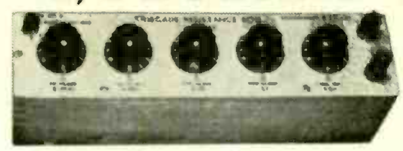

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V.H.F. Simultaneous Translation Systems

We continue to complete export contracts for the supply of simultaneous translation systems to overseas governments.

Based on the combination of the famous Audac Radiomicrophone Systems, combined with a new range of R.F. Inductive Loop equipment, Audac Systems now offer considerable advantages over fixed installations.

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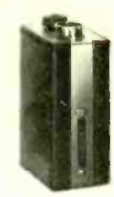
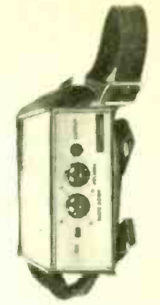
AUDAC the most versatile Radio Microphones in the world

AUDAC MARKETING COMPANY LIMITED / CAREY ROAD / WAREHAM / DORSET / TELEPHONE WAREHAM 2245.

Integrated Radio Microphone TX/65 Cordless. Incorporates SHURE Unisphere Microphone System, eliminates background noise. Operates in difficult acoustic conditions.



Transmitter Pack TX/T Size: $2\frac{11}{16}$" × $1\frac{11}{16}$" × $1\frac{1}{4}$" (69mm × 43mm × 31mm). A separate pocket transmitter unit of minimum size and weight. For use with Lavalier Microphone



Portable Receiver Unit RX/S Size: 4" × $1\frac{1}{8}$" × 5" (102mm × 26mm × 127mm). Narrow or wide band operation. Fitted into leather carrying case. Telescopic or strap aerial.

WW—148 FOR FURTHER DETAILS

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 105-118

	PAGE
A1 Factors	118
Acoustical Mfg. Co., Ltd.	37
Adcola Products, Ltd.	Cover iii
Ahuja Radios	77
Akurate Eng. Co., Ltd.	122
Amatronix, Ltd.	102
Anders Electronics, Ltd.	11-36
A.N.T.E.X., Ltd.	70
Armstrong Audio, Ltd.	22
Audac Marketing Co., Ltd.	126
Audio & Design	56
Audix, B. B., Ltd.	36
Avo, Ltd.	1
Avon Communications & Electronics, Ltd.	76
Batey, W., & Co.	82
Barratt, V. N.	123
Bentley Acoustical Corporation, Ltd.	84
Bentley, K. J.	123
Bi-Pak Semiconductors	94
Bi-Pre-Pak, Ltd.	100
Black, J.	120, 122
Brenell Eng. Co., Ltd.	46
British Institute of Engineering Technology	13
Britec, Ltd.	122
B.S. Radio & Electrical Stores	121
Bulgin, A. F., & Co., Ltd.	Edit 51
Bullers, Ltd.	54
Chiltmead	121
Combined T.V. Services, Ltd.	31
C.R.E.I. (London)	6
Cybanaut Controls, Ltd.	100
Danavox G.B., Ltd.	45
Daystrom, Ltd.	52-53
Decca Records	65
Dependable Relays, Ltd.	40
Derritron (Reslosound), Ltd.	62
Diatron, Ltd.	119
Dolby Laboratories Inc.	60-61
Drake Transformers, Ltd.	33
Duxford Electronics	101
Elcom, Ltd.	40
Electronic Brokers	86, 121
Electronics (Croydon), Ltd.	96
Electroniques (STC), Ltd.	38
Electrovalue	86
Electro-Winds, Ltd.	84
E.M.I. (Tape), Ltd.	69
E.M.I. (Tubes), Ltd.	59
E.M.I. (Sound), Ltd.	62
English Electric Valve Co., Ltd.	3, 5, 7-9
Erie Electronics, Ltd.	49
Ferranti, Ltd.	42
Ferrograph, The, Co., Ltd.	12
Finnigan Speciality Paints, Ltd.	122
Fylde Electronics Laboratories	48
Garage Gifts	120
General Engineering Co.	60
Glaser, L., & Co., Ltd.	125
Globe, Scientific, Ltd.	95, 121
G.E.C.-A.E.I. (Electronics), Ltd.	30
Godleys, Ltd.	125
Goldring Manufacturing Co., Ltd.	44
Grampian Reproducers, Ltd.	122
Greenwood, W. & Sons Ltd.	19-21
Hall Electric, Ltd.	2
Hammond, C. E. & Co., Ltd.	25
Harris Electronics (London), Ltd.	42
Harris, P.	119
Hart Electronics	123
Harversons Surplus Co., Ltd.	119
Hatfield Instruments, Ltd.	48
Henrys Radio Ltd.	93
Howells Radio, Ltd.	78
H.P. Radio Services, Ltd.	44
Iliffe Books, Ltd.	118, 124
I.M.O. (Electronics), Ltd.	75
Industrial Instruments, Ltd.	38
Instructional Handbook Supplies	125
International Correspondence Schools	42, 123
International Rectifiers, Ltd.	4
J.S. Supplies	123
J.X.K. Converters	123
KEF Electronics	26
Keyswitch	Cover ii
Keytronics	120
Lasky's Radio, Ltd.	87
Lawson Tubes	120
Ledon Instruments, Ltd.	46
Level Electronics, Ltd.	39
Lexor Dis-Boards Ltd.	102
Light Soldering Developments, Ltd.	64
Linear Products Ltd.	48
Lionmount & Co., Ltd.	125
London Central Radio Stores	123
London Microphone, Ltd.	100
L.S.T. Components	90
Lyons, Claude, Ltd.	63-72
M-O Valve Co., Ltd.	24
Marconi (Instruments)	73
Marshall, A., & Son (London), Ltd.	86
Mayco Products, Ltd.	120
Mills, W.	98, 99
Milo International	41
Milward, G. F.	101
Modern Book Co.	102
Morganite Resistors Ltd.	23
M.R. Supplies, Ltd.	44
Mullard Ltd.	16, 17, 68
Multicore Solders, Ltd.	Cover iv
Neco Electronics (Europe), Ltd.	102
Newmarket Transistors, Ltd.	10
Nombrex, Ltd.	61, 76
Olson Electronics, Ltd.	100, 122
Ofrect Electronic Systems Ltd.	123
Omron, Ltd.	35
Osmabet, Ltd.	123
Patrick & Kinnie	92
P.C. Radio, Ltd.	90, 91
Peak Sound (Harrow), Ltd.	78
Philips, N. V.	20
Pinnacle Electronics, Ltd.	27, 47
Politechna (London), Ltd.	54
Printed Circuits, Ltd.	36
Proops Bros., Ltd.	79
Pye Telecommunications, Ltd.	57
Pye T.V.T., Ltd.	26
Q Max (Electronics), Ltd.	28
Quartz Crystal Co., Ltd.	122
Racal Instruments, Ltd.	18
Radford Electronics, Ltd.	65
Radiomasts, Ltd.	21
Radio Exchange Co.	102
Radio & TV Components, Ltd.	94
Radio Components Specialists	125
Radionic Products, Ltd.	50
Radiospares, Ltd.	14
Rendar Instruments	55
Rola Celestion, Ltd.	50, 64
R. & R., Radio	121
R.S.C. Hi-Fi Centres, Ltd.	83
R.S.T. Valves	82
Salford Elect., Inst., Co., Ltd.	24
Samsons (Electronics), Ltd.	92
Service Trading Co.	96, 97
Servo & Electronic Sales, Ltd.	123
Sinclair Radionics, Ltd.	80, 81
S.M.E., Ltd.	43
Smith, G. W. (Radio), Ltd.	88, 89
Smith, H. L., Co., Ltd.	56
Smith, John Ltd.	78
Specialist Switches, Ltd.	82
Starman Tapes	102
S.T.C. Radio Division	15
Sugden, A. R., & Co., Ltd.	58
Sugden, J. E.	84
Suhner, P. (Electronics), Ltd.	32
Super Electronics, Ltd.	122
Sutton Electronics, Ltd.	123
Swanco, Ltd.	120
Tektronix U.K., Ltd.	34
Telequipment, Ltd.	66
Teonex, Ltd.	29
Thorn A.E.I. (Radio Valve & Tubes), Ltd.	71
Trend Electronics, Ltd.	74
Trickett	122
Trio Corporation	8
T.R.S. Radio Components	85
Ultra Electronics, Ltd.	58
United Electric	120, 123
Universal Book Co.	121
Valradio, Ltd.	38, 40
Vero Electronics, Ltd.	28
Vitality Bulbs, Ltd.	55
Vortexion, Ltd.	51
Welbrook, Ltd.	76
Watts, Cecil E., Ltd.	77
Webber, R. A., Ltd.	76
Wel Components	46
Weller Electric, Ltd.	55
Welwyn Tool Co.	52
West Hyde Developments, Ltd.	122
West London Direct Supplies	84
Wilkinsons, L. (Croydon), Ltd.	98
Z. & I. Aero Services, Ltd.	103

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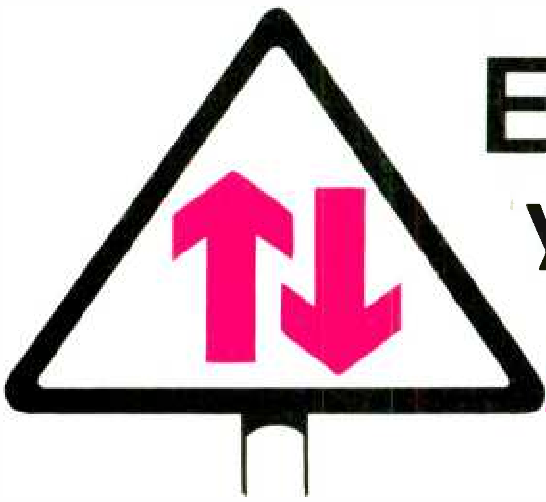

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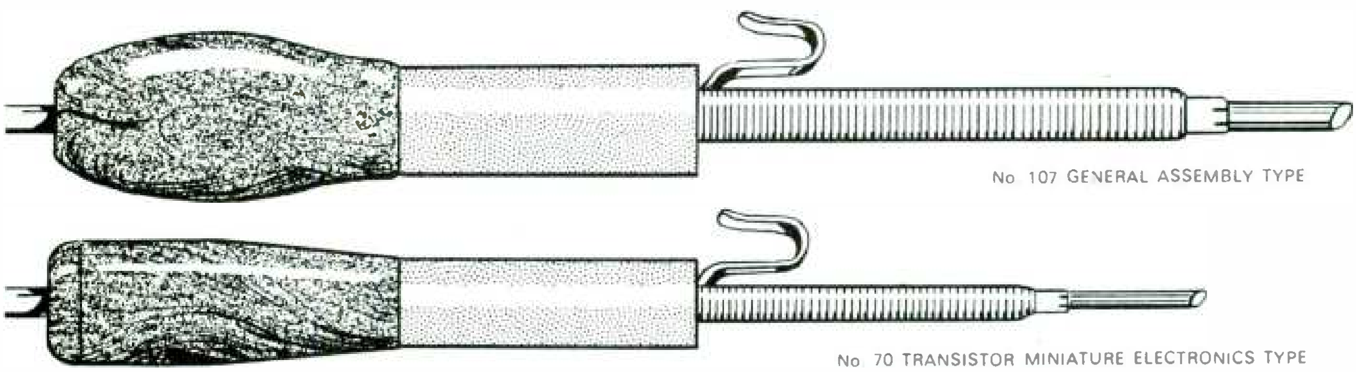

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THE QUEEN'S AWARD TO INDUSTRY 1966

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- Contains 5 cores of non-corrosive high speed Ersin flux. Removes surface oxides and prevents their formation during soldering. Complies with B.S. 219, 441, DTD 599A, B.S.3252, U.S. Spec. QQ-S-571d.
- Savbit alloy contains a small percentage of copper and thus prolongs the life of copper soldering iron bits 10 times. Liquidus melting temperature is 215°C–419°F. Ministry approved under ref. DTD/900/4535
- Solder Tape, Rings, Preforms and Washers, Cored or Solid, are available in a wide range of specifications.

STANDARD GAUGES IN WHICH MOST ALLOYS ARE MADE AND LENGTHS PER LB. IN FEET.

S.W.G.	INS.	M.M.	FT. PER LB. 60/40	FT. PER LB. SAVBIT
10	.128	3.251	25.6	24
12	.104	2.642	38.8	36
14	.080	2.032	65.7	60.8
16	.064	1.626	102	96.2
18	.048	1.219	182	170
19	.040	1.016	262	244
20	.036	.914	324	307
22	.028	.711	536	508
24	.022	.558	865	856
26	.018	.46	1292	1279
28	.014	.375	1911	1892
30	.012	.314	2730	2695
32	.010	.274	3585	3552
34	.009	.233	4950	4895

STANDARD ALLOYS INCLUDE

TIN/LEAD	B.S. GRADE	LIQUIDUS MELTING TEMP °C.	LIQUIDUS MELTING TEMP °F.
60/40	K	188	370
Savbit No 1	—	215	419
50/50	F	212	414
45/55	R	224	435
40/60	G	234	453
30/70	J	255	491
20/80	V	275	527

HIGH AND LOW MELTING POINT ALLOYS

ALLOY	DESCRIPTION	MELTING TEMP. °C.	MELTING TEMP. °F.
T.L.C.	Tin/Lead/Cadmium with very low melting point	145	293
L.M.P.	Contains 2% Silver for soldering silver coated surfaces	179	354
P.T.	Made from Pure Tin for use when a lead free solder is essential	232	450
H.M.P	High melting point solder to B.S. Grade 5S	296-301	565-574

EXTRUSOL®

EXTRUSOL is a new concept in solder for solder machines, baths and pots used in the electronics industry.

EXTRUSOL is a very high purity solder which is also substantially free of oxides, sulphides and other undesirable elements.

The percentages of impurities in EXTRUSOL are considerably lower than those quoted in national or company specifications, thus providing a solder more suitable for use in the electronics industry.

EXTRUSOL can be released under AID authority and conforms with USA QQ-S-571d

ADVANTAGES OF EXTRUSOL

1. Less dross on initial melting
2. More soldered joints per pound of solder purchased
3. Less reject joints
4. Improved wetting of electronic components and printed circuit boards
5. More uniform results

ALL EXTRUSOL IS COMPLETELY PROTECTED BY PLASTIC FILM FROM THE MOMENT OF MANUFACTURE UNTIL IT IS USED

A section of a typical cast solder bar. Note the surface dross and general contamination.

A section of an EXTRUSOL bar with the plastic coating removed showing no dross or contamination.

EXTRUSOL is supplied in 1-lb. and 2-lb. Trapezium Bars and Pellets in different alloys with strictly controlled tin contents to suit the appropriate soldering machines, baths and pots. Bars are available for automatic solder feed.

Ask for full details on solders, fluxes, soldering chemicals, on your company's notepaper.

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