IN THIS ISSUE:
BUILDING AN OSCILLOSCOPE
Never had your favourite programmes spoilt by a background of hissing, crackling and spluttering noises? No? Lucky you! But for thousands living in towns and cities near industrial electrical apparatus, near trolley-bus routes or in the vicinity of high-frequency equipment such interference is only too common.

B.L. Callender’s Anti-Interference Aerial when properly erected, will give you better listening and reveal many stations you never heard before.

The aerial is a 60ft. polyethylene insulated dipole type with suspension insulator and matching transformer. The 80ft. down lead is a fully screened coaxial cable with polyethylene plugs moulded to each end; it is matched to the receiver by a transformer with easily fixed suction mounting.

It acts as a “T” type aerial on long and medium waves and as a true dipole on short waves.

Write to-day for descriptive folder No. 221S on “Anti-Interference Aerial.”

Licensed under Amy Aceves & King, Inc. Patents Nos. 413917, 424239, and 491220.
The world’s most widely used combination electrical measuring instrument. It provides 50 ranges of readings on a 5-inch hand-calibrated scale fitted with an anti-parallax mirror, and is guaranteed accurate to B.S. first grade limits on D.C. and A.C. from 25c/s to 2Kc/s.

The meter will differentiate between A.C. and D.C. supply, the switching being electrically interlocked. The total resistance of the meter is 500,000 ohms.

CURRENT: A.C. and D.C. 0 to 10 amps.
VOLTAGE: A.C. and D.C. 0 to 1,000 volts.
RESISTANCE: Up to 40 megohms.
AUDIO-FREQUENCY POWER OUTPUT: 0—4 watts.
DECIBELS: -25Db. to +16Db.

The instrument is self-contained, compact and portable, simple to operate and almost impossible to damage electrically. It is protected by an automatic cut-out against damage through severe overload.

Various accessories are available for extending the wide ranges of measurements quoted above.

Fully descriptive pamphlet available on application.
**Stabilised Insulation by Modern Impregnation Methods**

**HYMEG**

**HIGH-SPEED PRODUCTION**

Now, special methods of continuous conveyor impregnation and baking developed with the use of HYMEG have still further reduced processing times to a fraction of those previously believed necessary. Often faster than infra-red baking with none of the defects, reduced handling, absence of special jigs, with complete freedom from blistering, bubbling and porosity, are some of the advantages claimed and substantiated for HYMEG High Speed Production methods.

**HYMEGLAS**

**GLASS FIBRE INSULATION SYSTEM**

This integrated system of development is successful in enabling machines to be designed and operated without weak links in the chain of insulation below 200°C. Thus the fullest advantage is taken of modern glass fibre insulation by providing a degree of bonding and insulation at every point in which the unifying of HYMEG impregnation with the HYMEG as used for subsidiary insulations gives a solid homogeneous winding of equally efficient characteristics and heat resistance throughout. HYMEGLAS therefore virtually eliminates any risk of insulation failure and enables motors and the like to operate under abnormal conditions for long periods without risk of electrical breakdown. Due to the excellent space factor of glass fibre as compared with the more usual asbestos and mica Class B insulations, it is often possible in redesigning with the HYMEGLAS system to employ larger copper sections with well-known advantages.

The Berger Technical Service—the research work of which produced HYMEG and HYMEGLAS—is available to advise manufacturers on all problems of insulation. Get in touch now with—

LEWIS BERGER & SONS LTD. (EST. 1760)
35, BERKELEY SQUARE, LONDON, W.1.
Telephone: MAYfair 9171.
MANUFACTURERS OF HIGH-PERFORMANCE INSULATING VARNISHES AND ENAMELS
Moulded in special bakelite and treated to resist humidity.

Exceptional stability is obtained by the design and method of manufacture of the silvered mica plates.

Engineering features provide for compactness, robustness and lightness of weight.

These capacitors are available in two types, in compact form, and cover the capacitance ranges detailed below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacitance Range</th>
<th>Maximum Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>S635</td>
<td>5 pF to 1,500 pF</td>
<td>350 V.D.C. Wkg.</td>
</tr>
<tr>
<td>S635</td>
<td>50 pF to 300 pF</td>
<td>750 V.D.C. Wkg.</td>
</tr>
<tr>
<td>S672</td>
<td>1,800 pF to 10,000 pF</td>
<td>350 V.D.C. Wkg.</td>
</tr>
</tbody>
</table>

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, W.3
Evidence of PROGRESS

The illustration above shows an ACOUSTICAL product of ten years ago—an amplifier designed for high quality reproduction of records and radio programmes. Using push-pull triodes throughout—RC coupled throughout—indeed treble, middle and bass controls etc., it was considered about the best that could then be obtained. Indeed the circuit is often specified today for high quality reproduction.

A comparison of the performance with that of the QA12/P reveals the extent of recent developments.

<table>
<thead>
<tr>
<th></th>
<th>Pre-War</th>
<th>QA12/P</th>
<th>Improvement achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output deviation</td>
<td>3 db</td>
<td>0.3 db</td>
<td>7 times better (%)</td>
</tr>
<tr>
<td></td>
<td>20-20,000 c.p.s. range</td>
<td>15-30,000 c.p.s.</td>
<td>Power change).</td>
</tr>
<tr>
<td>Frequency range</td>
<td>30-15,000 c.p.s.</td>
<td>15-30,000 c.p.s.</td>
<td>Increase of two octaves.</td>
</tr>
<tr>
<td>Total distortion</td>
<td>2%</td>
<td>0.1%</td>
<td>20 times 'less distortion.</td>
</tr>
<tr>
<td></td>
<td>10 watts</td>
<td>15-30,000 c.p.s.</td>
<td>Increase.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.2 v</td>
<td>0.0015 v</td>
<td>120 times more gain</td>
</tr>
<tr>
<td></td>
<td>r.m.s. for full output</td>
<td>r.m.s. at input</td>
<td>with no background</td>
</tr>
<tr>
<td>Background noise</td>
<td>120 microvolts</td>
<td>1 microvolt</td>
<td>Increase.</td>
</tr>
<tr>
<td></td>
<td>0-65 db</td>
<td>-80 db</td>
<td>15 db lower background.</td>
</tr>
<tr>
<td>Load impedance</td>
<td>2</td>
<td>12</td>
<td>Better damping.</td>
</tr>
<tr>
<td>Internal impedance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treble and bass</td>
<td>variable extent of boosts and cuts.</td>
<td>variable slopes of boosts and cuts.</td>
<td>Wider range of control and slopes of controls more accurately designed for small room listening conditions.</td>
</tr>
<tr>
<td>PRICE</td>
<td>£60</td>
<td>£30</td>
<td>50% less cost.</td>
</tr>
</tbody>
</table>

Portables V.H.F. COMMUNICATIONS EQUIPMENT by B.C.C.

The new Model L45 "Walkie Talkie" is specially designed to provide reliable and efficient two-way communication over 1-5 miles between sets. This range is greatly increased when used between a mobile or central station and distances of 15-20 miles have been obtained with a clear audible signal.

The model L45 is but one of the many items of V.H.F. equipment, developed and manufactured by B.C.C. It is the result of many years experience in the design of Miniature Transportable Communications Equipment.

Other outstanding achievements by B.C.C. in this field are the new Low Power Consumption 4-watt Mobile and "Handie Talkie."

Principal Features of the Model L45.

- Size 9½ in. by 4 in. by 11 in.
- Weight 16 lb.
- Crystal controlled transmitter and receiver.
- Operates on any spot frequency in the range of 75-100 Mc/s. A.M.
- On/off and send/receive switches mounted on microphone.
- Patented flexible aerial ensuring full mobility to user.
- Strong, sturdy, watertight case.
- Approved by the G.P.O. and now in use by the Police and Fire Service.
- We develop and design special V.H.F. systems to your specification.

Write for full information and catalogues to:

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GORDON AVENUE, STANMORE, MIDDLESEX.
Tel.: Grimsdyke 1455
Electronic Development and Research Engineers, Contractors to H.M. Government, A.I.D. approved.
The new Collaro R.P.49 Rim-Drive Gramophone Unit is an extremely simple and practical design, beautifully made and finished to the usual high Collaro standard, yet it is available at surprisingly low cost. The powerful induction type Motor is suitable for 100/130 and 200/250 volts, and is fitted with a cooling fan . . . the AUTOMATIC STOP is independent of length of playing surface — is fully automatic . . . four types of PICKUP HEAD are available — all fitted with ball-bearing bases . . . the complete unit, including baseplate, turntable and some types of pickup, finished in a hard scratch-proof enamel. Write today for trade terms and free leaflet which fully describes the new Collaro R.P.49 Rim-Drive Gramophone Unit.

**RIM-DRIVE GRAMOPHONE UNIT**

COLLARO LIMITED
Ripple Works, By-Pass Road,
Barking, Essex.

MAKERS OF FINE QUALITY GRAMOPHONE COMPONENTS, INCLUDING:— COLLARO AUTOMATIC RECORD CHANGERS, GRAMOPHONE UNITS, INDUCTION MOTORS, DE LUXE MICROGRAM PORTABLE ELECTRIC GRAMOPHONES.
THE COMPLETE SERVICE FOR SOUND RECORDING AND REPRODUCTION

- Mobile, static and specialised recording units
- Recording amplifiers, speakers, microphones, etc.
- Sapphire cutting and reproducing styli
- Blank recording discs from 5in. to 17in. Single and Double sided
- Groove locating and cueing devices
- A comprehensive range of accessories to meet every requirement of the sound recording engineer
- A development of special interest to users of sapphire and delicate pick-ups—THE SIMTROL. This is a controlled micro-movement easily fitted for use with any type of pick-up
- OUR CDR48A RECORDER UNIT complete and self-contained, measuring only 22in. x 14in. x 13½in., incorporating 7-valve amplifier, recorder unit, light-weight pick-up, speaker and microphone and with many exclusive features, is now ready for early delivery

OUR WELL-EQUIPPED WORKSHOPS ARE AVAILABLE FOR THE DEVELOPMENT OF EQUIPMENT TO MEET SPECIAL NEEDS.


Wharfedale Twin Speaker CORNER CABINET

Height 42", Width 25". Depth 18½". Impedance 6 or 15 ohms, without Transformer. Cabinet in Walnut, Oak or Mahogany.

Sets a new standard in life-like reproduction. Fitted with W.10 CSB unit for the Treble and W.12 CS for Bass, with the new Wharfedale Separator and Dual Controls. The Bass resonance is 35-40 CPS and wide diffusion of high notes is achieved. Maximum input 80 watts.

Demonstrations at:


BIRMINGHAM 8.—R. F. Sweeney & Co.

BIRMINGHAM 2.—Scotcher’s Ltd.

BRADFORD.—Radio Equipment (Yorkshire) Ltd. J. Scurreh & Son, Bankfoot.

BRAINTREE.—Nicholls Bros.

BRIGHTON.—Brighton Radio Circuit Ltd., 77, Grand Parade.

COVENTRY.—A. & F. E. Hanson Ltd.

PRICE £48 - 10 - 0

Made and Guaranteed by:

WHARFEDALE WIRELESS WORKS
BRADFORD ROAD — IDLE — BRADFORD

Telephone: IDLE 461. Telegrams: Wharfdel, Idle, Bradford
MAZDA VALVES

For SPECIAL PURPOSES

The 6.F.32 has a short cut off Suppressor Grid characteristic which makes it particularly suitable for use in Modulator, Variable Reactance and Timing Circuits.

TYPICAL OPERATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode Voltage (volts)</td>
<td>$V_a$</td>
<td>200</td>
</tr>
<tr>
<td>Screen Voltage (volts)</td>
<td>$V_{g2}$</td>
<td>200</td>
</tr>
<tr>
<td>Control Grid Bias Voltage (volts)</td>
<td>$V_{g1}$</td>
<td>4.5</td>
</tr>
<tr>
<td>Suppressor Grid Bias Voltage (volts)</td>
<td>$V_{g3}$</td>
<td>0</td>
</tr>
<tr>
<td>Anode Current (mA)</td>
<td>$I_a$</td>
<td>5.1</td>
</tr>
<tr>
<td>Screen Current (mA)</td>
<td>$I_{g2}$</td>
<td>3.45</td>
</tr>
<tr>
<td>Mutual Conductance (mA/V)</td>
<td>$g_m$</td>
<td>3.0</td>
</tr>
<tr>
<td>Approximate Suppressor Grid Bias</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watts for 50µA/V with $V_{g1} = -4.5V$</td>
<td></td>
<td>-0.8</td>
</tr>
</tbody>
</table>

CHARACTERISTIC CURVES OF AVERAGE MAZDA VALVE 6.F.32

Curves taken at $V_a = V_{g2} = 200V$

LIST PRICE 10/6

Further details on request.
We believe that the only way to build a receiver is to begin at the beginning with a sound circuit design—a design that’s been tested and re-tested—a design that will stand up to the most critical examination. From this design a prototype is constructed in which every component receives the same rigorous testing. We leave the experts to pass judgment on the resulting Sobell receivers. We are confident that for ease of control and absolute fidelity of reproduction this model will be found to have no equal—that, in fact, you will pronounce it to be ‘technically outstanding’.

5-valve, 3 wave-band superhet receiver, with switched gramophone pick-up sockets. Output 4½ watts. Housed in neat plastic cabinet with gilt loudspeaker grille of new and original design. For A/C mains.

**SOBELL MODEL 519P 5-VALVE RECEIVER**

**SOBELL RADIO**

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**IMPORT** “Our tests and measurings show that the Pick-up lies on top of what we before or after the war have been able to purchase.”

**EXPORTS CONTINUE**

In the Home Market also we sell Type ‘N’ and ARMA Pick-ups, moving coil and moving iron heads for Record Changers, Sapphires, Special Steel Needles, and our Type ‘O’ Groove Indicator.

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Utility Works, Holyhead Road, Birmingham, 21
The thermal coefficient of expansion of Nilo K is uniform with that of medium hard boro-silicate glasses over the range 20°-500°C.

NILO K— the alloy for sealing glass to metal

Nilo K, the alloy designed for sealing to medium hard boro-silicate glasses, is used for small but vital parts of the radio-frequency heating equipment made by Delapena & Son Ltd., Cheltenham. It is this alloy which makes possible the easy manufacture of the vacuum-tight glass-to-metal seals in the Ediswan valves. Write to us for further information about Nilo K and for a copy of the publication giving the expansion properties.

HENRY WIGGIN & COMPANY LTD

WIGGIN STREET • BIRMINGHAM 16
RELIABLE LINES FROM VALLANCE'S

MT:MI MIDGET MAINS TRANSFORMER.
A small upright type transformer, suitable for Signal Generators, V.F.O.'s, midget receivers, and many other applications where size is the limiting factor.

PRIMARY: 200-230/250 volts with electrostatic screen.
SECONDARIES: 60-0-60 volts 60 ma. 0-4-5 volts at 2 amps., 0-6.3 volts at 3 amps.

DIMENSIONS: 2½in. x 2in. x 3in. high with four mounting feet. New and improved design. Price 34/- post free.

ENAMELLED COPPER WIRE.

BAKELITE SHEET.
1/8in. thick. 12in. x 6in. 5/1, 10in. x 8in. 4/3, 10in. x 6in. 3/5, 8in. x 6in. 2/10, 6in. x 6in. 2/3, 6in. x 4in. 1/8.

CARBON THROAT MIKES.
A lightweight compact unit of American manufacture, complete with strap, cord and two pin plug. Brand new 1/11 post free.

DINKIE SPEAKERS.
For Communication Receivers. Housed in an attractive die cast cabinet, finished in black or grey crackle, and fitted with the latest F.V.O. concentrated flux unit (8,500 lines). Speech coil impedance 2 to 4 ohms. Price, less volume control, 25/-, plus 1/- post and packing.

"G-Max" CHASSIS CUTTERS.
For an easy, quick way of cutting holes in sheet metal or aluminium. The cutter consists of a die, a punch, and an Allen screw. Available in the following sizes: 1½in., 1½in. all at 12/6, plus 1/- for key. 1½in. button base 9/6, 8in. BRG 9/6, plus 9d. for key. Postage and packing 9d. extra (minimum).

DENC0 POLYSTYRENE SOLUTION.
1 oz. bottle 9d., 1 oz. 1/2, 2 oz. 1/10. Postage 6d. extra (minimum).

A.M.C. DIAL AND DRIVE ASSEMBLY.
An exceptionally fine dial for the home-constructed superhet. The scale is finished in brown with cream markings. Calibrated in frequency wavelength and station names. S.W. 16 to 50 metres. M.W. 200 to 590 metres. L.W. 800 to 2,000 metres. Indications are provided along the bottom edge of the scale for tone and volume controls, wave change switch and tuning control. Size of opening required 10½in. x 4in. Complete with rigid mounting brackets, tuning spindle, drive cord, pointer, drive drum and flexible coupler to drive condensers. Assembled ready for use, 21/9. Post and packing 1/-.

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The Sherlock Holmes of Radio, saves worry, trouble and solves all difficulties; can be used for testing motor car lighting circuits; H.T. and L.T. batteries, A.C. Mains direct; valves and a host of other applications.

Measures: AC and DC voltages. 0-6 volts also 0-240 volts D.C. current 0-30 ma. Valve testing, 4 and 5 pin English valves for filament continuity. A test instrument at a reasonable price, 25/-, plus 1/- post and packing.

When sending C.W.O. please include sufficient extra for post and packing.

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NEW SERIES 101
Our new Laboratory Power Supplies, Series 101, are based on our well-known Model 101-A, but incorporate a number of improvements and refinements.

DETAILS ON REQUEST.

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"I am extremely satisfied with the performance and tone, and feel proud to have such a very efficient and beautiful Extension Speaker in my home."

From one of many letters sent us by enthusiastic owners of the "BAFFLETTE" CONSOLE EXTENSION SPEAKER.

Precision-built, with independent volume control; stands in corner or flat to wall; walnut veneer cabinet. Mahogany £7 10.

Transformer 8½ extra.

OTHER BAFFLETTE MODELS INCLUDE: De Luxe £6 15 0

Standard £4 4 0

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Mahogany at small extra cost.

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Made and Guaranteed by
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Caledonia Road, Batley, Yorks.

Tel. Batley 1123

Grams: Acoustics, Batley
CERAMICS FOR ELECTRODE SUPPORTS and all radio components FREQUENTITE – FARADEX – TEMPRADEX

STEATITE & PORCELAIN PRODUCTS LTD.
Stourport on Severn, Worcester Telephone: Stourport III Telegrams: Steatain, Stourport
Webb's Radio

**NEW RADIO GLOBE**

An improved and enlarged version of our famous pre-war globe brought right up-to-date with new continental boundaries and 1948 Amateur Radio Prefixes. The enlarged diameter (13½”) greatly increases map area and a compass fitted in the base makes correct orientation simple. Invaluable for quick location of unfamiliar calls and a handsome adjunct to receiver or transmitter. Price 47/6 to callers. 50/- by rail.

**VALVES!**

No experimenter should miss this opportunity; even if not of immediate use these valves represent a sound investment for future experimental work. You will never buy cheaper. All are new and boxed—please do not confuse them with valves culled from broken down service equipment.

<table>
<thead>
<tr>
<th>Valve Code</th>
<th>Type</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>9003</td>
<td>UHF “button base” R.F. Pentode</td>
<td>4/6</td>
<td></td>
</tr>
<tr>
<td>957</td>
<td>Acorn Triode (1.25V/0.05A)</td>
<td>4/-</td>
<td></td>
</tr>
<tr>
<td>7193</td>
<td>As 6J5GT with anode and grid at top</td>
<td>3/6</td>
<td></td>
</tr>
<tr>
<td>832</td>
<td>UHF double Pentode</td>
<td>25/-</td>
<td></td>
</tr>
<tr>
<td>8012</td>
<td>UHF Triode for 500 Mc/s.</td>
<td>18/6</td>
<td></td>
</tr>
<tr>
<td>807</td>
<td>R.F. and A.F. general purpose</td>
<td>7/3</td>
<td></td>
</tr>
<tr>
<td>NEONS</td>
<td>Assortment of 4 standard type Neons, 2 miniature types, two 2” Neons for</td>
<td>2/-</td>
<td></td>
</tr>
<tr>
<td>100th</td>
<td>Popular “EIMAC” Triode</td>
<td>35/-</td>
<td></td>
</tr>
</tbody>
</table>

WEBB'S Radio, 14, Soho St., Oxford St., London, W.1

**SPHERE INSTRUMENTS**

NOW AVAILABLE!

The new “75” Range

**TESTGEAR**

Brief Specification of Item I

**SIGNAL GENERATOR “75”**

Model I

- **Frequency Range**: 110 to 50 Megacycles. With calibrated extension covering London andMidland Television frequencies, at over 60 Megacycles.
- **Modulation**: 400 C.p.s. sinusoidal.
- **Attenuator**: 5-step ladder, with fine control.
- **Output**: Switched via single test-lead. R.F. and A.F. 1 volt Max.
- **External Radiation**: Less than 1 microvolt for AC. mains operation. Complete with Standard Dummy Aerial.

**LOW COST EFFICIENCY**

**INQUIRIES INVITED**

SPHERE RADIO LIMITED
HEATH LANE, WEST BROMWICH, ENGLAND

**Measuring Electrolytic Leakage**

The generally accepted maximum permissible leakage current after forming is given by 

$$ I \leq 0.15 \times C \times V \times \text{wkg.} $$

This bridge measures leakage direct at voltages of 6, 12, 25, 50, 150, 250, 350 and 450. Capacity can be measured up to 500 mfd.

**COMPONENT BRIDGE B101**

- **C**: 5 pfd. to 500 mfd. — 8 ranges.
- **R**: 5 ohms to 500 MΩ — 8 ranges.
- **L**: 0.1 Hy. to 5000 Hys. — 4 ranges.
- Leakage: 0 to 15 m/a. Q: 0 to 30.

WAYNE KERR LABORATORIES LIMITED, NEW MALDEN, SURREY
Serve — with a sprinkling of nuts — to engineers who say that all small power tools get too hot to handle. Point out that some power tools — no names mentioned — are worked by little horses who keep cool even when running for hours on end at a perfectly furious pace. Remind discreetly — when presenting the bill — that bigger horses are known to get hot under the collar at the mere thought of such activity.

Specialists in Lightweight Pneumatic and Electric Portable Tools.

DESOetter

PHONE: COLINDALE 6346-7-9 GRAMS: DESPNUCO, HYDE, LONDON.
C.R.C.193
CELESTION

The quality of reproduction secured from Celestion Speakers greatly increases the pleasure of radio in the home.

The model illustrated has an attractively designed Cabinet with a special mahogany finish, it employs an 8" speaker of high sensitivity and excellent response. It is fitted with a volume control and is one of the finest 8" extension speakers available.

All interested in other Celestion Cabinet and Chassis models should write for Illustrated Brochure "W.W."

WHERE TO BUY CELESTION SPEAKERS

The Public are requested to order from their local Radio Dealer.

Wholesalers are supplied by the Sole Distributors: CYRIL FRENCH LTD., High Street, Hampton Wick, Middlesex. Phone: KINGston 2240.

Manufacturers should please communicate direct with:

CELESTION LIMITED, SUMMER RD., THAMES DITTON, SURREY.

HAVE YOU COMPARED OTHER MINIATURE NEEDLE PICK-UPS WITH THIS?

SHEFII Voigt Patent No. 538058

MOVING-COIL PICK-UP

It has many exceptional qualities. Try it now. Available from enterprising dealers or from distributors.

BROOKS & BOHM LTD
90, Victoria Street, London, S.W.1
Phone: VICToria 9550/1441

STANDARD 8 CABINET MODEL

Mahogany finish

Size: Height 10" Width 12" Depth 5½"

PRICE £3:18:0

Price with Universal Transformer £4:14:0

Technical Details of Chassis Model for use with your own cabinet: Dia. 8", Baffle opening 7½" Voice coil impedance at 400 cps., 2.3 ohms. Pole dia. 1". Flux density guss, 8,000. Total gap flux, 31,000. Peak power capacity 4 watts.

Price less transformer (£ suitable for outputs 1-5 ohms.) £1:17:6

Price with Universal Transformer (Suitable for all Receivers) £2:3:6

Telephone: EMBERBROCK 3402-S

"You’re CERTAIN to get it at ARTHURS!"

VALVES: We have probably the largest Stock of valves in the Country. Send your enquiries. We will reply by return.

Ex-Govt. brand new A.C. TEST BOARD approx. 12 in. x 6 in., completely wired comprising:—A.C. voltmeter, 300 v. 15 amp. bridges and fuses, 15 amp. 2-pin surface sockets, 2 fuse wire holders. Complete........................ £1 2/6

PERSONAL RADIO SETS IN STOCK

New Olympic Rome, Long and Medium Wave £17 16 11

Ever Ready ........................................ £12 18 10

Marconi ........................................... £15 19 5

REMINGTON FOURSOME SHAVING 210-220 v. AC/DC ................. £7 17 6

ALL AVO AND TAYLORS METERS. List on request.

PHILIPS CYCLE DYNAMO SET.............. £2 1 6

ALSO STOCKISTS OF ALL DOMESTIC APPLIANCES.

London’s Oldest Leading Radio Dealers.

PROPS: ARTHUR GRAY, LTD.

TERMS: C.O.D. or cash with order.

Our Only Address: GRAY HOUSE, 150, CHARING CROSS RD., LONDON, W.C.2

TELEPHONE: 5833/4.
THE RADIO LINK. Although in the main the problems of sound reproduction are concerned with low frequency systems, it is necessary to take a brief look at the radio side of a receiver to see what difficulties arise there which may have repercussions on the quality of the whole system. It is obvious that none of the faults which have been mentioned in our previous notes must be present in the radio set, and with one very important exception it is generally not very difficult to produce a high quality radio amplifier. The exception is, of course, the inevitable compromise between selectivity and high audio frequency response.

Perfect Reproduction?

PROBLEMS REFERRED TO IN PREVIOUS NOTES

Spatial Distribution of Sound.
Echoes in the Listening Room.
Limitations of Single Channel.
Limitations of the Human Ear.
Distortions and Faults caused by Apparatus.

In the good old days, before "side bands" had been admitted as respectable members of society, there were many who held that it was possible to produce a selectivity curve of any desired narrowness, without attenuating the higher audio frequencies. To-day we all know that with a conventional double side band receiver the acceptance band of the R.F. amplifier must be at least twice the width of the audio spectrum it is desired to handle. Therefore, if we say that for reasonable reproduction, frequencies up to 10,000 cps. are necessary, it follows that our radio frequency circuits must accept a band 20,000 cps. wide, and hence that a separation between radio frequency transmitters must be greater than 20 kc/s.

But medium and long wave band transmitters are normally spaced by only 9 kc/s, so that at first sight it would be impossible to reproduce audio frequency greater than 4,500 cps. without interference from the adjacent stations. That it is in practice possible to achieve better results than this is merely due to the fact that we tend to listen to very strong stations with comparatively weak interfering ones next door.

The sad fact is that there is no cure for this 'disease'. By careful international planning attempts are made to separate geographically those stations which are adjacent in frequency, and if possible to restrict by suitable transmitter aerial design the radiation from one station penetrating into an area where it is not required to be received.

There are, of course, known methods whereby the band width occupied by a transmitter can be reduced so that it occupies not twice the audio spectrum, but is equal to it. Such systems are known as single-side-band systems and they are used very extensively in certain types of commercial working, and in some television systems. It is certainly not impossible that single-side-band working will be extended to normal/medium wave broadcasting in the years to come.
DYNATRON
CABINET
RACKS
Rack Mounted System

DYNATRON offer a range of handsome cabinet racks with fixing centres and widths to Post Office specifications, to house Sound Amplifiers (also made by DYNATRON), all electronic panel mounted equipment, transmitter units and all forms of radio apparatus. The cabinet completely encloses and protects the equipment.

For several years they have been standard equipment in Government Radio and Radar Research Establishments throughout the country.

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- Standard panel width of 19" and offered in three heights of 3', 4' and 6'.
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- Runner bars and shelves adjustable.
- Earthing busbar and cable entries provided.
- Mobile Unit available as extra.
- Blank panels available.
- Standard finish Grey tint 32 and Chrome fittings.

 provides complete protection to the user and enhances the appearance of any installation.

Manufactured by

DYNATRON RADIO LIMITED
Perfecta Works — Ray Lea Road,
MAIDENHEAD, BERKS.
Tel.: Maidenhead 1211 and 392
**Osram VALVES**

**TECHNICAL TOPICS**

**B65 DOUBLE TRIODE**

The Osram valve B65 is a double triode designed for use in push-pull, parallel or cascade circuits. The valve is octal based, compact in design, and apart from the common 6.3 volt 0.6 amp. heater, the two sections are entirely independent.

A data sheet giving detailed information and typical curves may be had on request to:

THE OSRAM VALVE TECHNICAL DEPT., MAGNET HOUSE, KINGSWAY, W.C.2.

**TYPICAL OPERATING CONDITIONS (One Unit)**

<table>
<thead>
<tr>
<th>Anode Voltage</th>
<th>Control Grid Voltage</th>
<th>Amplification Factor</th>
<th>Impedance</th>
<th>Mutual Conductance</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 volts.</td>
<td>-8 volts.</td>
<td>20</td>
<td>7,700 ohms.</td>
<td>2.6 mA/volt.</td>
</tr>
</tbody>
</table>

**Price** 15/- (Purchase Tax 3/- extra)

**Osram**

PHOTO CELLS

**S.E.C.**

CATHODE RAY TUBES

**Osram**

VALVES

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, W.C.2
VIBRATORS FOR RELIABLE REPLACEMENTS

Entirely British in design and construction, and fully approved for Government Service equipment, W.E. Vibrators are ready for all your replacements. They are fitted as standard components by leading radio manufacturers.

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GARTH ROAD LOWER MORDEN - SURREY - TELEPHONE: DERWENT 4814, 5010.

A NEW B.P.L. INSTRUMENT

THE VOLTASCOPE—A combined valve-voltmeter and oscilloscope. VALVE-VOLTOMETER—Infinite Input Resistance for D.C. ranges 0 to 300 volts. A.C. ranges 0 to 150 volts in 5 ranges. 3½ inch scale meter. OSCILLOSCOPE—3 inch screen tube provided with balanced amplifiers for Y and X plates giving a 5 times trace expansion. Maximum sensitivity 150mV/cm. Response from D.C. to 100 kcs. Limited quantity available for early delivery.

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HOUSEBOAT WORKS, RADLETT, HERTS.

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WORLDWIDE S.C. TUBES, V.C.R97, 0.25 in. diameter, screen lead, screen, 4 1/3 in. 6.3 V., 2 a. Tapped at 32, 34, 36 v. 15/-

E.H.T. TRANSFORMERS. For 200-250 volts, 40-60 cycle mains. Four wavebands 13.6-52 net. Used in a Hospital for ward tx. £25.00.

MIDGET TRIPLE CARTRIDGE KIT. Consists of a complete kit of parts to construct an Midget Kit. £15.00.

MIDGET ELIMINATOR AND TRICKLE CHARGER KIT. Consists of a complete kit of parts to construct an Midget Kit with Eliminator with an output of 120 v. at 20 ma., and Provision for Trickle Charging a 2 v. Accumulator. £20.00.

MIDGET RADIO CABINETS in Brown Bakelite. Can be supplied for either of the above Midget Kits at 25/- each.

NEW 1948 MIDGET SUPERHETER KIT, with Illuminated Gnome Dial. All parts including Mains Transformer, Speaker and Instructions. 4 valves plus Metel Rectifier. 260-557 m. Size 12 3/4 x 12 in. £35.00.

MIDGET RADIO CABINETS in Brown Bakelite. Can be supplied for either of the above Midget Kits at 25/- each.

RECEIVER TYPE 1014. Radar Unit containing 14 valves; 1 cathode-ray tube, 7 V.C.R., 11 V.T.U., 1 valve, 3 power amplifiers, 3 E.H.T. transformers, 200-550 volts, 40-60 cycle mains. £35.00. Suitable for use as a V.M. Receiver. £35.00.

R-1155 POWER UNIT INCORPORATING OUTPUT TRANSFORMER. A robust unit designed to be used in a Hospital for ward tx. £15.00. Suitable for the R-1155 Receiver and output stage. £5.00.

Power unit only £2 10 0

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December, 1948

Wireless World

Advertisements

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SPECIAL OFFER OF ELECTROLYTIC CONDENSERS. 16+16 mf. 500 v. working. Cardboard £1.25.

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10 12 V. 70 a. An ideal Transformer for grcund heating or welding £60.

18 200-1500 V. 120 ma. 4 v. 2-3 a. 4 v. 2-3 a. 15/6.

100-1150 V. 50 cycle mains. Half Wave. For use with Valve or Metal Rectifier. £25.

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OSCILLOGRAPH POWER UNITS. Input 230 volt, mains, 100-250 v. or 12 v. accumulator. £15.00, £11.00.

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ON THE CENTRAL RADIO STORES

Government Surplus—From Stock

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Range 31 Mc/s to 90 kc/s, 9 Plug-in coils, 7 valves and rectifier, variable selectivity, B.F.O. stand-by switch, A.V.C. switch, bandspread dial, valve check meter. In heavy black crackle finished steel cabinet with chrome fittings. Complete with 200-250 V. A.C. Power Supply Unit. Complete with 250 V. A.C. Power Supply Unit. £25

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Suitable for Voltage Controls, Speed Regulators. Type 887A. 100 ohms on slider. 3 amp. max. Tapped fixed 200, 100, 50, 50 ohms, 21 - Small Type. 50 ohms, 3 amp. Dimensions 4in. 2in. 2in. high ......... 8.9

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- Compact with high power handling capacity.
- Ticonal G magnet forms centre pole giving efficiency, economies in weight and cost.
- Impossible for diaphragm to get out of centre with coil gap.
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Our famous 0F/12 winding multi-ratio, 3K to 12K match 2, 3, 5, 7, 10, 15 ohms. Now fitted with cast clamps and terminals. Balanced quality job, good for 50 watts.

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BRITISH MADE

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Subminiaturos-Midgets-Miniatures
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CONSISTENTLY Accurate
PULLIN SERIES 100 TEST SET

SENSITIVITY 10,000 OHMS/VOLT
with
A.C./D.C. Voltage Multiplier
for 2,500 V. and 5,000 V.
Volts A.C. and D.C. Range:
10, 25, 100, 250, 500, 1,000.
Milliammps D.C. only:
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Ohms: 0-10,000 and 0-1 megohm.
A.C. Current Transformer
Range: 0.025, 0.01, 0.5, 1.0, 5.0,
25.0 Amps.

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TELCON THERMOSTATIC BIMETALS

A COMPLETE RANGE NOW AVAILABLE TO MEET ALL REQUIREMENTS

PHYSICAL CHARACTERISTICS OF AVAILABLE TYPES

<table>
<thead>
<tr>
<th>TYPE</th>
<th>COMPOSITION</th>
<th>Deflection Constant* per °C. (d)</th>
<th>Resistivity microhms/cm. cube at 20°C.</th>
<th>Maximum Working Tem. °C.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Expansion % Ni</td>
<td>High Expansion % Ni</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIMETAL 140</td>
<td>38</td>
<td>20</td>
<td>14.0 x 10^-6</td>
<td>75</td>
</tr>
<tr>
<td>BIMETAL 160</td>
<td>36</td>
<td>20</td>
<td>15.6 x</td>
<td>78</td>
</tr>
<tr>
<td>BIMETAL 400</td>
<td>42</td>
<td>20</td>
<td>11.0 x</td>
<td>70</td>
</tr>
<tr>
<td>BIMETAL 15</td>
<td>36</td>
<td>100</td>
<td>9.7 x</td>
<td>15</td>
</tr>
</tbody>
</table>

* The deflection constant (d) is defined as the deflection of a strip of unit length and unit thickness for each °C. rise in temperature over the linear part of the deflection curve.

Further details on application.

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Output approximately 6kV at 100 micro-amperes.

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OUTSTANDING CHARACTERISTICS.

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VITREOUS RESISTORS, 20 watt, 500, 2,000, 4,700, 5,000, 0,000, 20,000, 20,000, 20,000 ohm. 25 each, or 200 dozen. 50 Watt, 3,000 ohm—3 each. 100 Watt, 7,000, 20,000, 20,000, 20,000 ohm. 5 each.


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Midget Polar, double metal end plates with ceramic insulation. Bar type ball bearing, baseboard mounting.


Midget Polar All ceramic End Plates, panel mounting.

Code F100 100 mmfd. single spaced. 2/6.

Code F101 100 mmfd. double spaced. 2/6.


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R.50
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This high-grade communications receiver incorporates the most highly developed techniques in modern receiver design. Five degrees of selectivity, including a crystal gate and crystal filter are provided, and the sensitivity is such that an input of between 1—5 microvolts gives a signal/noise ratio of at least 10 dB over the entire frequency range of 13.5 to 26 kc/s and 95 kc/s to 32 Mc/s. Separate power units for A.C. or D.C. operations are available.

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DESIGNERS & MANUFACTURERS OF RADIO COMMUNICATION & INDUSTRIAL ELECTRONIC EQUIPMENT Phone PUTney 5691

Sets a New High Standard

Redifon Radio

Maximum sensitivity with uniform frequency response from a more compact speaker, appreciably reduced in weight—that is what Rola technicians have achieved with the new G.12. Special features include dust-proof suspension completely protecting coil and magnet gap and the powerful Alcomax II magnet. Write for details and also for particulars of Rola 3" and 4" P.M. models, dust-proofed and equipped with Alcomax II magnets.

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quality is high, even when judged by British standards. The
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The current Allen Components catalogue includes:

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**Tuning Unit Type 310:** Chassis assembly of Type
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**Coil Unit Type 300:** Three wave range superhet
available in two forms—Short, Medium and
Long or Medium and two Short ranges. Output Transformers Types 201-2: For use with
push-pull 6V6s and 6L6s.

**IF Transformers Types 402-3:** Compression
trimmer tuned, iron dust cored, critically
coupled transformers. 465 Kc/s frequency.

**TELEVISION**

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and frame deflector coils suitable for scanning
9, 10 or 12 inch tubes.

**Focus Coil Type F1:** Low impedance coil for
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Type LI: 1:1 Ratio transformer for line
frequency blocking oscillator circuits.

**Line Output Transformer Type L2: 39:1 Ratio
line frequency output transformer.**

**Frame Frequency Oscillator Transformer: 2:1
Ratio Transformer for frame frequency block
oscillator circuits.**

**Frame Output Transformer: 13:1 Ratio frame
frequency output transformer.**

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**ALLEN COMPONENTS LTD., Tower Works, Tower Road, London, N.W.10**

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**For precision alignment of Tuned Circuits and visual observation of Electrical Phenomena.**

Illustrated are the latest models of the 1200B Oscilloscope and the 1400B Visual Alignment Signal Generator.

Special features of the Oscilloscope are:

- High gain D.C. amplifiers on both axes.
- Linear time-base with perfect synchronisation at any frequency.
- Complete independence of all controls from each other.
- The 1400B Unit will show the shape and characteristics of a tuned circuit response curve on the Oscillograph screen. Thus perfect alignment of an L.F. or R.F. amplifier is easily accomplished. Overall size of combined instruments: 7" wide, 11" high, 9" deep.
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The simplest voltage stabilising circuit is that shown in Fig. 1(a) and its action may be explained by reference to Fig. 1(b). The stabiliser tube V1 behaves in a similar manner to a battery with a small but finite internal resistance r; the voltage appearing across the load \( E_L \) will be the sum of the burning voltage of V1 and the voltage drop across r. With the circuit values given in Fig. 1(a), the change in \( E_L \) will not be greater than 2V for load changes between 7 and 14mA or input voltage changes between 170 and 220V.

When a very much higher degree of stability is required the circuit of Fig. 2 may be employed. Its stabilising action is as follows: (1) An increase in \( E_t \) causes a corresponding increase in \( E_L \). (2) A fraction of the change in \( E_L \) is fed back to the grid of V2 which causes a fall in the anode voltage of V2 and the grid of V3. (3) This increases the voltage drop across V3 and tends to keep \( E_L \) constant.

It will be seen that the function of V1 is to provide a stable reference voltage for the cathode of V2. Changes in voltage across V1 due to its internal resistance are automatically compensated by the circuit but any irregular changes in this voltage may cause considerable changes in \( E_L \). These irregular changes in voltage stabiliser tubes arise mainly from (1) Discontinuities in the I/V characteristic and (2) Variations in burning voltage with temperature. Provided that the 85A1 is operated with a current of at least 4.5mA no discontinuities occur in its I/V characteristic; its temperature coefficient is \(-3.25\text{mV per C deg.}\) and temperature effects will therefore be negligible in all normal applications.

**85A1 NEON STABILISER TUBE**

![Diagram of stabilising circuit](image)

**Characteristics of 85A1**

- Mean burning voltage: 85V
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Reprints of this report from the Mullard Laboratories together with additional circuit notes can be obtained free of charge from the address below.

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(MVM79)
The Wireless Telegraphy Bill
Establishing a New Principle

Up to the present time radio in Great Britain has been controlled by the Postmaster-General under the powers conferred on him by the Wireless Telegraphy Act of 1904. It is a high tribute to the foresight of those who drafted the Act that it has provided a workable basis for regulating such a rapidly growing art for 44 years. In strict justice, perhaps still greater tribute should be paid to the Post Office for the generally benevolent and effective manner in which it has exercised its powers. This is all the more remarkable because our legislation has been on a foundation that, to most lay minds at least, seems inherently unsure. The Act of 1904 was concerned with establishing the Postmaster-General’s monopoly, rather than with the good governance of the art. In spite of that, cases of restrictive action likely to hamper development have been remarkably few, and, so far as this journal is concerned, the Post Office has generally lent a sympathetic ear to any protests we have been impelled to make.

With the passage of time the Postmaster-General has gradually assumed control of the various offshoots of wireless telegraphy. The main part of the Bill now before Parliament will merely confirm his powers. Such things as radiolocation (in the widest sense) as well as radio control of machinery are to become, legally speaking, “wireless telegraphy.”

Undoubtedly, the most important part of the Bill is the section dealing with interference. Wireless World has long contended that a situation where there is no legal barrier to the radiation of interference is intolerable, and we welcome the principle that power will be given to the Post Office to prevent with force of law the use of apparatus likely to cause undue interference.

It is not intended here to discuss in detail the methods proposed for putting into effect the principle of compulsory interference suppression. Unfortunately, criticism of this part of the Bill has been largely on emotional and party-political grounds with which we are not concerned. Exception has been taken to the conferring on the P.M.G. of right of entry in the enforcement of the anti-interference clauses, but it seems to have been forgotten that for many years he has possessed a legal right of entry to homes licensed for broadcast reception—about 90 per cent of all those in the country. Other and more useful grounds of criticism present themselves. For instance, the appointment of an advisory committee to advise the P.M.G. on such matters as permissible levels of interference may possibly cause interminable delays through failure to reach agreement. Earlier proposals for compulsory suppression have been bedevilled by delays through this cause. But that is a small matter compared with the broad principle, which will be readily conceded in all radio technical circles, that there should be unified control of all man-made radiation, deliberate or fortuitous, within our part of the frequency spectrum. That principle is now to be established, and at last the P.M.G. will have power to give his licensees the protection to which they should be entitled. Not only radiation, but “deliberate reflection of electro-magnetic energy” up to three million Mc/s is covered.

Wireless World Overseas Issues
Starting with this issue, copies of Wireless World going abroad will be printed on heavier paper, and, periodically, will include extra pages. This has been made possible by a modification of Board of Trade regulations; these changes cannot apply to copies for home readers.
WITH large numbers of small ex-Govt. cathode-ray tubes available on the radio market, the home construction of oscilloscopes seems to be the vogue. While this natural desire to make oneself the owner of such an attractive and versatile instrument has much to recommend it, yet there is the serious error into which many intending constructors fall of believing that the tube itself is the be-all and the end-all of the equipment's design. This is far from the truth, for the purchase of a tube, even if it happens to be perfectly suitable for inclusion in an oscilloscope, is only the first small step towards the final aim—a well-constructed and attractive instrument that really will be a valuable piece of test equipment.

In the instrument to be described everything is built up from scratch. The tube employed at present is a 3-in Emiscope 4/i (Marconi), used on visual-indication equipments (V.I.E.) in the early stages of the war, operating at 750-800 volts on the final anode. This type of tube is eminently suitable for oscilloscope work and is preferable to many larger types now available requiring considerably higher working voltages. Any small tube (about 3-in to 4-in screen diameter), operating at about 750-1,000 volts, is, however, suitable for the present design, since the only small modifications required to the full circuit of Fig. 1 are those involving the tube supply network, and these will be fully

---

Fig. 1. The complete circuit diagram of the oscilloscope. A three-valve time base is used and a single-valve signal amplifier. The wobbulator has two valves—an oscillator and a reactor. All resistors are 1/2-watt types except those otherwise marked and variable types which should be of 3-W nominal rating. Capacitors should be generally of 450-V rating except where otherwise marked.
Oscilloscope

described later on. All other circuit details are suitable as designed, and no alterations are necessary for a change of tube.

Briefly, the complete design incorporates:

(i) a time-base circuit (3 hard valves), generating a linear saw-tooth waveform of controllable amplitude and covering the frequency range 5–200,000 c/s approximately. This extremely high frequency is set by the difficulty of designing, and no alterations are necessary for a change of tube. The time-base is built around three valves, $V_2$, $V_3$ and $V_4$, and utilizes Puckle's generator circuit. It generates without difficulty a linear sweep of controllable amplitude through the frequency range 5–500,000 c/s.

(ii) a single-valve amplifier for vertical deflection giving a gain of some 50 times over the frequency range 60–550,000 c/s with a useful amplification up to 2 Mc/s, thus making it suitable for work on pulsing circuits and television, a further important feature;

(iii) an entirely optional frequency-modulation circuit (2 valves), controlled by the time-base, giving a variable amplitude output of 445–480 kc/s ± 12 kc/s, for I.F. circuit alignment on receivers employing a frequency in the upper frequency limit enables independent adjustment through the frequency range 5–200,000 c/s in 9 steps, each of these being continuously variable.

Referring to the circuit diagram, the time-base charging capacitor $C_9$ to $C_{14}$ is selected by $S_1$, the high-frequency contact being dependent upon the circuit strays $C$. The selected capacitor charges linearly through $V_4$ which is an R.F. pentode (6J7) connected as a constant-current valve, the time of charge being controllable by $V_R$, feeding the screen. $V_R$ is thus a fine frequency (velocity) control and permits smooth control of all sweep frequencies between the extremes set by the selection of $S_1$. As the selected capacitor charges through $V_4$, the cathode of the triode discharger (6J5) falls towards earth, and thus approaches the voltage present upon its grid due to the drop across $V_R$ and $R_3$ in the anode of $V_2$ (EF36). The extent to which this grid is held negative with respect to the H.T. line depends upon the setting of $V_R$. As soon as the cathode has fallen to the potential level of the control grid, $V_3$ conducts and a drop is present across $V_R$ which appears as a negative pulse on the suppressor of $V_2$. $V_2$ thus swings towards cut-off, and the consequent voltage rise present at the grid of $V_3$ into saturation, thus discharging the time-base capacitor through $V_R$ and the valve internal resistance (both low). When the capacitor is discharged the cathode of $V_3$ again rises to H.T. level and the valve is non-conducting, after which the cycle repeats.

The setting of $V_R$ determines the amplitude of the pulse applied to the suppressor of $V_2$ and should consequently be as high in value, consistent with proper working of the valve, as possible. At the same time this component in series with the discharge path of the capacitor and cannot, therefore, be too large in value without seriously lengthening the fly-back time. With a total value of 2,000 $\Omega$ given in the present circuit a compromise setting is easily found where the lowest value consistent with good triggering action is the aim in view. For very low settings the time-base will collapse. In general, a higher value is required for the upper frequency end of the time-base range, and to avoid the 1,000-$\Omega$ preset control, a 2,000-$\Omega$ fixed resistor may be inserted in this anode lead. $V_R$ determines the amount by which the grid of the discharger $V_3$ is held negative with respect to the H.T. line and its cathode at the commencement of the charging cycle. It therefore controls the amplitude of the generated saw-tooth and enables the sweep length to be adjusted within very wide limits.
Cathode-ray Oscilloscope—

maximum setting of this control does not, however, necessarily give the maximum length of time-base, and also, as for the action of VRs, very low settings of VR4 may cause the time-base to collapse. This control is very useful as a velocity vernier since changes in its value do affect the time-base frequency slightly.

When S1 is set to either of the two highest frequency time-base capacitors (C18 and C19) a negative impulse is developed across either R22 or L22 respectively by the application of a negative pulse from the suppressor of V2 during the fly-back period, via C28, which momentarily reduces the tube brilliance during the return trace. Similarly, there is some brightening effect during the forward sweep on these switch positions when the suppressor of V2 swings positive, and the brilliance of the trace thus tends to constancy as the spot velocity increases up to the maximum frequency of some 200 kC/s. On these latter two switch positions the brightness control (VRs) has very little effect on spot brilliance. It will be noticed, also, that on the 2nd position of S1 (reading anticlockwise on the diagram) the charging capacitor is replaced by a resistance (Rs = 1.5 kΩ). On this position the time-base becomes inoperative and the X1 plate of the tube is released by S2 from the time-base circuit. Only the spot then appears on the screen, a useful point for certain D.C. and amplitude test work. Since the X1 plate is completely ‘floating’ in this position, a high-resistance D.C. path must be provided for it to return to earth or inaccuracies will result due to spot drift. A suitable value is 2 MΩ. An external time-base may, of course, be applied at this switch setting, through X1 terminal.

Synchronizing

The time-base sweep may be synchronized to the work input by simply connecting the SYNC terminal to the Y1 input. This has an input impedance sufficiently high to have no effect on the work voltage source and is isolated from the time-base circuit proper by its connection to the control grid of V1 through the Sync control VR1. Normally, this control should always be set fully anticlockwise (slider to earth), and for effective synchronizing should only be advanced as little as possible consistent with effective locking. Too much of this control will destroy linearity of the trace and produce excessive X distortion. When using the amplifier it is essential that the SYNC terminal be connected to the Y1 terminal and not to the AMP input.

The amplifier used in this circuit is a single-valve stage designed as for television video-frequency amplification with an eye to frequency response rather than high gain. To be of any real value an oscilloscope amplifier should give substantially level amplification over the range 50 to 500,000 c/s with a useful range up to at least 1 Mc/s. The present stage adequately fulfils these conditions by making use of a high-slope power pentode (42SP5), and a gain of some 50 times is obtained over the above mentioned frequency range. At first, various types of R.F. pentode such as the 6P6R and EF35 were tried in this position without a great deal of success, and finally the power pentode was employed in order to obtain the voltage swing required without distortion.

The problem of gain control necessitated something better than the ordinary grid potentiometer. With this latter system the input impedance of the stage is different at different settings of the control and for very low settings the input capacitance of the valve offers a serious shorting effect to high frequencies. The only useful method of overcoming this is to employ a tapped input potentiometer with a small capacitor connected permanently across the upper half to compensate for the valve capacitance. This circuit was tried out, using a normal potentiometer with a suitable capacitor from the slider to the hot terminal, but the H.F. response suffered on account of the cumulative error in the correction as the slider approached earth. In the end, on account of the complication of a tapped input potentiometer, the whole system was scrapped in favour of a feedback control such as is used on some commercial amplifiers.

This circuit makes use of the current in the bias control VR5 to develope a feedback voltage and thus vary the gain of the stage. This feedback system of control tends to stabilize the output current rather than the output voltage developed and there is thus a tendency for a sharp falling off in response at high and low frequencies for a constant alternating current in the anode load. This form of feedback, considered as such, therefore, does little to improve the frequency response of the amplifier (though there is some improvement at low gain), but it tends to minimize amplitude distortion and it does away with the evils of the input potentiometer. A further important point in connection with this form of control is that of the input resistance which is virtually constant throughout the range of gain control setting, and any tendency to phase distortion at low frequencies is minimized by working at a deliberately reduced level. In actual use, this form of control is apt to appear ‘rough’, that is, the trace is liable to jump violently while the control is actually being rotated. This is not a fault, however, and once set, the trace is perfectly stable.

Some experiments were conducted with inductance compensation in the anode circuit to improve the H.F. response of the amplifier, but with little effect. As it stands the response is substantially flat from 60 to 550,000 c/s with a drop of 3 db at 1 Mc/s. Considerable gain remains up to...
2 Mc/s, making the amplifier useful even at this frequency. The response curve of Fig. 2 was taken at half gain and for smaller settings there is some improvement in both the high- and low-frequency response, a useful point to bear in mind when using the amplifier.

**Tube Circuit and Controls**

Little explanation is needed for the tube circuit and controls as they stand in the present design, but there are several points worthy of attention with regard to possible modification of this part of the circuit to utilize a different make of tube. Since this is the only section requiring alteration on this account, some little space will be given to the problem.

Referring to the main circuit, the actual tube network from which Brightness and Focus control is obtained, consists of $R_{19}$, $VR_6$, $R_{29}$ and $VR_9$ in series between earth (final anode) and the negative pole of the E.H.T. rectified earth, and so final suitable values for $R_{17}$ and $R_{18}$ are 270 kΩ and 2.2 MΩ respectively.

The smoothing capacitors $C_{22}$, $C_{23}$ and $C_{34}$ are not critical in value and those indicated in the table are perfectly adequate. The only point requiring attention is that of working voltage which must be adequate for the voltage applied, itself depending upon the tube used.

This two-valve circuit was included in the design simply to extend the range of usefulness of the instrument without increasing the number of panel controls which already numbered ten. Some readers may wish to omit this part of the circuit entirely, and this is easily accomplished by the simple procedure of replacing $R_{24}$ and $VR_{19}$ by a single 22 MΩ resistor.

The circuit is designed to cover only the 465-ke/s I.F. band, and throughout this range 'wobulation' is effected over a range of about $\pm 12$ ke/s on either side of resonance. The circuit is very simple and consists of a tuned-grid oscillator, back coupled from the anode through $C_{28}$ and a coupling coil, and a variable-reactance valve $V_7$ (6J7) is connected across the tuned circuit $C_{34}$ and $L_2$. The important components in this part of the circuit are $R_{28}$ and $C_{35}$; these are connected in series across the triode tuned circuit, their junction being returned to the control grid of $V_7$. $C_{23}$ is simply a blocking capacitor and $R_{29}$ provides grid circuit continuity. The value of $R_{28}$ is 0.27 MΩ and is consequently very high compared with the reactance of $C_{35}$ (150 pF) at frequencies around 465 kc/s. Hence, when the oscillator is functioning the current through $R_{28}$ and $C_{35}$ is very nearly in phase with the oscillator voltage, and the voltage on the control grid of $V_7$ is in phase with the grid voltage functioning the current through $R_{28}$ and $C_{23}$; the valve anode current is in phase with the grid voltage and is consequently lagging 90° on the oscillator voltage. From the point of view of the oscillator, therefore, $V_7$ and its associated components draw a lagging current and hence behave as an inductance. This 'inductance' is in parallel with the oscillator tuned circuit and thus modifies the tuning of the latter by an amount depending upon the value of the

![Fig. 3. The tube voltage-supply network, which may need alteration with different tubes, is shown here.](image-url)

![Fig. 4. This diagram is used in computing the values for the shift network.](image-url)
Cathode-ray Oscilloscope—
former. This value is adjustable by the amount the slope \( \left( g_m \right) \) of the valve is adjustable, and is given by \( C_{35} R_{28} / g_m \) for a particular value of \( g_m \).

Control voltage is applied to the suppressor grid of \( V_f \) from the time-base saw-tooth supply and modifies the slope of the valve by an amount dependent upon the setting of \( V_{R_f} \). The slider of this control falls from a positive value to earth during the charging cycle of the time-base and hence changes \( g_m \) from a large to a small value as the charge proceeds. Since the spot on the screen is moving across the screen during this period, its position at any instant is a function of the slope of the valve and hence the frequency generated by \( V_f \).

The output from the frequency modulator is adjustable by the setting of \( V_{R_f} \), and is normally applied, through a low-capacitance screened line, to the I.F. or F.C. valve in the receiver under test. This receiver output is generally best taken directly from the diode load through the oscilloscope amplifier which has an adequate response to cope with the frequencies concerned. The correct setting of \( V_{R_f} \) to ‘fit’ the receiver I.F. response curve on to the screen (i.e., to give the correct amount of frequency change) is quickly found in practice (it is fairly high up \( V_{R_f} \)), and the trace can be centred by adjustment of the core of \( L_2 \). The setting of \( V_{R_f} \) and the Amp. Gain can be set to give the best amplitude of the image. As the frequency modulation and the horizontal sweep of the spot are both controlled from the time-base, synchronism is automatic and a steady response curve is readily obtained. It is best, however, to lock the time-base to the mains frequency to avoid any possibilities of hum pick-up affecting the trace and this is best done by choosing the lowest time-base speed (capacitor \( C_4 \) position of \( S_1 \)) and adjusting the velocity control \( V_R \) to give a steady image.

The actual time-base frequency is fairly important and it cannot be high (a maximum limit is 100 c/s) without the possibility of distorting the trace. Capacitor \( C_8 \) (2 \( \mu F \)) is specially included in the circuit diagram to allow a very slow sweep to be obtained from the time-base if required, but in general it is not needed and this switch contact may be connected across to the \( C_9 \) contact or ignored altogether.

Construction
The photograph shows a general view of the complete instrument, the nearest valves being the time-base components. The amplifier and the frequency-modulator valves are on the far side, and the whole power unit is behind the dividing screen at the rear. This layout, together with careful screening below chassis, gives a trace free from hum troubles, though a mu-metal tube screen may be included if one is available.

A mains transformer with all windings may be difficult to obtain and two separate items may, of course, be employed. Particularly note that the diode is a 4-volt valve and is run from the 6-volt heater winding. A series resistance of about 1\( \Omega \) is included in its heater path and is not shown in Fig. 1; this is best found experimentally.

APPENDIX
Frequency Modulator
Oscillator tuning capacitance = 200 \( \mu F \), and therefore the effective \( L \) for 455 and 475 kc/s (assuming a 20-kc/s swing) is 605 \( \mu H \) and 555 \( \mu H \) respectively. This effective \( L \) is made up of \( L_2 \) and the reactor valve \( V_e (L_1) \) in parallel, and \( L_1 \) is variable by the amount \( g_m \) is variable. If \( g_m \) varies from 0.5 \( \times 10^{-4} \) A/\( \mu H \) to \( 2 \times 10^{-3} \) A/\( \mu H \), then the larger value becomes 20.5 mH, whence \( L_2 \) must be 0.25 \( \mu H \). Hence for \( g_m = 2 \times 10^{-3} \) A/\( \mu H \):

\[
C_{35} R_{28} = 41 \times 10^{-6}
\]
so that making \( R_{28} = 0.27 \) M\( \Omega \), \( C_{35} = 150 \times 10^{-12} \) F = 150 \( \mu F \).

“NUCLEONIC” EQUIPMENT

Many of the electronic measuring instruments associated with government research in nuclear physics were developed by the Ministry of Supply in conjunction with Dynatron Radio, of Maidenhead, who are now free to offer these products to approved research organizations.

The use of radioactive tracer elements in medicine is well known, and the technique is being applied in industry to the investigation of chemical and metallurgical problems. For the detection of radioactivity the most sensitive device is the Geiger-Muller counter which produces pulses of current, due to other points to note are: \( C_{35} \) should not be metal cased, or if it is the case must be insulated from earth; the spindles of \( V_{R_8} \) and \( V_{R_4} \) should be insulated from chassis as an extra precaution against breakdown. Switches \( S_1 \) and \( S_5 \) are ganged and select the inputs: (a) D.C. to \( Y_1 \)—position shown in the diagram, (b) A.C. to \( Y_1 \), (c) Amplifier to \( Y_1 \) plate, and amplifier output available at \( Y_1 \) terminal, (d) Amplifier available at \( Y_1 \) terminal freed from internal circuits.

The ionization of the gas forming the dielectric between polarized electrodes in a sealed glass tube. The rate of production of pulses is a measure of the radioactivity, and electronic counters (scalers) have been devised for this purpose.

In the Dynatron Type SC.200 scaling unit, indications up to 100 are given by a series of miniature neon lights, and multiples of 100 up to 1,000,000 by a Post Office relay counter. The instrument operates with a pulse separation of 6 microseconds or, alternatively, with a ‘‘paralysis’’ time up to 1 millisecond.

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Dynatron Type 200 scaling unit for counting ionization pulses.

Cabinet racks for housing these and similar units, made to the Post Office standard panel width of 19 inches, are available in heights of 3, 4 and 6 ft.
CIRCUIT SYMBOLS

Notes on the New British Standard

By L. H. BAINBRIDGE-BELL
(Royal Naval Scientific Service)

The appearance of a revision of "Graphical Symbols for Telecommunications" (briefly recorded in last month's *Wireless World* after a lapse of eleven years will be welcomed particularly by workers in the short-wave and microwave techniques and in the complicated circuits which have made such strides during this interval.

The book deals with symbols for "block schematics" and plans as well as the type of graphical symbol for use in circuit diagrams with which we are here concerned. A circuit diagram is defined as: "a diagram which depicts in simple form, by means of symbols, the essential components and the interconnections required to provide the information necessary to show the operation of the circuit. A circuit diagram will usually be drawn so as to show this as clearly as possible and therefore will not necessarily depict the various items and their connections in their actual spatial relationship."

The last sentence should be a warning to those who spoil a circuit diagram . . . some particular component . . . by the writer's opinion, the most important additions to facilitate such location is illustrated below. This indication extends along the length of a diagram." [See also diagrams on pp. 88, 89 of the book.]

Guiding Principles

The pages dealing with "Guiding principles" to be observed in using the symbols and in preparing diagrams are, in the writer's opinion, the most important additions. To borrow a term from Frederick Bodmer's "The Loom of Language" they might well be called the "table-manners" of circuit drawing. The following "principles" are selected in order to give an idea of the field covered.

"Diagrams should be drawn so that the main sequence of cause to effect goes from left to right, and from top to bottom." (The writer would prefer "or from top to bottom."). When this is impracticable, the direction should be shown by an arrow."

"Frequently occurring groups of symbols should be drawn in standard recognized forms." The groups shown include multivibrators, rectifier circuits, filter-network and bridges.

The applications of these principles are illustrated in two of the diagrams at the end of the book. It should be emphasized that these two diagrams are not intended as examples of complete drawings but are intended only for the above purpose. With this in view, they have been distorted so as to include as many "principles" as possible. The diagrams referred to are: page 88 "Modulator and Master Oscillator" and page 89 "Oscilloscope."

On page 8 we read "Of wires meeting at a connecting point, not more than two should be collinear. They should be drawn thus and not thus . . ." The writer considers that the observance of these "Staggered cross-roads" would contribute more than any other rule to the avoidance of "accidents" in the shape of mistakes in drawing or in careless tracing. He would respectfully draw the attention of the *Wireless World* drawing office to this rule, which has had a rather unnoticed existence in this British Standard for fourteen years.

Before leaving these pages one other recommendation (on page 15) is worthy of mention. We read "It is frequently necessary to locate why not "find"? in a circuit diagram . . . some particular component . . . by the coded reference only. One method of facilitating such location is illustrated below. This indication extends along the length of a diagram." [See also diagrams on pp. 88, 89 of the book.]

Too Many Symbols?

There are shown nearly three hundred circuit symbols. The writer often hears the opinion expressed that there are far too many symbols, and that there is an unwise tendency to distinguish by different symbols the differing method of construction or differing materials of devices which perform the same electrical operation (for example, different types of transformer cores) and also to indicate mechanical details (for example, direction of rotation of control knobs).

In defence of this large number of symbols, the writer produces the following arguments:

(1) Many of the 300 are variants of about 100 basic symbols and illustrations of combinations of these. For example, No. 25 (resistor) plus No. 20 (sliding control) gives No. 25.11 (potential divider, variable).
Circuit Symbols—
(1) If all technical manuals contained diagrams showing mechanical details in addition to the essential circuit diagram, many of these extra symbols would be unnecessary. Often only one diagram (the circuit diagram) is provided; this, then, is the only place where these apparently irrelevant details can be shown.

(2) The writer is constantly being asked by rather unimaginative people, who have perused the nine symbols for valve elements (grid, anode, etc.) and the twenty examples of their combinations (diode, pentode, etc.). "How do you draw, say, a double-diode octode?" The 200 variants are useful to such people.

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Criticism would be disarmed if B.S.I. or some other body were to produce "Basic Circuit Symbols"—much as the B.S.I. has produced a card containing extracts from its standard on proof-correcting.

The adjoining symbols, which have not appeared in previous editions, are worthy of attention.

The above review has tried to show that an important new aid to standardization and interpretation has been produced; it should find its way into the hands of those who want their diagrams to "be understood of the people." Readers who have been (or are still) in the fighting services may be glad to know that items which are common to B.S. 530 and to the "Services" book (B.R. 1079—Tels. A. 301—A.P. 2807 to give the Navy, Army and Air Force references) are represented by the same symbols in the two publications, except for trivial differences.

No. 41. Crossing of conductors without connection:

The bridge is included as an alternative but it is associated with a note "The bridge is deprecated unless considered essential." The writer hopes that *Wireless World* will continue to consider it "essential" in the type of circuit which it illustrates so clearly.*

No. 19.1

Pre-set adjustment

No. 25.4

Thermistor

The full disc indicates a negative resistance temperature characteristic: positive characteristic is indicated by an open circle.)

No. 43

Vibrator as used for power supply

* Wireless World drawing office says "Mr. Bainbridge-Bell's approval of our practice in the matter of bridge cross-overs seems to cancel out his disapproval of our use of colinear connections (see previous page). When inductors are used, the risk of errors through this cause automatically disappears."—EB.

Birmingham.—On December 10th meetings of the Radio Society will be given demonstrations of home recording by D. O'C. Roe, of Birmingham Sound Reproducers. Meetings are held fortnightly at 8.0 at the Parochial Hall, Slade Road, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Birmingham, 23.

Croydon.—The normal monthly meeting of the Surrey Radio Contact Club will not be held in December as the club's annual social gathering has been fixed for December 14th at the Purley Hall, Barne Road, Purley. The next meeting will be on January 11th at 7.30 at the Blacksmith's Arms, Southend. Croydon. Sec.: L. C. Blanchard, 122, W. S. Andrew's Road, Coulsdon, Surrey.

Derby.—A series of television lectures is being given to members of the Derby and District Amateur Radio Society which meets on alternate Wednesdays at 8.00, London Road, Derby. Sec.: F. C. Ward, G2CVV, 9, Uplands Avenue, Littleover, Derby.

Edinburgh.—Meetings of the Lothian Radio Society are held on the last Thursday in each month at 7.30 in the same places. Meetings are held on the second and fourth Wednesdays of each month at 7.30. Sec.: C. Alabaster, 34, Lothian Avenue, Hayes, Middx.

Southend.—The West Middlesex Amateur Radio Club has been unable to find a suitable building for a club-room and workshop and has, therefore, started a fund for the purchase of a hut. Meetings continue to be held at the Labour Hall, Uxbridge Road, Southall, on the second and fourth Wednesdays of each month at 7.30. Sec.: T. A. Balfour, 34, Lothian Avenue, Hayes, Middx.

Southeast.—At the meeting of the Southeast and District Radio Society at 7.45 on December 10th the Municpal College, Victoria Circus, R. Ritchie, of E. K. Cole, will speak on pulse modulation. Sec.: J. H. Bar- rance, M.B.E., 49, Swanage Road, Southend-on-Sea, Essex.

Walworth.—Meetings of the Wal- wor (Men's Institute) Radio Club have restarted on Wednesdays and Fridays at 7.0 at the Avenue School, Pennc Lane, Liverpool, 15. Sec.: W. G. Andrews, G2DVW, 17, Lingfield Road, Broadgreen, Liverpool, 14.

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TELEVISION WAVEFORMS

Some Comparisons Between British and American Standards

All television systems now in use have a fundamental likeness in spite of a number of surface dissimilarities. The number of scanning lines used may vary and the synchronizing signals may be somewhat different in form; some systems may use positive modulation and others negative, while again vertical polarization of the radiated wave may be adopted in some cases and horizontal in others.

Through all these minor differences the broad principles of line scanning, interlacing, and synchronization by pulses transmitted as 'blacker than black' signals remain the same in all systems. Some of the differences are not always well understood, with the result that unjustifiable claims are not infrequently made by their supporters. As will appear later, it turns out in some cases, at least, that there is very little to choose between the alternatives on technical grounds. This being so, it is unfortunate that one or other of the alternatives has not been universally adopted.

Two of these points of difference only will be discussed here, the sense of modulation and the inclusion, or otherwise, of equalizing pulses in the synchronizing signals. In Britain, positive modulation has been adopted with peak-white corresponding to full carrier amplitude, black to 30 per cent of full amplitude and the tips of the synchronizing pulses to zero carrier. In America negative modulation is used; with this the tips of the sync pulses correspond to the full carrier amplitude, black to 75 per cent of the full amplitude and white to 15 per cent. In both systems the duration of a line sync pulse is 10 per cent of the full line period.

Because the peak power with negative modulation is radiated for only 10 per cent of the time as compared with 85 per cent for positive modulation with a white picture, the ratio of peak/mean powers is greater with it. This is often claimed to mean that higher power can be obtained from the same transmitter output valve with negative modulation than with positive. This is not necessarily true, however.

---

<table>
<thead>
<tr>
<th></th>
<th>White</th>
<th>Black</th>
<th>Sync</th>
<th>Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Carrier Amplitude</td>
<td>...</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Relative Instantaneous Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>1.0</td>
<td>0.15</td>
<td>0.3</td>
<td>0.75</td>
</tr>
<tr>
<td>Anode Dissipation</td>
<td>1.0</td>
<td>0.022</td>
<td>0.09</td>
<td>0.562</td>
</tr>
<tr>
<td>Grid Dissipation</td>
<td>1.0</td>
<td>0.27</td>
<td>0.5</td>
<td>0.94</td>
</tr>
<tr>
<td>Occupance</td>
<td>0.85</td>
<td>0</td>
<td>0.05</td>
<td>0.9</td>
</tr>
<tr>
<td>Relative Average Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.85</td>
<td>0</td>
<td>0.003</td>
<td>0.506</td>
</tr>
<tr>
<td>Anode Dissipation</td>
<td>0.85</td>
<td>0</td>
<td>0.025</td>
<td>0.845</td>
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<tr>
<td>Grid Dissipation</td>
<td>0.85</td>
<td>0</td>
<td>0</td>
<td>0.29</td>
</tr>
<tr>
<td>Total Relative Average Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output W&lt;sub&gt;m&lt;/sub&gt;</td>
<td>0.855</td>
<td>0.606</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anode Dissipation D&lt;sub&gt;a&lt;/sub&gt;</td>
<td>0.875</td>
<td>0.945</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid Dissipation G&lt;sub&gt;g&lt;/sub&gt;</td>
<td>0.83</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Peak Power W&lt;sub&gt;m&lt;/sub&gt;</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Useful Picture Signal (= change from black to white)</td>
<td>0.7</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

The matter is not as simple as it seems at first sight, however, and in a recent paper L. H. Bedford has analysed the position in some detail. He compares the two systems under the highest mean power conditions for each; these are the transmission of a white picture with positive modulation and a black picture with negative. The results are summarized in the Table above which may need a little explanation.

In each column the left-hand set of figures refers to positive modulation and the right-hand to negative. The first line gives the relative carrier amplitudes for the three different signal conditions, and the next the relative instantaneous power output. The relative instantaneous anode power dissipation is then calculated on the assumption that the efficiency is constant at 50 per cent, and that the grid power dissipation is proportional to the fourth power of the carrier amplitude.

The line 'Occupance' shows the fraction of time allotted to each quantity and is used in computing the relative average powers given in the three following lines. The appropriate figures are then summed to give the total relative average powers.

Since the changes of carrier amplitude between black and white are not the same in the two systems, this must be taken into account and is represented in the table by E<sub>m</sub>. The figures of merit for the two systems are then computed as the ratios of E<sub>m</sub> to the square roots of the various powers.

When peak power is the limitation positive modulation is superior in the ratio 0.7/0.6 = 1.16; it is also better when the limit is set by anode dissipation and in the ratio 0.75/0.62 = 1.2. However, when grid dissipation forms the limit negative modulation is superior and the difference is then rather greater, the ratio being 0.96/0.76 = 1.26.

The greatest difference between the two systems is no more than 3db, and occurs with negative...
modulation in the rather unlikely event of grid dissipation being a limiting factor. In the more likely event of anode dissipation providing the limit the advantage is with positive modulation but only to a little less than 1.5 db.

**Interference**

The differences between the two systems affect matters much more at the receiver. In the paper already referred to Bedford has pointed out that there are three main differences to be considered—the effects of ignition interference of greater peak amplitude than the full carrier on the picture and on the synchronizing, and the possibilities of A.G.C.

Ignition interference causes white spots on the picture with positive modulation but black spots with negative. With a simple limiter circuit the spots can be prevented from spreading in the former case and there is little to choose between the two systems. The advantage does lie with negative modulation, however, as it needs no limiter.

Matters are very different when the effect of interference on synchronizing is considered. With negative modulation a large interference peak may trip the line time base at any time and cause ‘tearing of lines,’ but with positive modulation it cannot produce false sync signals and can affect the synchronizing only by obliterating a genuine sync pulse. It can do this only when an interference peak coincides with the leading edge of a sync pulse.

This is quite a big point in favour of positive modulation, and it is worth noting that in America it has become necessary to adopt ‘flywheel sync’ circuits whereas they have not been adopted in any British commercial receiver to date.

The problem of A.G.C. is not an easy one in television in spite of the claims made for negative modulation in connection with it. It has never been considered as important in Britain as in the U.S.A., probably because the provision of a number of alternative programmes was considered from the outset in that country.

The simple A.G.C. system originally envisaged for use with negative modulation has proved rather a failure, for it is affected by interference. As a result, the use of A.G.C. has been abandoned in most American receivers. With both methods of modulation it is necessary to adopt ‘strobing’ if a satisfactory A.G.C. system is to be secured. Nevertheless, there is probably still some advantage in negative modulation.

One practical point which is not mentioned in Bedford’s paper is that with negative modulation it is hardly practicable to use direct coupling between detector and V.F. stage and between the V.F. stage and the C.R. tube, as is the almost universal British practice. Since 15 per cent carrier level corresponds to peak white the cessation of a signal will send the tube into the ‘whiter than white’ region, and it will be underbiased. With positive modulation black level corresponds to 30 per cent modulation, and the cessation of the signal only drives the tube into ‘blacker than black’ beyond cut-off and does no harm. Because of this it is usual in American sets to use A.C. couplings with D.C. restoration. This means slightly more equipment.

**Equalizing Pulses**

On balance it will be seen that there is not a great deal of difference between the two systems. The advantage would seem to lie generally with positive modulation because synchronizing is less affected by interference and direct coupling can be used with some simplification of the receiver. This outbalances the need for a limiter.

Turning now to the synchronizing waveforms, British and American practice is very similar. Both adopt the elegant concept of odd-line interlacing with a frame signal slotted at twice the line frequency. The only significant difference lies in the provision of equalizing pulses before and after the frame pulses in the American system.

When an integrator is used for separating the frame pulses there is an error in interlacing. Bedford works out the timing error as

$$\delta t = \frac{t_s}{T} e^{-t_s/t_i} \left[ 1 - e^{-t_s/T} \right]$$

where

- $\delta t$ = timing error of the frame time base firing point
- $T$ = integrating time constant
- $t_s$ = duration of line sync pulse
- $t_i$ = duration of whole line

The error can be as great as 20 per cent of the line period when reasonable values of the integrating time constant are used, and this is sufficient to cause severe pairing.

When equalizing pulses are used, however, the error is reduced by the factor $e^{-t_s/t_i}$ where $t_s$ is the interval between the first equalizing and the first frame pulses. This is a considerable reduction.

It is, however, quite easy to secure a much better performance still and without the use of equalizing pulses, by adopting an alternative to integration. One method due to H. A. Fairhurst depends on passing the wave through a suitably short time constant circuit which gives a partial differentiation. This makes the trailing edge of the first frame pulse stand out so that it is separable by a limiter and can be used for synchronizing.

This method gives as sharp an edge to the pulse as in the case of the line pulses, and so leads to very precise synchronizing. However, even perfect precision does not necessarily result in perfect interlacing because only the firing point of the time base is controlled. Careful design is needed to secure perfect interlace, but as long as there are sufficient frame pulses to cover the whole firing time of the frame saw-tooth generator, the presence or absence of equalizing pulses has no bearing on it.

It will thus be seen that while equalizing pulses are beneficial when frame pulse separation by an integrator is adopted, they are unnecessary when other methods are used, and these other methods are usually advisable for an accurate interlace.

---


BATTERY diode-triode type ILH4 may be conveniently replaced by type ILD5, stocks of which are now available.

Type ILD5 is a diode-pentode and it is therefore necessary to fit a screen series reistor together with a decoupling condenser to chassis.

Substitution by type ILD5 will give increased gain and if this is excessive, the anode load may be reduced to give the desired gain as shown in the table below.

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>ILH4</th>
<th>ILD5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament Voltage</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Filament Current</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Anode Voltage</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Screen Voltage</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Anode Current</td>
<td>0.15</td>
<td>0.6</td>
</tr>
<tr>
<td>Mutual Conductance</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Grid Bias</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

RESISTANCE COUPLED OPERATION (Supply Voltage 90 Volts)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>ILH4</th>
<th>ILD5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode Load Resistance</td>
<td>0.47</td>
<td>1.0</td>
</tr>
<tr>
<td>Screen Series Resistor</td>
<td>0.27</td>
<td>1.0</td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>34</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHANGE VALVE</th>
<th>SOCKET CONNECTIONS</th>
<th>OTHER WORK NECESSARY</th>
<th>PERFORMANCE CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM</td>
<td>ILH4</td>
<td>LOCTAL</td>
<td>TO</td>
</tr>
</tbody>
</table>

Insert Screen Resistor between Pin No. 3 and HT+. Fit 0.1 condenser between Pin No. 3 and chassis. See table above for correct values. Increased gain. (Reduce Anode load if necessary as given in table above.)

BRIMAR says...

9 in. CR TUBE (C9A) NOW AVAILABLE

BRIMAR RADIO VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.
Sensitivity

The bat is said to derive its amazing sensitivity in flight from the echo of a high pitched sound which it emits. The Weston Model E772 Analyser, however, relies upon the more tangible asset of a sensitivity rating of 20,000 ohms per volt on all D.C. ranges and 1,000 ohms per volt on all A.C. ranges. This instrument is designed to assist you in the tracing of difficult electrical faults and its quality is in accord with the highest Weston standards.
THE increasing use of vertical rod-type aerials for broadcast and television reception has made evident a particularly troublesome form of interference which, although sporadic, is usually of very great intensity.

The experienced gained by the writer's observations over the last twelve months, with the help of observers' reports, has resulted in the adoption of a device which will effect a permanent cure in the majority of cases. The few cases in which complete suppression is not realized can be explained, and the further steps required to complete the cure are outlined.

It has been customary to refer to the form of interference to be discussed as "precipitation static," and it is believed that the term was originally used to describe atmospheric electricity phenomena in connection with operational aircraft.†

It is well known that when aircraft fly through water vapour, sleet, or snow carrying electrical charges, these charges are precipitated upon the surface of the aircraft so that it gradually attains a potential and ultimately causes corona (brush discharge) when they are situated in a sufficiently intense electric field created by atmospheric conditions.

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AERIAL CORONA INTERFERENCE

Its Cause and Cure

By F. R. W. STRAFFORD, A.M.I.E.E. (Technical Manager, Belling & Lee)

Nature of Interference

The conditions necessary to produce this interference are invariably those obtaining in thundery weather. There are usually heavy and low rain clouds accompanied generally by heavy and sudden showers of rain, sleet or hail. There may be no thunder or normal lightning discharge atmospheric at the time. The interference usually commences abruptly with a series of slow clicks rising in repetition frequency to a few hundred per second. Sometimes the frequency is much higher and musical or squealing effects are produced. A burst of such interference can last between a few seconds and as many minutes and usually ceases as abruptly as it commences. If lightning discharges are occurring substantially overhead the burst will cease at the instant of the discharge, due to the sudden reduction of the electric intensity in the vicinity of the aerial.

It is not the intention of this article to consider in any detail the physics of atmospheric electricity, for we are concerned only with one of the annoying effects it can produce, but briefly it must be realized that, in perfectly clear weather, an electric field exists in the atmosphere. This field, which is perpendicular to the earth, attains a maximum of about 1 volt/cm at the earth's surface, falling off with increasing height to negligible value in the tropospheric region.

During a thunderstorm, or under thundery conditions, the intensity of the field (usually reversed in polarity) increases a hundredfold or more.

The voltage gradient which will exist at the tip of an aerial will depend, apart from its position in the electric field, upon the sharpness of the tip. The gradient reduces as the tip is made blunter and rounder, and continues to reduce if a conductive sphere is fitted to it, the reduction increasing with diameter of the sphere. Irrespective of the size or shape of the aerial tip there may, at times, exist a sufficiently intense field to provide gradients at the surface of the aerial capable of causing electrical breakdown of the air which initiates the discharge and the intense radio interference which accompanies it.

Vertical Rod Aerials

Naturally the more elevated and "spiky" the aerial becomes the greater the voltage gradient at its tip. It is for this reason that the more extensive use of chimney-mounted rod-type aerials has been followed by more widespread complaints of corona interference.

It is not necessary for the listener's aerial to corona in order to observe the interference. Neighbouring objects, particularly lightning arrestors or nearby rod type aerials, may be in a state of...
Aerial Corona Interference—
corona and radiate their interfer-
to the listener’s aerial.

Observations on this aspect of
the problem have proved that the
radiated interference from an 18-
ft vertical spike aerial located
approximately ten feet from, and
at the same height as, an identical
receiving aerial produced an in-
terfering level at least one hun-
dred times lower than when the
receiving aerial was itself in a
state of corona.

The reader may justifiably ask
how such an experiment was car-
rried out in view of the identical
character and elevation of the two
aerials.

It should be stated that the tip
of the receiving aerial was, in the
first place, fitted with a spherical
conductive ball of approximately
2 inches diameter. During the
test the gradients at the aerial tips
were such that the unprotected
aerial was just in a state of corona
so that the protected receiving
aerial was below the corona
threshold.

The sphere was then removed
quickly and the increased level of
interference observed. Several
observations were made in all.

It can be stated with moderate
assurance that re-radiated corona
interference is not likely to be
very serious, and at the worst can
be reduced to negligible propor-
tions by removing the aerial from
the more likely neighbouring
sources of corona.

So far as corona at the tip of
the receiving aerial is concerned
it does not require much thought
to appreciate the intensity of the
interference caused by the pas-
sage of the impulsive corona
current through the input in-
pedance of the receiver. It is
quite usual for a broadcast signal
of 100 mV/m to be rendered un-
intelligible by this form of inter-
ference.

Partial Cure

The fitting of a conductive
sphere to the tip of the aerial will
naturally reduce the occurrence of
the interference as compared with
the unprotected tip. Since the
atmospheric electric intensity
varies over wide limits during
thundery conditions, there will be
times when the unprotected aerial
will just attain a state of corona
while the protected aerial will
remain unaffected.

It must be realized that the interfer-
ence does not come on gradually as the gradient in-
creases. There is very little inter-
ference until the critical threshold
gradient is attained and then
intense interference immediately
results.

Thus the greater the diameter of
the sphere fitted to the aerial
the less are the chances of interfer-
ence arising during thundery
weather, but complete immunity
cannot be expected.

A far better method of remov-
ing the interference, however, is
to make use of a device2 which
does not in itself prevent corona
but splits up the corona currents
through a multitude of highly
resistive paths.

Under these conditions the

capacitance of the aerial in series
with each high-resistance path
reduces, very considerably at the
receiver input, the proportion of
interfering energy lying within
the broadcasting and communi-
cation frequency spectrum. In

other words, the steepness of the
wave front of the corona discharge
impulses is greatly reduced.

The “silent discharger,” as the
writer prefers to call it, consists of
a short length of soft lamp
wick, one end of which is teased
out into a fluffy brush. The wick
is impregnated with a rapid-dry-

2 J. R. Clement, Jr.: Seventh Par-
tial Report on Precipitation
Static Problems; U.S. Naval
Laboratory Report No. 0-2309.
June, 1944.

aerial with a good insulating com-
 pound of low permittivity and
 high dielectric strength. It is
 essential, however, that the com-
 pound be closely adherent to the
 aerial rod. Slipping a jacket of
 insulating material over the rod is
 unsatisfactory because the small
 air gap thereby provided breaks
 down and the corona at the inter-
 faces is as severe as that produced
 in the absence of the jacket!

Even if a good quality and
adherent coating is employed it
is only necessary for it to be punc-
tured on one occasion by an
unduly high surface voltage
gradient for it to be quite useless
thereafter.

Probably some form of bitu-
 mastic compound, or some sub-
aerial. Under these conditions the

reduces, very considerably at the
receiver input, the proportion of
interfering energy lying within
the broadcasting and communi-
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2 Patent applied for.
BRITISH COMPONENTS IN SWEDEN

Local Reactions to the R.C.M.F. Show

(from a Correspondent)

STOCKHOLM has been the scene of a concentrated drive by the British radio industry—components, television and lectures. The exhibition, organized by the Radio Components Manufacturers' Federation, was the most important event. In spite of the minor faults which I shall discuss below, it was a really good show, and it has done a lot of good. It was a small show, with only 36 stands, but nearly all the major firms were represented, and the layout was attractive.

The Swedish visitors were both surprised and impressed. German propaganda and American publicity have combined to make Swedes think that Great Britain, the industrial heart of a community of 550 million people, survives by copying such bright ideas as magnetrons and jet engines. This exhibition made them think. One feature which gave a great deal of satisfaction was the fact that most stands had someone there who knew the answers. This was especially important in Stockholm, because whereas in the U.K. we simply say "Type approved?", in Stockholm they ask all the questions which type approval implies.

More Data Wanted

The chief criticism is an old friend, and dates back to before the war. There were not enough detailed technical catalogues, though the exhibition was planned long enough ago to allow of their preparation. I should also prefer to see the R.C.M.F. emulate the Physical Society, and provide a single volume, for which they would be paid. In Stockholm industrial heart of a community of 550 million people, survives by copying such bright ideas as magnetrons and jet engines. This exhibition made them think. One feature which gave a great deal of satisfaction was the fact that most stands had someone there who knew the answers. This was especially important in Stockholm, because whereas in the U.K. we simply say "Type approved?", in Stockholm they ask all the questions which type approval implies.

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ELECTRONIC CIRCUITRY

Selection from a Designer's Notebook

Last month two gate circuits were described, the second of which was a cathode-coupled arrangement. Another cathode-coupled arrangement suggested by the writer's colleague Mr. T. C. Nuttall, is shown in Fig. 1. This circuit has the advantage that the output is derived in push-pull across the equal resistances \( R_1 \) and \( R_2 \), and there is no loss of gain due to \( R_1 \). The mode of operation is an extension of the simpler cathode-coupled circuit.

On the positive half-cycle of the switching waveform \( V_\text{p} \) and \( V_\text{n} \) are cut off by the positive excursion of the common cathode potential. On the negative half-cycle \( V_\text{p} \) is cut off, leaving \( V_\text{n} \) and \( V_\text{v} \), operating as a cathode-coupled phase splitter as described by Mr. Cocking in a recent article. \( V_\text{n} \) and \( V_\text{v} \) may be used with either single-ended input or in push-pull as required, and in either case a push-pull output is obtained. This is very convenient as most modern cathode-ray tubes are intended for symmetrical deflection. Another obvious advantage is that \( R_1 \) now introduces no loss of gain, and the larger \( R_2 \) is made the better balanced will be the output voltages across \( R_1 \) and \( R_2 \).

The overall gain of \( V_\text{n} \) and \( V_\text{v} \), when conducting, will be nearly \( g_m R_1 \), so it is, of course, the working mutual conductance of one valve.

As before, the grid-cathode capacitances of \( V_\text{n} \) and \( V_\text{v} \) are charged or discharged at each switching operation through whatever grid impedance there may be—in the case of one valve at least this will be the signal source impedance. Generally speaking a high switching frequency can be satisfactorily obtained only when either a low-impedance signal source (e.g., a cathode follower) is provided, or when the circuit is entirely symmetrical. Under these latter conditions any effects of switching appear at the anodes of \( V_\text{n} \) and \( V_\text{v} \) in push-pull and so leave the C.R.T. unaffected.

In a two-beam switch, two such gates are used, and the \( V_\text{n} \) anodes of each channel are connected in parallel, as are the \( V_\text{v} \) anodes. Each signal can be given its own "shift" by arranging for a manually controlled unbalance of the standing anode currents in \( V_\text{n} \) and \( V_\text{v} \), and by direct coupling to the C.R.T. deflection plates.

More Notes on Beam Switches

The last of the gate circuits to be described is shown in Fig. 2. Here the switching waveform is applied to the double triode so that on positive half-cycles \( V_\text{n} \) is conducting and \( V_\text{v} \) cut off, and on negative half-cycles the reverse is true. The cathode current of the double triode is continuously modulated by the signal applied to \( V_\text{n} \), and when \( V_\text{n} \) is conducting the signal voltage appears across \( R_2 \). The gain from input to output is approximately \( g_m R_1 / (g_m R_2 + 1) \) where \( g_m \) is the mutual conductance of \( V_\text{v} \).

The main limitation to rapidity of switching is the stray capacitance between the anode of \( V_\text{v} \) and earth, which has to be charged or discharged at each switching operation. This capacitance is the sum of the anode-earth (\( V_\text{v} \)), the cathode-earth (\( V_\text{n} \), \( V_\text{v} \)) and grid-cathode (\( V_\text{n} \)) capacitances. By the use of miniature valves these can be kept to a minimum. This total capacitance has to be charged through the cathode of \( V_\text{v} \), \( V_\text{n} \), and this is fortunately a low impedance point (\( V_\text{n} \) is a cathode follower, and \( V_\text{v} \) a grounded-grid stage). If in addition the mutual conductance of \( V_\text{n} \), \( V_\text{v} \) is made high, conditions are very favourable for rapid switching.
switching. To obtain a "shift" associated with each signal $V_s$, may be shunted by $R_s$ and $P_s$, as shown, so that by variation of $P_s$ the standing current in $R_s$ may be varied.

This last circuit has most of the advantages of the previous circuits and is capable of being switched extremely rapidly. Using a 6J6 for $V_p$, $V_s$, and an EF91 for $V_m$, it was not found difficult to make a beam switch with a switching frequency of 100 kc/s. By arranging to "blank" the C.R.T. for a period of about 0.15/μsec at each switching operation, a beam switch with a switching frequency of 1 Mc/s was found to be practicable.

THE photocell is now widely used in a variety of applications, and in many of these a very short response time is unnecessary. It is not always realized that many of the difficulties of direct-coupled amplifiers can be avoided by using a high-resistance load for the photocell — provided it is not gas-filled. In a normal vacuum photocell it is necessary to provide a sufficient anode potential to achieve saturation (i.e. collect at the anode all electrons emitted by the cathode), and this potential is generally 20-70 volts according to the cell construction. As long as this potential is always available the cell current is independent of external resistance, so that it is possible to detect minute photo-currents by developing a relatively large potential across a resistance of large value.

A simple circuit frequently used by the writer with success is shown in Fig. 3. With a photocell load ($R_s$) of 100 MΩ, then obviously one volt output will be obtained with $1/1000\,\text{A}$ cell current—corresponding to the light resulting from a 100 watt lamp about 150 ft away from a cell of average size and sensitivity. Because the "amplifier" is only a cathode follower, considerable freedom from instability can be expected. The speed of response is, however, limited by the time constant formed by the capacitance at the valve grid and the load resistance. If $R_s=100\,$MΩ and the stray capacitance is 20 pF the time constant is 0.2 milli-second.

One word of warning. When using such high resistances (to-1,000 MΩ) care must be taken to eliminate stray leakages. The use of guard rings is sometimes desirable, and these may conveniently be connected to the cathode of the cathode follower. The cathode load, $R_s$, should be large.

—J. McG. S.

### HIGHLIGHTS OF CAR RADIO

#### New Models for Cars, Coaches and Motor Launches

*Fig. 3. Photocell amplifier Cs is the stray capacitance*

Because the bulk of motor car production in this country is ear-marked for export it is perhaps not surprising that the car radio sets that were shown at this year's Motor Show should cater more for overseas than for home users.

The latest Ekco production is the Model CR61 and it provides five manual tuning ranges covering 0.515 to 1.64 Mc/s, 3.3 to 7.4 Mc/s, 0.3 to 10 Mc/s, 11.5 to 12.1 Mc/s and 15 to 15.5 Mc/s. The last three will be seen are the 31-, 25- and 19-metre bands expanded to cover the full scale. In addition there is switch selection of four preset stations, three in the medium and one in the long-wave band.

The receiver is a 7-valve plus rectifier superhet with permeability tuning throughout. It has an R.F. stage, push-pull output and a noise limiter. Miniature valves are used and overall size of the receiver is 7 x 7 x 4½in only. The power unit is separate and so is the control head but this only takes up 6½ x 1½ x 3½in. One or more external loudspeakers can be fitted.

The CR61 is available in the home market and costs £31 10s plus tax and excluding aerial. There is a home version with medium- and long-wave facilities only at £28 7s, plus tax. It is the Model 84.

A number of circuit improvements have been made to the H.M.V. car radio sets shown by Radiomobil in addition to which a new model, the 4020, has been developed for large limousine cars. Designed primarily for the Humber Pullman the set is divided into two parts, control head and main unit, respectively. The former is designed to fit into an ash-tray receptacle just below the off-side rear window and contains the R.F. and frequency changer valves, push-button and manual tuning, on-off and wave change controls. The volume control is separate.

The pre-selection mechanism is similar to that used in the Model 100 and the remainder of the set is basically the same. Separate loudspeakers are, however, employed. The price is £48, plus £12 tax, including installation and aerial.

Other firms showing home and export models include Delco-Remy-Hyatt, Masteradio, Philco, Romac and World Radio (Motorola).

A new application for car radio is appearing in the form of special equipment for motor coaches. Included are facilities for making announcements through a microphone, using the audio stages of the re-
 Highlights of Car Radio —

Receiver as a small public-address amplifier.

Basically the set is a normal car radio with a larger output stage, and provision is made to operate several loudspeakers in the body of the coach. It is fitted in the driver's cab.

Sets of this kind are also being fitted to some of the large motor cruisers, while normal car radio sets were seen in the smaller motor launches and in caravans.

CAR RADIO MANUFACTURERS AT EARLS COURT MOTOR SHOW

Delco - Remy - Hyatt (Delco) (Division of General Motors Ltd.), 111, Grosvenor Road, London, S.W.1.

E. K. Cole Ltd. (Ekco), Ekco Works, Southend-on-Sea, Essex.


Philco Radio and Television Corporation of Great Britain, Ltd., Wadsworth Road, Perivale, Greenford, Middlesex.


Radiomobile Ltd. (His Master's Voice), Cricklewood Works, London, N.W.2.

World Radio Ltd. (Motorola), Edgeware Road, Cricklewood, London, N.W.2.

A comprehensive range of transformers and chokes, from minia
tures with internal mu-metal shields, to power transformers of 170 VA, audio transformers up to 60 watts rating and smoothing chokes up to 20 HW at 250 mA are now available in seven different sizes of container.

The form of construction adopted protects the components against all climatic effects, from extreme cold to extreme heat and high humidity. Corrosion fungus and fumes are excluded and they are particularly well suited for use in aircraft at high altitudes and in land mobile equipment.

New Valves

FIVE new A.C./D.C. valves with 0.1A heaters have been introduced by Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2. They are mounted on BBA bases and the type numbers and functions are as follows:

UCH42 (14-V heater). Triode-hexode frequency changer.

UAF41/UAF42 (12.6-V heater). Var.-mu pentodes with single diodes.

UL42 (45-V heater). Output pentode, 4.2W at 10 per cent with 165V H.T.

UY41 (51-V heater). Half-wave rectifier, 90mA.

A change in the nomenclature of two R.F. power double tetrodes is announced. In future the QVO4-20 and QVO7-40 types will be known as QVO4-20 and QVO7-40 respectively.

Portable Record Player

A BATTERY-OPERATED record player with carrying capacity for nine records has been introduced by Vidor, Ltd., Erith, Kent. The 3-valve amplifier works from a combined L.T. and H.T. dry battery and the whole outfit weighs only 17 lb. The price is £14 14s inclusive of tax.

Pre-set Resistors

A SERIES of miniature pre-set resistors for circuit balancing and matching has been introduced by Electro Methods, 220, The Vale, London, N.W.11. The range of maximum values is from 5 ohms to 1,800 ohms and the rating is between 3 and 4 watts. Silver contacts are used and the slide is adjusted by means of a screw thread. The dimensions are 1/8in x 1/8in x 1/2in.

The new "Mercury" series of iron-cored components, including mains and A.F. types, introduced by Parmeko Ltd., Percy Road, Leicester.

All are vacuum impregnated and hermetically sealed in drawn copper containers with connections brought out through glass seals.

Fixing bushes are provided in both the top and the base of the container so that upright or inverted mounting can be employed to suit surface or under-chassis wiring.

A comprehensive range of transformers and chokes, from minia
tures with internal mu-metal shields, to power transformers of 170 VA, audio transformers up to 60 watts rating and smoothing chokes up to 20 HW at 250 mA are now available in seven different sizes of container.

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MANUFACTURERS' PRODUCTS

"Mercury" Transformers and Chokes

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THE SEE-SAW CIRCUIT

Applications as a Stable Wide-band Voltage Amplifier

PARTLY as a result of its use in war-time radar, but also because it is being realized that it can be used as a versatile feedback amplifier stage the see-saw or anode follower circuit is becoming more and more popular. It has been well described in several journals but these descriptions have usually been confined to the discussion of the conditions required for a gain of unity, for use as a phase reversal stage in push-pull amplifiers. By analogy with the cathode follower the circuit is sometimes called the anode follower—a name to be deprecated as the anode potential does not follow that of the grid;

they are, in fact, reversed in phase.

A gain of unity is by no means essential to the see-saw circuit, and a gain of anything less than the gain of the stage alone (without the see-saw attachments) can be obtained, as will be seen from the following notes.

There are two ways in which the see-saw circuit may be connected. In Fig. 1, is shown a common arrangement which is quite suitable for low-frequency work—up to 10 kc/s, say. This connection is, however, unsuitable for the higher frequencies because as soon as the reactance of the grid—earth capacitance \( C_e \) (shown dotted) becomes comparable with \( R_i \) or \( R_f \), the gain begins to change with frequency. Although an improve-

ment may be effected by the introduction of additional capacitances \( C_i \) and \( C_f \) (shown dotted) across \( R_i \) and \( R_f \) respectively, a feedback independent of frequency cannot be obtained. This is obvious when it is remembered that \( R_a \), \( R_i \), \( R_f \), and \( R_c \) in parallel with the impedance of the valve form a \( \pi \) circuit, and the capacitances \( C_i \), \( C_e \), \( C_f \), and \( C_a \) (the stray anode capacitance) form a loaded \( \pi \) circuit.

If the use of frequencies above the audio range is contemplated, it is preferable to arrange the see-saw as in Fig. 2. It is obvious that the network now forms a loaded \( \pi \) circuit composed of three impedances \( Z_i \), \( Z_f \), and \( Z_a \), each of which is of the same character being composed of a resistance shunted by a capacitance. By making the time constants of the three arms equal (i.e. \( R_i C_i = R_f C_f = R_a C_a \) the \( \pi \) network becomes independent of frequency, and the only capacitance which plays any great part in the attenuation of high frequencies is \( C_a \) to which must be added the apparent capacitance \( C_i \) presented to the anode of the valve by the \( \pi \) network.

Design of the T See-Saw—

If the see-saw is to be designed for a fairly wide bandwidth, as in an oscilloscope amplifier for example, it is usually necessary to make \( R_a \) relatively small, and it is then easy to arrange that the resistance looking back into the \( \pi \) from the anode of the valve is large compared with \( R_a \). Hence it will be sufficiently accurate for most practical purposes to assume that the anode load resistance is unmodified by the introduction of the \( \pi \); but that the capacitance \( C_r \) must be added to \( C_a \) in calculating the high-frequency performance.

The overall gain \( E_{12}/E_{AB} = A \)
can be expressed in terms of three parameters: the gain without feedback \( A_0 = E_{12}/E_{AB} \), the attenuation \( a \) through the \( \pi \) alone from terminals \( AB \) to the grid of the valve, and the feedback factor \( \beta \) which is the attenuation of the \( \pi \) alone from terminals \( 1, 2 \), to the grid. A short-circuited termination is assumed in each case. The overall gain is thus

\[
A = \frac{2A_0}{1 + \beta A_0}
\]

We may proportion \( a \) and \( \beta \) more or less as we please to yield the required overall gain. We could, for example make \( \beta \) approach zero (by making \( R_f \) exceedingly large) and then simply choose \( a \) to give the required
The See-Saw Circuit Again—overall gain. But by doing this we should have thrown away the possibility of reducing the distortion and output impedance by feedback. If we go to the opposite extreme and make \( R_1 \) very small and control the gain almost entirely by feedback, then the input impedance becomes very small and the stage is consequently difficult to drive. Another assumption has to be made before useful design data can be derived. The assumption has been made here that \( (R_f + R) = R_0 \) as this represents a reasonable compromise in most practical cases between too little feedback, and too low an input impedance.

As will be seen from the Appendix (equation 5), the analytical results are not very convenient to handle, and the design of a see-saw stage is more easily tackled graphically with the aid of the curves of Fig. 3. These show \( A \) (over the range 1 to 100) been drawn for \( A_0 \) infinitely high so the results with values of \( A_0 \) exceeding 500 may be estimated. Having found a suitable value of \( R/R_1 \) from the curves—by interpolation if necessary—and assumed a convenient and reasonable value for \( R_0 \), it is a simple matter to find \( R_f \) and \( R_1 \) from \( R_f = R/R_0(1+R_f/R) \) and \( R_1 = R_a - R_f \). Trimmer condensers may then be added to make the time constants equal in all the arms of the T network. The input resistance is then virtually \( R_0 \), and the input capacitance \( C_1 \) is given by equations (9) and (10) of the Appendix.

The output resistance is modified by the feedback, and this is conveniently described as a low resistance \( R_1 = R_0/R + R_f \). From the Appendix we may take the result

\[
R_f = \left( \frac{1}{E_m} + R_0 \right) F \quad \text{and the factor} \quad F \quad \text{may be taken from the curve so labelled in Fig. 3.}
\]

The high-frequency response of the stage is determined by the stray capacitance across \( R_f \), and this is composed of \( C_a \) and \( C_1 \). Calling this total capacitance \( C' = (C_a + C_1) \), the frequency at which the response is three decibels down is

\[
f_s = \frac{160}{C'R'} \text{in } \mu \text{sec/mc/s} \quad \text{and } R' \text{ in k}\Omega.
\]

For most purposes it is sufficiently accurate to assume that \( C_1 = C_1 \); see equation (10a) in the Appendix.

Direct Coupled See-Saw.—The L.F. response of the circuit of Fig. 2, is limited by the blocking condenser \( C_1 \), and if a response down to zero frequency is required, the direct-coupled see-saw of Fig. 4 may be adopted. The arrangement is not generally suitable for an input stage, because it has a relatively low input resistance and the gain is partially dependent on the internal impedance of the signal source. The circuit is however suitable for subsequent stages. It will be remembered that for the circuit of Fig. 2, we made the reasonable assumption that \( (R_f + R_1) = R_0 \) thus fixing the relative values of feedback and attenuation for a given overall gain. In the circuit of Fig. 4 we need to
APPENDIX

The resultant valve anode current i_a is

\[ i_a = \beta v_\text{m}(\beta V_{12} - i_a R_b) \]

or

\[ i_a = \frac{\beta V_{12} - i_a R_b}{1 + \beta R_b} \]

Hence the apparent anode resistance is

\[ R_a = \frac{V_{12}}{i_a} = \frac{1 + \beta R_b}{\beta} R_m \]

or

\[ R_a = \left( \frac{1 + \beta R_b}{\beta} R_m \right) g_m \]

Substituting (17) in (15) we find

\[ R_a = \left( \frac{1 + \beta R_b}{\beta} R_m \right) g_m \]

Referring to Fig. 4

To find R_i and R_i' for a given overall gain, A

\[ A = \frac{A_{EAB} R_i}{R_i} \]

where E = E_m - E_n and \( \alpha \) and \( \beta \) are defined by (2) and (3).

Hence

\[ \alpha + \beta = \frac{R_i R_{s+} + R_i R_{s-}}{R_i (R_i + R_{s+})} = A \]

Where

\[ R_i = \frac{R_i (1 - E)}{E (R_i + 1)} \]

Equating (15) and (16),

\[ R_i = \frac{(1 - E)(A + 1)}{E - A/A_0} \]

Substituting (17) in (15) we find

\[ R_i = \frac{(1 - E)(A + 1)}{E - A/A_0} \]

To find the apparent anode resistance, R_a of the valve.

From (13),

\[ R_a = \frac{1}{\beta} \left( \frac{1}{g_m} + R_b \right) \]

Substituting (17) and (18) in (3), and substituting the result for \( \frac{1}{\beta} \ln \) in

\[ R_a = \frac{A + 1}{E - A/A_0} \frac{1}{\beta} + R_b \]

Extracting the relevant results from the Appendix:

\[ R_a = \left( \frac{1 - E}{A + 1} \right) R_b \]

where \( E = E_m + E_n \)

and

\[ R_a = \left( \frac{1 + E}{A + 1} \right) R_b \]

As before, the output resistance R' = R_b R_a / (R_b + R_a), and

\[ R_o = \frac{A + 1}{E - A/A_0} \frac{1}{\beta} + R_b \]

The calculations of H.F. performance are exactly as before.

It is hoped that the foregoing notes will facilitate the design of see-saw circuits. They can be used in standard laboratory amplifiers, oscilloscope amplifiers, and in fact whenever a stable voltage amplifier of low output impedance is required. The writer has found the circuit of particular use in oscilloscope amplifiers when a wide-band frequency response (e.g. 0 c/s - 5 Mc/s) is needed, the effective load capacitance is liable to variation according to the conditions of use, and adequate inductive compensation is consequently difficult of satisfactory realisation. Occasionally the see-saw circuit might be useful as a low gain phase-inverting video amplifier.

Thanks are due to the writer's colleague, Mr. T. C. Nuttall, for helpful discussion on the applications of see-saw circuits.

REFERENCES


NEW TELEVISION RECEIVERS

THREE new television receivers have been added to the range made by Ultra Electric, Western Avenue, London, W.3. The Model D570, costing £119 15s 6d, is of the superheterodyne type with 21 valves and has automatic frequency control as well as A.V.C. on the sound channel. The 21in tube gives a black-and-white picture 10in x 8in.

Model W570 is technically similar to the D570 but has a less expensive cabinet and costs £90 4s 6d, while the W470 with 20 valves and a picture 7in x 6in costs £77 6s 8d, including tax.
WORLD OF WIRELESS

Set Manufacture ♦ Television News ♦ Naval Recruiting ♦ U.N. Radio

Relaxation of Controls

The Government Order (S.R. & O. 226/47) controlling the manufacture and supply of broadcast and television receivers and radio-gramophones has been revoked. Under this Order, which was designed to limit production for the home market and encourage export, licences were issued yearly for definite quotas for sets for this country, while for export, licences were issued against firm orders, or, in the case of manufacturers with a well-established export trade, for an export production programme.

Among the many other products and materials on which control has been withdrawn are phonograph records and accumulators.

U.S. Television Standstill

The mushroom-like growth of American television has been stopped. The F.C.C. has decided not to issue further licences for the building of television stations to operate between twelve of the thirteen channels until a decision has been reached on the question of possible changes in television engineering standards. This may take six or nine months.

There are at the moment about forty stations on the air and some eighty in the process of building. It is, however, the number of pending applications for licences which is significant—some 300.

The position has apparently been reached where the number of proposed television stations has outgrown the accommodation of the thirteen channels available. These channels range from 43-216 Mc/s and the decision affects all but the lowest—44-50 Mc/s.

Our Washington contemporary, Broadcasting, states that the F.C.C. made it clear that it intends to provide more space for television in the 175-890 Mc/s band.

Television Française

The note in our November issue on the provision of high-definition television equipment for France was a little ambiguous.

The position is that the Paris 455-line television system is to continue until 1956, but during this period experiments with higher definition systems are to be carried out by the broadcasting authority, Radiodiffusion Française. To this end it has accepted from the Compagnie Radio-Industrie the 810-line equipment referred to. R.D.F. has also asked the Compagnie Française Thomson-Houston to provide equipment of 729 lines, and still higher definition gear (1029 lines) is being supplied by the Compagnie des Compteurs.

A new transmitter is to be erected at Lille, which it is anticipated will provide a higher definition service. The decision on this is expected to be delayed until the three experimental systems have been tested. The station is planned to be in service toward the end of 1949.

Naval Radio Officers

The Admiralty has announced a scheme for Short Service Commissions in the Electrical Branch of the Royal Navy to former officers of the Royal Naval Volunteer Reserve who were employed on technical duties connected with radar, wireless and air radio.

Candidates, who must have completed one year's mobilized service as an officer, and be under the age of 45 on January 1st, 1949, will be entered in the substantive rank, and with the relative seniority in that rank, which they held at the time of their release. They will be eligible for promotion under the normal rules. Service will be for five years on the Active List and four years on the Emergency List.

Applications should be made to the Director of Naval Electrical Department, Admiralty, Queen Anne's Mansions, London, S.W.1, from whom further details are obtainable.

R.N.V.(W).R.

With the object of training telegraphists to serve in the fleet in a national emergency until the ordinary mobilized men have been trained for the task, the Admiralty re-constituted some months ago the Royal Naval Volunteer (Wireless) Reserve. The prescribed strength is 39 officers and 1,200 telegraphists.

So far only 200 ratings have been enrolled at the training centres established in London, Grimsby, Hove and Northampton. Twenty-five other training centres will be equipped. Training is essentially operational. When a trainee has reached a sufficiently advanced stage in his training he is lent a naval transmitter and receiver for home use, and is granted an allowance of £3 a year for maintenance and operation costs.

Trainees must be between 17 and 26, unless they have served in the Navy, when they are eligible up to 45. Period of service is five years.

Details of benefits, bonuses, periods of training, etc., are obtainable from Naval Reserves, Admiral, Queen Anne's Mansions, London, S.W.1.

Long-Distance Television

All records for long-distance television reception were broken recently when a transmission from Alexandra Palace was resolved in Cape Town—nearly 6,000 miles.

Having picked up on occasions the television or direct channel, an amateur, H. Reider, secured from this country a standard Pye BriT receiver in the hope of receiving a picture. This set was used successfully without pre-amplification.

It has long been predicted (see "Short-wave Conditions," October issue) that long-distance working on very high frequencies would frequently be possible during the month.

Australian Broadcasting

For some time there has been agitation in Australia for the whole of radio administration to be taken out of the hands of the Post-master-General and placed under the control of a communications board as is done in the U.S.A.

A step in this direction has now been taken by the Federal Government which proposes the transfer of the control of broadcasting from the P.M.G. to a board of three members having no financial interest in broadcasting or its industries. This board will not replace the Australian Broadcasting Commission which will continue to operate the thirty national stations. The hundred or so commercial stations operated by individual companies or organizations. The activities of these stations are co-ordinated by the Federation of Commercial Broadcasting Stations.

United Nations Radio

At very short notice, the French broadcasting organization, aided by the French radio industry, has installed an exceptionally complete equipment for the broadcasting and recording of speeches at the Paris session of the United Nations Organization. About 28 hours daily of short-wave broadcast transmissions can be effected, and facilities are provided for up to 35 simultaneous commentaries in duplex. Links with the broadcasting systems
of many countries allow of direct or delayed recorded re-broadcast. Some 16,000 disc recordings are expected to be made during the session.

In addition to the facilities provided by R.D.F., the technical services of the U.N. organization have installed in the Palais de Chaillot equipment enabling delegates to hear speeches simultaneously translated into any one of the five official languages.

**Amateur Licences**

The present arrangement whereby Service experience is accepted by the P.M.G. as giving exemption from parts of the examination for an amateur transmitting licence will be slightly modified from January 1st. From that date the exemption will be granted only if applicants have been engaged in the specified Service trades or duties within two years of the date of the application for a licence.

**OBITUARY**

It is with regret we record the death on November 3rd of H. Bevan Swift, who was past president of the R.S.G.B. He was 74 years old. Following his presidency of the society from 1931 to 1933 he was honorary editor of the R.S.G.B. Bulletin until 1940. In recognition of his work for the society which went back to the pre-broadcasting days, he was elected an honorary member in 1940. He will be remembered by many as a chairman of the old T. & R. Section.

**PERSONALITIES**

C. G. Allen, the well-known radio amateur (GAI;) and sales manager of McMichael Radio, has been appointed to the company’s Board of Directors. It was in 1923 that he founded McMichael’s, prior to which he was a radio operator with the Marconi International Marine Communication Co. Radio is his business and hobby.

Another appointment to the Board is that of J. A. Klein, who is export manager.

H. Bishop, C.B.E., B.Sc.(Eng.), chief engineer of the B.B.C., has been elected a vice-president of the I.E.E. He was chairman of the Radio Section for the 1941-42 session.

Dr. E. H. Colpitts, who is known throughout the radio world because of the circuit which bears his name, has been awarded the Cresson Medal of the Franklin Institute, New York, for his work in the development of long-distance radio communication.

P. R. Coursey, B.Sc.(Eng.), technical director of Jubilee, gave a lecture on the standardization of components to 150 technical officers of the Swedish Armed Forces during the recent exhibition of British radio components in Stockholm.

H. J. Denham, C.B.E., M.A., D.Sc., served as a member of the Ordinance Board with the rank of Colonel from 1941 until 1946, has been re-appointed as a civilian member of the Board which is the inter-Service authority on armaments. Dr. Denham has also been appointed Head of the Electronics Division of the Board.

H. Faulkner, Deputy Engineer-in-Chief, G.P.O., has gone to Mexico as joint leader of the British delegation to the International Administrative High-Frequency Broadcasting Conference which opened on October 23rd. The delegation also includes L. W. Haynes, F. Axon and R. A. Craig of the B.B.C. and P. W. Fryer and P. N. Parker of the G.P.O.

L. W. Haynes, who is head of the B.B.C. Overseas Engineering Information Dept., is resigning from the service of the Corporation at the end of the year in order to take up his recent appointment to the International Radio Consultative Committee (C.C.I.R.) as vice-director for broadcasting. The C.C.I.R. is one of the constituent bodies of the International Telecommunication Union. Mr. Haynes, who has been with the B.B.C. for over 25 years, is at present in Mexico for the H.F. Broadcasting Conference. When he takes up his new appointment in January he will reside in Switzerland.

**IN BRIEF**

Licences.—Despite the increase of 4,000 in the number of television licences issued during September, bringing the total to 14,600, the total number of receiving licences had decreased during the month by approximately 13,000. The only apparent reason for this is the tardiness of listeners in renewing expired licences. The comparative figures are: August, 11,324,000; September, 11,311,200.

Danish Television.—A correspondent points out that, in spite of the enthusiasm with which the public received the television demonstrations during the British Exhibition, the attitude in official circles is "wait and see what is adopted as a European standard." No decision is likely to be taken, however, until the attitude of Norway and Sweden is known. Opinion is sharply divided on the question of definition. It is understood the offer, at a nominal price, of the Pye equipment used for the demonstrations has not been accepted.

Navigation.—H.R.H. the Duke of Edinburgh will open the exhibition "Navigation through the Ages," which is being organized jointly by the Institute of Navigation and the Royal Geographical Society, on December 17th. It will be open free to the public from December 18th to January 20th at the R.G.S., 1, Kensington Gore, London, S.W.7. Radio aids will be a feature of the exhibition.

Radiolympia.—The Radio Industry Council has appointed an organizing committee for the Sixteenth National Radio Exhibition, which is planned to hold at Olympia next autumn. The chairman of the Committee is F. W. Perks (R.M.I.) and the vice-chairman is V. M. Roberts (B.T.I.). The remaining seven members are R. Arbib (Multecore), B. J. Axtsen (S.T.C.), A. F. Balgin, H. J. Dyer (Phillips), F. V. Green (S.T.C.), F. J. Jones (Marconi- phone) and W. M. York (Ekco).

Components Exhibition.—The sixth annual private exhibition of radio components, materials and test gear, organized by the Radio Component Manufacturers’ Federation, will be held at Grosvenor House, Park Lane, London, W.C.1, from March 7th to 9th.

**E.M.I. Evening Courses.**—Three evening courses, each of three months’ duration, dealing respectively with Practical Television, Television Principles and Practical Radio, are to be introduced by E.M.I. Institutes. Details of the courses, which are planned for students with some knowledge of the fundamentals, are obtainable from

**SOBELL INDUSTRIES** installed a specially built television transmitter at the recent Ideal Homes Exhibition in Birmingham in order to demonstrate their receivers on a closed circuit.
World of Wireless—

the Principal, E.M.I. Institutes, Ltd., Grove Road, Chiswick, London, W.4.

Brit.I.R.E. Officers.—As previously announced, the new president of the Brit.I.R.E. for 1948-49 is L. H. Bedford, who succeeds the Earl Mountbatten, who is now vice-president. W. E. Miller, Editor of our associated journal The Wireless & Electrical Trader, who has been chairman of the council since 1946, was elected a vice-president. The new ordinary members of the council are Prof. H. M. Barlow, H. A. Brooks, Cdr. A. J. B. Naish, L. H. Fiddle and H. C. Thomas. J. W. Ridgeway was re-elected on the council.

Outward Form.—Various stages in the development of the Ecko "Radiotime" receiver and the Murphy V16 television set are illustrated and described in the exhibition "Design at Work" at Burlington House, Piccadilly, London, W.1.

Europe's New Wavelengths.—The list of Copenhagen Frequency Allocations, published in the November Wireless World, is now available from our Publishing Office as a reprint, price 6d post free.

Great Circle Map.—Many reprints of the Wireless World Great Circle Projection Map have been issued since it was first drawn by the late J. St. Vincent Plets at the time when world-wide radio communication was beginning. A new edition, containing extra tabulated information on standard times and geographical positions, has just been issued. This map, giving the true bearing and "radio" distance to any part of the world from London, is obtainable from our Publisher, price 2s 6d, plus 3d postage and packing.

"W.W. Diary."—All copies of the Wireless World Diary, 1949, have now been distributed to stationers and book sellers. The eighty reference pages contain information, mostly technical, on the kind of radio often received by radio men but seldom memorized. The price, including P.T., is 3s 4d.

INDUSTRIAL NEWS

Pye Australasia, Ltd., is the name under which a new company, formed in Australia jointly by Pye, Ltd., of Cambridge, and Electronic Industries, of Australia, will operate.

Chilian Agency for valves and condensers is sought by John Cameron Reid & Hijos, Agasinas 1870, Of.131, Santiago. Information regarding the company may be obtained from the Export Promotion Department, Board of Trade House, North Millbank, London, S.W.1, quoting ref. 40424/48.

P.E.R.A.—The official opening of the Production Engineering Research Association took place at S. M. The Lodge, Melton Mowbray, which has actually been established for some months, took place on October 26th. P.E.R.A. has been established to assist the engineering industry in improving its efficiency of production.

With the January issue, the price of WIRELESS WORLD will be 2/-

Wireless World

December, 1948

PRESS - BUTTON RECORD PLAYER—In this new single-record player introduced by the Plessey Co., Ilford, Essex, the pickup is automatically lifted and placed at the start of 10-in. or 12-in. records by pressing the appropriately marked operating lever. A moving-iron pickup is standard and the turntable is rim-driven by a constant speed A.C. motor.

It is assisted financially by the Government, which donates £1,000 p.a. for every £1,000 subscribed by industry, and recently granted £25,000 for the purchase of equipment.

Iron-cored Components.—Samples and prototypes, as well as long-production runs, of power and A.F. transformers and inductors, can be handled by a new firm, the Transformer Equipment Co., Ltd., St. Mark's Road, Bromley, Kent. The range of sizes extends from miniature communications components to units of 10kVA capacity.

Wright & Wearie point out that although restrictions prevent the import of coils and coil products complete to certain countries it is possible to supply the mechanical parts of a coil pack, leaving the manufacturer to assemble his own coils. The company's three-coil unit, with pre-formed wiring and built-in wave-change switches, which is totally enclosed and measures 4½ x 4½ x 6½ in, can be supplied without cores.

Plastics "Hall Mark."—A scheme has been launched jointly by the British Plastics Federation and the British Standards Institution for the certification of plastic materials and products. At present the certification mark, which is in the form of a circle with the initials B.S. in the centre and B.I.P. on the left-hand side, is only applicable to moulding powders made from phenol formaldehyde and urea formaldehyde resins and certain cements made from these.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Fixed Resistors for use in Communications Equipment, with special reference to High Stability Resistors" by L. R. Coursey, B.Sc. (Eng.), at 5.30 on December 1st. Discussion on "V.H.F. Mobile Radio-Telephone Services" opened by P. H. Hughes, at 5.30 on December 14th.

The above meetings will be held at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group.—"Three-Dimensional Cathode-Ray Tube Displays," by E. Parker, M.A., and P. R. Wallis, B.Sc. (Eng.), at 6.15, on December 20th at King's College, Newcastle-on-Tyne.

Northern Ireland Centre.—"Analysis-Synthesis Telephony, with special reference to the Vocoder," by R. J. Halsey, B.Sc. (Eng.), and J. Scalféed, Ph.D., at 6.45, on December 14th, at Queen's University, Belfast.

British Institution of Radio Engineers

London Section.—"Power Applications of Microwave Waves," by J. B. Birks, B.A., at 6.0, on December 16th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Heating by Centimetric Power," by R. Keitley, B.Sc., at 7.0, on December 16th, at the Technical College (Room A), The Butts, Coventry.

Mersyside Section.—"Negative Feedback," by J. Durnford, at 6.35, on December 15th, at the Incorporated Accountants' Hall, Derby Square, Liverpool, 2.

Radio Society of Great Britain


Television Society

Midlands Centre.—"Studio Technique in Television," by D. C. Birkinshaw, M.H.E., M.D., at 7.0, on December 15th, at the Chamber of Commerce, New Street, Birmingham.

Institute of Physics

Electronics Group.—"Gas Discharge Tubes," by G. F. Heymann, M.Sc., at 7.0, on December 7th, at the University, Glasgow.

British Sound Recording Association


Institute of Navigation


Royal Society of Arts

"Television and Education," by Mrs. Mary Adams, at 6.0 on November 29th at the R.S.A., John Adam Street, London, W.C.2.

Junior Institution of Engineers

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

The "Belling-Lee" Page

When we first introduced the L.638 range of eighteen-foot *5 "Skyrods" for direct chimney mounting (without pole) we had a number of perfectly logical enquiries as to their relative performance as anti-interference aerials compared with the old-twelve foot collector on a twelve-foot pole. When we were faced with the present difficulties in getting just the material we required, and with the high prices of everything, our research department were set the fresh problem. After a lot of work, and a great many measurements it was found that in most cases the sacrifice of the pole was not so important provided we increased the length of the collector.

Faulty Parts

The other day the writer of these notes had the misfortune to have a serious fault develop in a new car. The maker was prompt in authorising a free replacement of the faulty part, but the account from the garage for carrying out the work was far in excess of the value of the part. "Belling-Lee" adopt the same procedure as the motor manufacturer. We will replace faulty goods under guarantee but we cannot contribute towards any installation charges which may be incurred.

Incidentally, the car mentioned above cost between four and five hundred pounds and is rusting in places within a few months of delivery, and underneath it is rusty. The makers will not do anything about it. It's a good car for all that. Though our aerials cost but a fraction of the cost of a car, we do give them the best rust prevention available at the moment, but we must admit that we have not yet been able to return to our pre-war standard.

Skyrod Dimensions

Midland Television Frequencies

The "Belling-Lee" television aerials*3 already sold or installed in this area were produced before the decision to allocate frequencies at the Wave-length Conference, which necessitated a slight reduction in the frequencies allocated for the Midland television service, and before the decision to use asymmetric side bands for the vision transmission. These changes were made by the B.B.C. after consulting the Radio Industry when we, and other manufacturers, assured them that the effect of these small changes would be negligible as regards sensitivity, bandwidth and the polar diagrams of the aerials.

When on this subject, we have had to disillusion some correspondents who thought that by cutting down the elements they could convert a dipole and reflector made for London, to one suitable for the Midland transmitter. Quite a number of people had overlooked the fact that the length of the cross arm between the dipole and its reflector is also critical.

Connecting the Feeder the Right and Wrong Way

Most television receivers have their aerial input terminals marked " A " and " E " and " A " should be connected to the top element of the dipole, and " E " to the lower. When using coaxial*1, the inner conductor should connect the top element of " A " and the screen should connect the lower element to " E. " There is a noticeable improvement in most cases when this connection is carried out correctly.

When balanced feeder L.336*2 is used it is easy to tell one lead from the other as one is bare copper. With other present types a continuity test is necessary to ensure correct connection, but we have no doubt that within a reasonable time all makers will arrange for the leads to be distinguished. L.336 type of balanced feeder was originally made to a 1938 specification issued by Belling-Lee,*1 and for years was the only 80-ohm feeder of its kind, but lately other manufacturers have paid us the compliment of producing something similar.

Attic or Loft Television Aerial

Whereas this indoor aerial*4 was designed to conform with the shape of the average roof and so enable the user to take full advantage of available height, it will function if mounted upside down, i.e. with its legs in the air. If used like this it may be unnecessary to enter the loft, just lift the flap, coax the assembly through, and fix it to a joist within reach after having satisfied yourself that the tips are not close to the water tank or some run of conduit or other metal. The farther they are away from such conductors the better. The easy way is seldom the best.

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A Merry Christmas to our numerous supporters—and this is a very appropriate time to announce

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which provides coverage for the Television Sound band, in addition to two Short, Medium, and Long Wave bands.

Circuit: R.F., Oscillator, two I.F. with Variable Selectivity, Diode Detection, Magic Eye indicator, two Tone Control Valves, terminated by our latest paraphase coupled push-pull amplifier with negative feedback, driving a Phase Inverter Dual Suspension Auditorium Speaker.

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AGENTS: Barnes & Avis, Reading; Bowers & Wilkins, Worthing; Binns Ltd., Newcastile; Dalton & Sons Ltd., Derby; Clark & Sons, Isle of Wight; Hickie & Hickie Ltd., Reading (and branches); Holley’s Radio Stores, London; S.E.S.: Jewkes & Co., Birmingham; Thomas Lynn & Sons, Andover; Marriotts Ltd., Bristol; Needham Engineering Ltd., Sheffield; Pank’s Radio, Norwich; Sound Ltd., Cardiff; Bernhard Smith, Barnstaple; Sound Services, Jersey, C.I.; Precision Services, Edinburgh; Seals Ltd., Southea; G. E. Samways, Hazel Grove; Weybridge Radio Electric, Weybridge; West End Radio, Farnham; Vailance & Davison Ltd., Leeds (and branches).

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3.—Extension of Output Voltage Range

By M. G. SCROGGIE
B.Sc., M.I.E.E.

We come lastly to the problem of extra-wide ranges of output voltage. Maximum \( V_o \) can be extended in the upward direction by increasing the supply voltage and the maximum value of \( R_1 \); but, as the working-out of a design with the aid of Fig. 4 showed, unless the minimum \( V_o \) is raised equally it is necessary to provide series valves capable of greater anode dissipation. Alternatively, and more economically, the full range of control can be split up into two or more bands by means of a switch controlling \( E_1 \) (the source voltage) and \( R_{1a} \) simultaneously in steps (footnote reference 4, Part 2). The value of \( R_{1a} \), if used, ought also to be changed; but in practice it will be found that when \( R_{1a} \) considerably exceeds \( R_2 \) the error due to omitting \( R_{1a} \) altogether is unimportant.

Lowering the minimum \( V_o \) is less straightforward. As we saw in Part I, the limiting condition with the circuit considered until now is that \( V_o \) must be sufficient to supply \( V_{ni} \), \( V_{n2} \) and \( V_{1g1} \) (max) in series. The lowest available \( V_{ni} \) is about 50 V; \( V_{n2} \) can hardly be reduced below 20 V, and in our example \( V_{1g1} \) (max) was 66 V, making 140 V about the lowest practicable \( V_o \). Further reduction, down to perhaps 100 V, could be obtained at the expense of range of \( V_o \) control.

For some purposes, however, it may be desirable to extend the range down to zero volts. This can be done by providing a source of negative potential for \( V_2 \). Such a source can conveniently be made to add still further to the facilities of the unit, by providing an external grid bias supply.

Although the modification to the circuit is fairly obvious in principle, there are a number of practical details that require care and attention. These will be discussed with reference to Fig. 13, an extension of the previous design, to cover 0-500 V in two equal bands.

Since \( N_1 \) cannot be fed from the main stabilized output it is necessary to consider very carefully the effects of its A.C. resistance. Any voltage variations across it are amplified perhaps 2,000 times and injected into the main supply, and are not reduced by feedback. The most effective way

Fig. 13. Modification of Fig. 7 to provide output voltage variable over the range 0-500 V. The resistors underlined at least, should be wire-wound. The outputs obtainable from the negative terminals are:—A, 0 to —9 V, or fine control of B if shorted to 0; B, —9 to —100 V, or 0 to —100 V with fine control if A shorted to 0; C, 0 to —100 V with fine control.
Stabilized Power Supplies—
of avoiding them is to stabilize the auxiliary negative supply; but this is somewhat elaborate, necessitating a separate transformer H.T. winding, valves, etc.
The alternative is to smooth the negative supply very thoroughly. It should be noted that while hum can be reduced by reactances, slow fluctuations in mains voltage are reduced only by series resistance. It is therefore necessary for this resistance to be high. The supply in Fig. 13 is taken from 420 V tappings on the mains transformer, using a pair of Westinghouse 16HT28 metal rectifiers. The 620 V tappings, with appropriately rated components, would be better still. Current in this supply should be kept as small as possible, the requirement for large smoothing resistance overriding the rectifier maximum rating of 15 mA. The reservoir capacitance is limited by the rectifier rating to 1 μF.

The effect of the resistance between screen grid and cathode of V2 is quite different in this circuit. It forms one arm of a bridge, the others being R1, R2, and R1 (completed by the negligible R3). V2 (grid to cathode) is the detector, and the negative supply is the signal source. To eliminate the effect of slow fluctuations in the latter completely, therefore, it is only necessary to make R6R7 = R1R2/R3. Such a resistance, being quite insufficient to supply V2, must be supplementary to a tube N3; 0.2kΩ would usually do.

Unfortunately the value of R6 = R7 alias rX3, needed to balance the bridge varies directly with R1, which in this type of unit obviously varies a lot. It can be ganged with R19 and the voltage range switch; a rather elaborate device which may incline one more favourably to a stabilized negative source. This balance is rendered ineffective for hum and other rapid fluctuations by the capacitor across R1. A balancing capacitor across rX3 would have to be very large, and in practice it has been found better to apply most of the available capacitance in the hum filter. Some is useful across N3, however, to suppress random noise.

Since the fluctuations in the unstabilized negative source correspond only partially with those in the main supply, adjustment of rX3 is not very effective for neutralizing R1, and still less R19. Fig. 10 can be applied successfully, but Fig. 11 and 12 (Part 2) are not directly applicable. Hogg has suggested a modified form in which R2 is inserted in the negative main supply as before, while in place of R3 there is a potential divider across the negative source. The parallel resistance of the two resistors composing it must be equal to R2, and their individual values such as to apply the correct standing Vz. Changes of Vz are thus passed to the control grid, but R2 has to be several times greater than in Fig. 11 to allow for the step-down in potential. Moreover the current to be supplied by the negative source is considerably increased. It was considered that these drawbacks were not outweighed by the advantage of separate current feedback, especially as Fig. 10 can be adjusted to do the same thing more simply, though at some slight loss of mains voltage stabilization.

Connecting the heater of V2 to cathode was found to introduce about 10 mV of hum, which could be avoided by transferring it to the zero volts line. If N3 has a tendency to go out when Vp is adjusted towards zero, it is because the anode of V2 is "bottoming," causing I2 to increase sharply. The tendency can be reduced by increasing rX3 or preferably by removing the cause such as by reducing Vz or increasing R5.

The procedure for calculating resistance values, etc., is the same as for Fig. 7. The grid bias scheme calls for no comment, except to point out that the outlets are not to be used for supplying appreciable current.

The voltage range switch ought, of course, to be capable of safely handling the high voltages, up to about 1750 V peak, across the transformer. One of the old-fashioned "anti-capacity" types, slightly modified to increase the leakage paths, has been found satisfactory.

It can be seen from all this that the facility of voltage control below 100–200 V necessitates considerable elaboration of the unit and reduces the possibilities of obtaining a high degree of stabilization. By accepting some restriction on the output current and the regulation, one or more output voltages, variable down to zero, can be obtained quite simply as additions to the main highly-stabilized output. This device is the subject of an article to follow.

APPENDIX

Fig. A shows the theoretical circuit of a stabilizing unit of the type considered, and Fig. B relates the quantities shown to a current/voltage diagram such as Fig. 4. Increments of these voltages and currents are denoted by the prefix d; and it must be borne in mind that dI0, I0, etc., are by no means constant, and their values must be related to the particular working points considered, while if the increments are not infinitesimal the valve parameters must be mean values.

It is assumed that the voltage and current changes are slow enough for reactance to be neglected. Of course the system could be considered more generally by substituting complex impedances for resistances. The results given here do not apply to hum.

Although the sign of equality is used in all the following equations, they are subject to the approximations stated.
The interesting performance characteristics are:

(i) The stabilization ratio, as regards variations in $E_i$ other than $H_i$, is virtually independent of $V_i$, is the voltage gain of $V_2$ via its screen grid.

(ii) $R_0$, the output resistance, defined as

$$R_0 = -\frac{\Delta V_o}{\Delta I_o}$$

(F, constant) . . . . (2)

In the following, all current increments through $R_1$, other than $\Delta I_o$ are neglected.

From valve theory

$$\Delta I_o/\Delta V_o = \Delta V_1 + \mu_1 \Delta V_{1+2}$$

Also

$$\Delta V_1 + \Delta I_1 R_1 - \Delta V_0$$

Hence $\Delta I_o/\Delta V_o = \mu_1 \Delta V_{1+2}$

Assuming $V_2$ is a pentode, whose anode current, $I_2$, is virtually independent of $V_{2e}$,

$$\Delta V_{1+2} = \Delta V_{2e} - \mu_1 \Delta V_{2-2} - \mu_2 \Delta V_{2e}$$

where $V_{2e}$ is the anode feed voltage for $V_2$, relative to $V_o$.

Also $4V_i$ is the voltage gain of $V_2$ via its grid, $m_2$ is the voltage gain of $V_2$ via its grid screen.

By defining the voltage variations of the $V_2$ electrodes $m_2$, in terms of $E_i$, $V_o$ and $I_o$, according to the circuit conditions, and substituting in (3), $S'$ and $R_0$ can be evaluated.

In the circuit of Fig. 6 and Fig. 7, neglecting $r_{1+2}$ in comparison with $R_1$,

$$\Delta V_{1+2} = 0$$

$$\Delta V_{2e} = \mu_1 \Delta V_{1+2}$$

$$\Delta V_{2-2} = (\mu_1 + \mu_2) \Delta I_1 R_1$$

$$\Delta V_{2e} = \Delta V_{2e} + \mu_1 \Delta V_{1+2} + \mu_2 \Delta V_{1+2}$$

Substituting in (3) and (4),

$$I_o/\Delta I_o + \Delta V_{1+2} = E_i q - 4V_i$$

where $q = 1 + \mu_1 R_1$.

$\Delta I_o = \mu_1 m_2 R_1$ . . . . . . . (5a)

$\mu_2 = \frac{m_2}{m_1} = $ amplification factor of $V_2$, control grid to screen grid, and $q$ is neglected in comparison with $\mu_1 m_1 p_0$.

Substituting this and (1) in (5a), and neglecting $r_{1+2}$ in comparison with $\mu_1 m_1 p_0$,

$$S' = q \mu_1 m_1 p_0$$

If the cathode and screen-grid potentials of $V_2$ are constant, $q = 1$, and

$$S' = \mu_1 m_1 p_0$$

i.e., the stabilization ratio as defined by (1) is equal to the overall gain in the feedback loop.

$q$ can also be made equal to 1 by making

$$R_0 = \mu_2 R_1 R_1$$

Also from (2) and (5a), if $E_i$ is constant, so that $\Delta E_i = 0$,

$$R_0 = \frac{r_{1+2} + q R_1}{\mu_1 m_1 p_0}$$

If $q = 1$ for either of the reasons given above for (7a) or (8a),

$$R_0 = \frac{r_{1+2} + q R_1}{\mu_1 m_1 p_0}$$

i.e., the internal resistance of the unit is divided by the stabilization ratio.

If $S'$ is made infinite, as in (9a),

$$R_0 = \frac{r_{1+2} + q R_1}{\mu_1 m_1 p_0}$$

i.e., the source resistance $R_s$ is cancelled by input feedback.

To cancel the valve resistance too and make $R_o = 0$, put $r_{1+2} + q R_1 = 0$, i.e.,

$$R_0 = \frac{r_{1+2} + q R_1}{\mu_1 m_1 p_0}$$

in which case

$$S' = \mu_1 m_1 p_0$$

i.e., the anode feed condition multiplies the apparent source resistance by the divisor ($\mu_1 + 1$).

$(\mu_1 + 1)$ can be made equal to $\mu_1$.

Assuming $m_0 > \mu_1$,

$S' = \mu_1 m_1 p_0$ . . . . . . . (6b)

If $V_2$ anode is fed from the anode side of $V_1$, so that $\Delta V_{2e}$ is written in (4), the equations (5a) to (1c), are modified thus, respectively,

$$\Delta I_o/\Delta I_o + \Delta V_{2e} + \mu_1 \Delta V_{2e}$$

Assuming $m_0 > \mu_1$,

$$S' = \mu_1 m_1 p_0$$

i.e., the anode feed condition worsens the stabilization ratio by the divisor ($\mu_1 + 1$).

$(\mu_1 + 1)$ can be made equal to $\mu_1$.

Assuming $m_0 > \mu_1$,

$S' = \mu_1 m_1 p_0$ . . . . . . . (7b)

$V_{2e}$ and $V_{2e}$ constant $S' = \mu_1 m_1 p_0$ . . . . . . . (7b)

If $V_2$ anode is fed from the anode side of $V_1$, so that $\Delta V_{2e}$ is written in (4), the equations (5a) to (1c), are modified thus, respectively,

$$\Delta I_o/\Delta I_o + \Delta V_{2e}$$

Assuming $m_0 > \mu_1$,

$S' = \mu_1 m_1 p_0$ . . . . . . . (8b)

If $V_2$ anode is fed from the anode side of $V_1$, so that $\Delta V_{2e}$ is written in (4), the equations (5a) to (1c), are modified thus, respectively,

$$\Delta I_o/\Delta I_o + \Delta V_{2e}$$

Assuming $m_0 > \mu_1$,
Stabilized Power Supplies—

\[ S' = \infty \]

\[ R_0 = \frac{\mu_{mp} p_0}{t} \quad \cdots \quad (12b) \]

which is the same as (12a).

\[ R_0 = 0 \]

\[ R_{zb} = \mu_{mp} \left[ \frac{R_4}{\mu_{mp} R_2} \right] \quad \cdots \quad (13b) \]

In practice this may be excessively large.

In Fig. 7, following typical circuit values, similar to those in Fig. 6:

\[ R_{1a} = 0.7 \Omega \quad \mu_{224} \text{(effective) } = 65 \]

\[ R_{1a} = 0.3 \Omega \quad m = 280 \]

\[ R_1 = 0.28 \Omega \]

\[ p_0 = 0.28 \]

The values of \( R_{1a} \) and \( S' \) are plotted against \( R_0 \) for the following typical circuit values, similar to those in Fig. 7:

\[ R_0 = 1\Omega \]

\[ 12 \times 2 \Omega \quad \mu_{1a} = 8 \]

\[ r_{1a} = 0.7 \Omega \]

\[ \mu_{224} \text{(effective) } = 65 \]

\[ R_1 = 200 \Omega \]

\[ p_0 = 0.28 \]

With the anode of \( V_2 \) fed from a constant-potential point as in Fig. 7, the following results are shown:

- The relevant part of Fig. 9 can be represented by the network Fig. D.
- The new 88-page edition of the Tin Research Institute's handbook is intended primarily for industrial users of solders of various kinds but is useful to many others. Mass-production soldering methods are dealt with at some length and special emphasis is laid on an important point that is too often overlooked: parts that are to be joined by soldering should be so designed as to facilitate the making of good, sound joints. The book describes both the theory and the practice of many kinds of soldering. There is a most useful section (illustrated by 8 good photographs) on wiped joints in lead pipes, the successful making of which is perhaps the most satisfying of soldering achievements. Another section shows how to solder such "difficult" metals as stainless steel, cast iron and aluminium. The best fluxes for use on both straightforward and difficult metals are given and the writer is careful to state which of them are or are not permissible in electrical work. Altogether, this is an extremely valuable little book; it is obtainable free of charge from The Tin Research Institute, Fraser Rd., Greenford, Middlesex.
WHEN the KT66 valve was first introduced in 1937 it was given maximum anode and screen voltage ratings of 400 and 300 respectively. At these voltages a pair of valves will provide an output of 30 watts with quiescent anode and screen dissipations of 21.5 and 0.75 watts.

Recent investigations have shown that it is permissible to increase the anode and screen voltages to 500 and 400 respectively and the anode dissipation to 25 watts. These new limits permit the design of an economical 50-watt amplifier. This output represents an increase of nearly 70%, which is obtained with an anode supply voltage only 20% greater than that required for the 30-watt amplifier.

Under the quiescent condition the dissipation is below the permitted maximum, though, due to the regulation of the supply, the voltages are slightly higher than the normal working limit. No ill effects will be experienced from this cause.

The comparative operating conditions per pair of valves unless otherwise stated are:

<table>
<thead>
<tr>
<th></th>
<th>Auto Bias</th>
<th>Fixed Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.T. supply voltage</td>
<td>Q</td>
<td>FO</td>
</tr>
<tr>
<td>Anode voltage</td>
<td>450</td>
<td>535 V</td>
</tr>
<tr>
<td>Screen voltage</td>
<td>425</td>
<td>500 V</td>
</tr>
<tr>
<td>Anode current</td>
<td>415</td>
<td>325 V</td>
</tr>
<tr>
<td>Screen current</td>
<td>390</td>
<td>480 V</td>
</tr>
<tr>
<td>Grid bias per valve</td>
<td>300</td>
<td>385 V</td>
</tr>
<tr>
<td>Power output</td>
<td>275</td>
<td>80 mA</td>
</tr>
<tr>
<td>Anode load resistance</td>
<td>104</td>
<td>175 mA</td>
</tr>
<tr>
<td>Anode dissipation per valve</td>
<td>125</td>
<td>3 mA</td>
</tr>
<tr>
<td>Screen dissipation per valve</td>
<td>5</td>
<td>21 mA</td>
</tr>
<tr>
<td>Peak input voltage approx.</td>
<td>18</td>
<td>45 V (appx.)</td>
</tr>
<tr>
<td>R.M.S. voltage to rectifier (approx.)</td>
<td>500 ohms</td>
<td>50 W</td>
</tr>
<tr>
<td>Efficiency*</td>
<td>500 ohms</td>
<td>6,000 Q</td>
</tr>
<tr>
<td></td>
<td>500 ohms</td>
<td>21 W</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>4 W</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>45+45 V</td>
</tr>
<tr>
<td></td>
<td>525+525</td>
<td>600+600 V</td>
</tr>
<tr>
<td></td>
<td>49%</td>
<td>52%</td>
</tr>
</tbody>
</table>

Q = Quiescent or no signal condition.  
FO = Full output.  
* Efficiency = \( \frac{\text{Watts output}}{\text{Watts input to anode and screen}} \times 100 \)

Some small differences from the above data are to be expected with various pairs of valves.

The circuit used to obtain 50 watts output is shown in Fig. 1. The two KT66 valves being driven from a low-impedance triode via a push-pull transformer \( T_1 \).
Economical 50-watt Amplifier——
latter is not essential since the
KT66 valves are not driven into
the positive grid current region,
and any of the recognized phase-
splitting arrangements are suit-
able, but the D.C. resistance from
each KT66 control grid to earth
should not greatly exceed 100,000
ohms under the fixed bias con-
ditions.
Independently adjustable bias
controls, R1, R2, provide a bias
supply variable from 30 to 60
volts. The bias circuit is some-
what unorthodox in that it is
taken from the anode supply
transformer T3 via a small con-
derenser C, of high working voltage.
The maximum bias voltage obtain-
able is determined by the capaci-
tance of C1 and the resistance of
R1, R2, R3 and R4. This arrange-
ment has the advantage that no
put valves are not driven into the
positive grid current region. The
value of the condenser C2 may be
increased or decreased to provide
higher or lower voltages for use
with other types of valves. It will
be noticed that the rectifier fila-
ment is earthed and may be run
from the 6.3-volt amplifier heater
supply with a resistance R5
dropping the voltage to 4 or 5 for
the rectifier. Suitable resistances
values are Uo—2.3 ohms, U14—
0.9 ohms, and U50—0.65 ohms.
A considerable increase in anode
and screen currents takes place with
increasing signal input and a low-
impedance H.T. supply is required.
A choke input filter circuit using
two low-resistance chokes L1
L2, provides a hum-free supply of
good regulation. When a small
amount of hum can be tolerated
at full output, the second choke
dropper the voltage to 4 or 5 for
the rectifier. Suitable resistances
values are Uo—2.3 ohms, U14—
0.9 ohms, and U50—0.65 ohms.
A considerable increase in anode
and screen currents takes place with
increasing signal input and a low-
impedance H.T. supply is required.
A choke input filter circuit using
two low-resistance chokes L1
L2, provides a hum-free supply of
good regulation. When a small
amount of hum can be tolerated
at full output, the second choke
not change materially with varying
current, the screens are maintained
at approximately 115 volts below
the anode supply under all con-
ditions of operation. This reduced
voltage is also used to supply the
earlier valves. The screen grids
must not be connected directly to
the 500 volt supply.
The meter shunts R12, R19 are
permanently connected in the
cathode circuits of the KT66
valves and the meter measures the
total cathode current of each out-
put valve. The quiescent screen
current (approx. 1.5 mA) is small
compared to the anode current
(approx. 40 mA), and may be
safely ignored when adjusting the
bias voltages by means of the
resistances R1, R2. The actual
quiescent current is not important
and any value between 30 and 40
mA may be used. At lower currents
"crossover" distortion becomes
evident and at higher currents the
anode dissipation is increased un-
necessarily. Both valves must of
course be set to identical quiescent
currents. A meter having a full-
range deflection with its shunts, of
100/150 mA is suitable.
The performance of the amplifier
is illustrated by the curves of Fig.
2, and is suitable for small public
address equipment and also makes
an economical modulator for low
power transmitters, being capable
of providing 100% modulation for
a 100-watt carrier. It has a high
efficiency and a lower quiescent
dissipation than many other 50-watt
amplifiers. The use of fixed grid
bias instead of the more usual
cathode bias arrangement renders
the amplifier rather less foolproof,
and a meter is essential for adjust-
ing the anode current and should
preferably be built into the equip-
ment. However, it is not essential
that it should have a high accuracy
and one of the miniature type is
suitable.

Fig. 2. Performance curves of the amplifier operated in class AB, with
\( V_a = 480 \), \( V_{gs} = 385 \), \( V_{gs} = -45 \), and an anode-to-anode load of 6,000 ohms.
All types of MICROPHONES, STANDS and SPEAKERS available from stock including 12 in. GOODMAN P.M. SPEAKER

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EXTREME SENSITIVITY. Perhaps the most noteworthy feature of these amplifiers is their high sensitivity, which allows wide-range pick-up with low-level high fidelity microphones.

For example, the 25-watt has an overall power amplification of 133 d.b. or twenty-million-million-times. This is mainly achieved by the inclusion of a high-gain input stage completely enclosed in a rubber-mounted magnetic screening case.

OUTPUT. The output transformer of each amplifier is of generous size, and has an eight-sectioned primary in order that it can be included in the inverse feed-back loop. The following outputs are provided:

- Max. undistorted voltage (R.M.S) 100, 50, 25 volts.
- Load impedance (25-watt) - 400, 100, 25 ohms.
- Load impedance (50-watt) - 200, 50, 12.5 ohms.

These amplifiers are normally intended to use with the 300-volt-line system in which each loudspeaker has its own transformer. This allows simple parallel connection of the loudspeaker load, the use of long lines, and the rating of loudspeakers in terms of their actual power consumption in watts.

MICROPHONE INPUT
Input required for full drive: 0.8 millivolts
Impedance: 1 megohm

GRAMOPHONE INPUT
Input required for full drive: 90 millivolts
Impedance: 0.25 megohm

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INVISIBLE COMPONENTS

THE ability to think out intricate problems mentally, without external aids such as written or drawn symbols, is given to only a few great intellects. Most of us are obliged to lean rather heavily on such aids, though perhaps we do not always realize how well they serve us. If you want to get some idea of how much you owe to our system of numerals, for example, try working out a little simple "sum" in Roman figures, say, dividing MCMXI by XCI.

The circuit diagram is another example of a practically indispensable aid to thought: simple and effective. But the very effectiveness of such aids creates a danger; the danger of handing over to them too much of our reasoning powers.

When some piece of circuitry behaves unexpectedly, it is usual to place the circuit diagram on the desk in front of us and gaze at it intently, trying to arrive at a plausible explanation of the action in terms of what we see. But it is a great mistake to assume that because a correctly drawn diagram, complete with values of components and any other necessary data, tells the truth, it tells the whole truth and nothing but the truth.

Workers in megacycles are, of course, familiar with the importance of such unrevealed details as inter-electrode capacitances. Sometimes they dot them into the diagram. A year or so ago* I showed how circuits that appear to be unorthodox or even inexplicable can be accounted for in this way. Many—perhaps most—of the snags that so often crop up in new arrangements or modifications can be traced to the "invisible components." Out of sight, out of mind.

Ever when aware of their existence, one is often tempted to regard them vaguely as "capacity effects," and either fail to adopt suitable precautions in the right places or go to a lot of trouble to apply them in unnecessary places.

One of the first places where "capacity effects" became well known was at the aerial lead-in. As long as a quarter of a century ago books and articles for wireless amateurs were emphasizing the importance of keeping the aerial lead-in well away from walls—and still more from pipes and gutters—and as short as possible, to prevent a large stray capacity to earth bypassing away the precious R.F. currents that were so much needed in those days of low-power transmitters and crystal detectors. With the type of input circuit commonly used (Fig. 1a), that was sound advice. One had only to grasp the aerial lead and notice how signal strength fell off to demonstrate its truth. But it was one of those generalizations which, if accepted blindly, might mislead. Some receivers used the tapped-down input connection (Fig. 1b), sometimes with only a turn or two between aerial and earth terminals; and such sets are almost immune from "capacity effects." The aerial lead can be wired all over the house in lead-covered cable, even, without much loss of signal.

The explanation, of course, lies in the impedance across which the stray capacitance occurs. A "stray" amounting to 100 pF, at 1 Mc/s, is a reactance of about 1000Ω. In Fig. 1(a) the input impedance of the receiver is probably tens of kilohms; in (b) perhaps only a few tens of ohms. So the effect of shunting 1000Ω across is likely to be disastrous to (a) and unnoticeable with (b). As interest developed in the direction of higher frequencies, amateurs naturally became more conscious of "capacity effects" than ever. And rightly so, seeing that the shunting effect of a capacitance is directly proportional to frequency. It would never have occurred to those who rely on second-hand generalizations, therefore, to invent the coaxial cable, with its many pF per foot, for these very high frequencies. "A little knowledge" would have rejected such a proposal scornfully, as obviously having far too much "stray capacity." Fuller knowledge took account of another hidden component—distributed inductance—and found that this exactly neutralized the effect of the distributed capacitance.

A valuable accomplishment, then, is the ability to estimate

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Invisible Components—
the values of the uncharted quantities and calculate their probable effects in the circuit. In a stage of tuned R.F. amplification one would not normally connect a capacitor between the "live" sides of the input and output.

![Fig. 3. Another circuit in which valve capacitance may play an important part.](image)

But it has long been common knowledge that one exists, in the form of the anode-to-grid capacitance of the valve (denoted by \( C_{g1} \) \( -k \); Fig. 2). The screen grid valve was invented to reduce it to a minimum; and then it became necessary to look carefully to the capacitance of the valve holder and the wiring. Even 0.01pf could make all the difference. At the same time, much larger capacitances can be tolerated across input and output (namely, \( C_{o1} \) and \( C_{o2} \)), because they are neutralized by the tuning inductance and simply necessitate a reduction in tuning capacitance. Ultimately, however, the possible gain at a given frequency—especially a very high frequency—is limited by these input and output capacitances; gain is approximately proportional to coupling impedance, which in a tuned circuit is \( \frac{1}{\pi f C} \) so inversely proportional to \( C \).

It is quite wrong to suppose that such effects are confined to radio frequencies. The "invisible components" can sometimes dominate the situation at audio or even power frequencies. It is well known that when a high resistance (\( R \) in Fig. 3) is used in a grid circuit, the fact that the valve is biased and operated to avoid grid current does not exclude voltage drop in \( R \). One must take account of the valve input capacitance, which combines with \( R \) to form a potential divider that progressively reduces the overall gain of the stage as signal frequency is increased.

![Fig. 4. Example in which a stray capacitance may be vital even in a zero-frequency power unit.](image)

Part of this hidden capacitance is doubly hidden; because in addition to the fairly straightforward \( C_{g1} \) \( -k \), there is \( C_{g2} \), which is by no means straightforward, for the "geometrical" or "cold" capacitance is multiplied by the gain of the valve ("Miller effect"), and in a high-\( \mu \) triode may amount to several hundred pF.

An interesting example of how stray capacitances can cause serious trouble, even at the lowest frequencies, occurred in a piece of apparatus where the cathode potential of a cathode-follower valve was adjustable over a range of several hundred volts. The valve makers generally refuse to answer for the consequences if the potential between cathode and heater is increased beyond 100V; sometimes even less. At the same time they recommend that the resistance between them should not exceed, say, 20,000\( \Omega \). So the heater could neither be joined to a fixed potential nor left floating, and it was therefore necessary to connect the heater to cathode. Since the cathode follower, the valve would have an output resistance something less than \( 1/\beta \); assuming \( \beta \) to be in the region of 5 mA/V that would be 200\( \Omega \). C might be in the region of 100pF; at 50c/s, 100pF is about 30 \( \text{M}\Omega \), which seems large enough to be harmless. Yet assuming these figures, the hum voltage in the output would be about 5mV, which is more than five times larger than there was reason to expect it to be from other causes.

But the position was likely to be very much worse. If the output terminals were open-circuited, \( \beta \) would be zero, and there would be little to stop the "hum" rocketing up to hundreds of volts! A capacitor across the output terminals would have to be 50pF or more to be much good; it would be quite bulky and expensive for up to 500V working! The proper solution, of course, was to cut out C by carefully screening the winding. Another alternative—to balance out the hum by capacitance to a point in opposite phase—is in principle and in practice less satisfactory. It is better to avoid undesirable effects by balancing them out with arrangements that require critical adjustment and may leave substantial "residuals."

The term "residuals" is a cue to dilate on the extreme importance of the invisible components in A.C. bridges. But dealing with them is a special art and far too long a story to tell here. So I go on to say a few words about the more relevant problem of "earthing," in the sense of "tying down" parts of the circuit that one wants to have at constant potential. Decoupling, and such like. This too can be made quite a long story, and I only give an example of the sort of thing.

Suppose you have a high-gain amplifier. One of the most important requirements in its design is to prevent it from picking up stray fields. The usual methods are either to build it on a metal chassis, with suitable metal screens for the more vulnerable parts, or to enclose the whole amplifier in a screen; in either case the metalwork is intended to be earthed. If the common negative lines of the circuit can be connected to this metalwork it
simplifies matters to do so. But sometimes it is not; perhaps because there is a necessity to connect it to a point at a different potential to earth. If so, there may be trouble. Fig. 5 represents, say, the input to the first stage, which, of course, is the most sensitive part of the amplifier, so the grid lead has a screen round it (shown dotted) connected to the earthed chassis. Suppose now the common negative lead is connected to some other equipment. Even if the other equipment is also earthed, the leads between the two units or between them and earth may pick up a trace of hum or other interference. This can be represented as a small alternating voltage between the two terminals in Fig. 5; and it is easy to see that it is applied, via the capacitance between grid lead and screen, across the grid resistor, and therefore right in at the front door of the amplifier.

So one often has to think rather hard to decide whether screens should be connected to the "earthy" side of the circuit, or to chassis, or what.

Up to now we have been concentrating mainly on the effects of hidden capacitors. But the possibility of stray "pick-up," just referred to, is a reminder that transformers, too, are hidden in most circuits; often in unsuspected places. One is apt to assume that the alternating magnetic field in a mains or audio transformer is confined to the iron core; but that is very far from true, especially of those chokes and output transformers whose cores are interrupted by gaps.

Any leads within a foot or two must be regarded as loosely-coupled turns on the transformer, and although the voltage generated in them may be small it can be very troublesome when highly amplified. P. J. Baxandall showed, in the February, 1947, issue, how careful one has to be about the loop formed by the input lead to an amplifier, the valve itself, and the return. Another thing one tends to forget when studying a circuit diagram is that there is no perfect insulator, so there is a conductance between every pair of points in the circuit! In most places the unintentional conductance is so small as to have no appreciable effect; for example, it may come across a relatively low intentional conductance. Or the effect may be appreciable—for example, the leakage of electrolytic capacitors—but harmless or even slightly beneficial. There are some danger points to look out for, however; one of the most important is a coupling or blocking capacitor in front of a high-resistance circuit. Consider the input to a valve voltmeter (Fig. 6). In order to avoid loading the circuit being measured, R may be made very large, perhaps 50 MΩ; but call it only 10 MΩ. C will generally have to be fairly large in order to cause no appreciable error in reading at low frequencies, say 25 c/s. And it may be there for the purpose of enabling alternating voltages to be measured in the presence of a relatively large direct voltage, say up to 1,000. Even if the instrument is only moderately sensitive it may well be desirable to limit leakage of this unidirectional voltage to, say, 0.01 V. Considering R and the leakage of C (call it R_L) as a resistive potential-divider, then, R_L must be not less...
Invisible Components—

than a million megohms. Which means that no ordinary capacitor will do.

Although this effect is generally less acute in an ordinary amplifier, neglect of it may lead to unexpectedly large anode currents and distortion.

We have seen that small stray mutual inductances may be important even at the lowest frequencies. Self-inductances can generally be neglected at audio frequencies, but not at very high radio frequencies. It is easy to draw a bypass capacitor in a circuit diagram and think you have "earthed" that part of the circuit; but what about the inductance of the leads? What you really have is not Fig. 7(a), as in the diagram, but Fig. 7(b), which is a low impedance at only one frequency. Increasing the capacitance may actually increase the impedance at the working frequency. The best policy is to reduce L as much as possible; the "bushing" types of bypass capacitor are the most familiar expression of that policy. A good deal of ingenuity has been used in devising still more nearly perfect E.H.F. "seals."*

Another place where invisible "coils" are a major problem is inside a valve. The inductance of the connections is a principal factor limiting the frequency at which the valve can be effectively used. While the usual simple symbol for a valve is good enough for most audio and moderate radio frequencies, it is seriously misleading at E.H.F. unless replaced by quite a complicated "circuit diagram."

The general conclusion, then, is a resolve to cultivate the habit of considering what "hidden components" may have to be taken into account under the conditions that apply. This may not always be easy, especially when the quantities in question are distributed around the circuit instead of being conveniently localized or lumped as the standard circuit symbols represent. On the other hand, some problems of this kind that seem at first sight vague or difficult can often be successfully treated as an "equivalent circuit." The common "transmission line" is a classical example. The intervalve transformer is another; Terman in his "Radio Engineering" shows very clearly how it can be treated as three simple equivalent circuits, valid respectively at low, middle, and high audio frequencies. And there are plenty of other examples in the literature.*

NEW DOMESTIC RECEIVERS

A new "Ambassador" radio-gramophone Model 4756. Type S, with storage space for 150 records has been introduced by R. N. Fitton, Hutchinson Lane, Brighouse, Yorks. The A.C./D.C. superhet (4 valves+rectifier) covers six wavebands with bandspread tuning between 9.4 and 50 metres. The walnut cabinet measures 33in x 18in x 15in and the price is £59.5s including tax.

The K.B. Model DR15 receiver. This is a superhet with four valve and a rectifier. The output valve is rated at 4 watts and there is an 8-inch P.M. loudspeaker. The price is £26 2s 6d including tax and an A.C./D.C. version including a barretter is also available.

Negative feedback on the pickup circuit is an unusual feature of the K.B. Models DR10 and DR15 which are A.C. and universal mains versions of a new superhet using an 8-inch speaker in a shallow large-area cabinet. The price is £19 10s, including tax and the makers are Kolster Brandes, Footscray, Sidcup, Kent. The Model 848 "Town and Country" receiver made by Rainbow Radio, Mincing Lane, Blackburn, Lancs, can be operated either from A.C. mains, or from a 6-volt accumulator, H.T. being provided through the medium of a vibrater. The set covers medium waves and 9.8 to 98 metres in three short-wave ranges. An R.F. stage precedes the frequency changer and a separate electron-coupled oscillator is employed. The 10-inch loudspeaker is fed by a push-pull output stage; with mains operations the output is 7 watts and on batteries, 4 watts. Power consumption is 42 watts on mains or 27 watts (4.5 A at 6 V) from batteries.
During October, in accordance with the seasonal trend for these latitudes, the average daytime maximum usable frequencies increased very considerably, while the average night-time M.U.F.s decreased somewhat. Thus the 28-Mc/s band was quite frequent, for example with New Zealand, and many contacts were made occasionally on higher frequencies. As is well known, Alexandria Palace television transmissions were received in Cape Town towards the end of October. That this is a long-distance record is due probably to installation of a test television receiver in South Africa, as otherwise it is by no means an unusual distance for propagation of signals of this frequency at the epoch of maximum sunspot activity. Indeed, such results were anticipated in this column's forecasts for October and November. Night-time working frequencies were fairly high for the time of the year.

Sunspot activity in October was less than in September. Two fairly large groups were observed, which crossed the central meridian of the sun on the 17th and 27th. The month was exceptionally disturbed, particularly so in the last two weeks. Ionospheric storms were observed on 1st-6th, 15th-16th, 18th-24th, 26th-31st, these latitudes, the average daytime maximum usable frequencies increased very considerably, while the average night-time M.U.F.s decreased somewhat. Thus the 28-Mc/s band was quite frequent, for example with New Zealand, and many contacts were made occasionally on higher frequencies. As is well known, Alexandria Palace television transmissions were received in Cape Town towards the end of October. That this is a long-distance record is due probably to installation of a test television receiver in South Africa, as otherwise it is by no means an unusual distance for propagation of signals of this frequency at the epoch of maximum sunspot activity. Indeed, such results were anticipated in this column's forecasts for October and November. Night-time working frequencies were fairly high for the time of the year.

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Not very many 'Dellinger' fade-outs have been recorded in October, but those on the 9th and 11th were fairly severe.

Forecast.—Daytime M.U.F.s will be probably rather lower in December than in November because of the 'midwinter' effect in the Northern Hemisphere. However, daytime working frequencies will be still relatively high, and long-distance communication on very high frequencies should therefore be possible in all directions from this country. The 28-Mc/s amateur band should be regularly usable at suitable times of the day, but conditions on higher frequencies for long-distance contacts will not be as favourable as in November. The night-time M.U.F.s will fall to their lowest values for the winter, so that the night-time working frequencies will be of as low as 7 Mc/s over many long-distance circuits, and they will be in use over longer periods than in November.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during December for four long-distance circuits running in different directions from this country. (All times are G.M.T.) In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25% of the time.

### Montreal:
- 0000: 7 Mc/s (11 Mc/s)
- 1000: 9 .. (12 ..)
- 1100: 11 .. (15 ..)
- 1200: 17 .. (23 ..)
- 1300: 21 .. (27 ..)
- 1400: 26 .. (33 ..)
- 1700: 21 .. (28 ..)
- 1800: 17 .. (24 ..)
- 1900: 15 .. (22 ..)
- 2000: 11 .. (17 ..)
- 2100: 9 .. (14 ..)
- 2200: 7 .. (10 ..)

### Buenos Aires:
- 0000: 10 Mc/s (13 Mc/s)
- 0400: 7 .. (11 ..)
- 0500: 9 .. (16 ..)
- 0900: 15 .. (20 ..)
- 1000: 21 .. (28 ..)
- 1200: 26 .. (32 ..)
- 1400: 17 .. (25 ..)
- 1600: 15 .. (20 ..)
- 1900: 15 .. (20 ..)
- 2100: 16 .. (22 ..)
- 2200: 9 .. (13 ..)

### Cape Town:
- 0000: 9 Mc/s (13 Mc/s)
- 0500: 7 .. (11 ..)
- 0900: 15 .. (20 ..)
- 0900: 21 .. (25 ..)
- 1000: 15 .. (22 ..)
- 2100: 11 .. (16 ..)
- 2200: 9 .. (13 ..)

### Chunking:
- 0000: 21 Mc/s (30 Mc/s)
- 0500: 9 .. (14 ..)
- 0900: 15 .. (21 ..)
- 0900: 17 .. (24 ..)
- 0900: 21 .. (29 ..)
- 1100: 26 .. (33 ..)
- 1100: 21 .. (27 ..)
- 1200: 15 .. (22 ..)
- 1300: 11 .. (19 ..)
- 1500: 14 .. (21 ..)
- 1700: 7 .. (10 ..)

### Ionosphere storms are not very frequent in December, but if they do occur during periods of darkness they are very troublesome on account of the already very low ionization prevailing during the winter night. At the time of writing it would appear that such disturbances are more likely to occur within the periods 4th-5th, 8th-12th, 16th-17th, 19th-21st, 27th-28th and 31st, than on the other days of the month.

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

December, 1948 Wireless World

Short-Wave Conditions

October in Retrospect: Forecast for December

This instrument is fitted with the latest type Garrard Automatic Record Changer which operates with ten 10in. or 12in. records. Magnetic pick-up, first-class amplification and a 6½-in. dia. high-efficiency loudspeaker provide excellent quality of reproduction with adequate volume.

Volume and tone controls are provided and the whole unit is designed to operate on A.C. Mains. The case is covered in best quality leather cloth with rubber feet and rust-proofed fittings. All components are tropicalised.

As an alternative there is a Single record player instead of the automatic changer.

Both these models have had an enthusiastic reception in many export markets and are now available in limited quantities for home buyers.

Send for illustrated lists and full details.

THE TRIX ELECTRICAL CO. LTD.
1-5 Maple Place, Tottenham Court Road, London, W.I.
"Trixette", "Trixadel, Wesdy, London,"

Sound Equipment

"TRIXETTE" Automatic Model Portable Electric Gramophone

Details.
Unbiased

English as She is Spoke

RADAR is, without doubt, one of the major developments of radio and, apart from its wartime uses, has already proved itself a very present help in trouble to the fog-encircled mariner nosing his way cautiously along a crowded estuary amid the raucous bellowings of other ships under way and the bell-ringing bedlam of those lying uneasily at anchor. But it needed a visit to the radar research station at the end of Southend pier to convince me of the real marvels of this new application of radio science. I knew, of course, that I should be able to see on the screen the luminous representation of ships moving over the face of the waters in densest fog, but little thought that radar would also enable me to see the ghostly forms of stationary and firmly anchored buoys silently and eerily passing up and down on the broad bosom of old Father Thames.

This sort of thing must surely be very bewildering and disconcerting to sailors of the old school, accustomed, as they are, to placing firm reliance on these invaluable aids to navigation to show them the fairway and keep them off the treacherous shoals and sandbanks. Yet they must learn that in this atomic age must learn that in this atomic age one cannot cast less abandon of a woman driver on an arterial road; for one cannot cast an arterial road; for one cannot cast any hesitations about the control of the receiving range of [television] sets manufactured for sale to the public. Such a control of receiver range would, of course, be impossible unless the public were compelled to buy a television volksempfänger in a sealed box which it would be verboten to open. If such a thing did happen, let me say at once that I should immediately take to the Cave of Adullam and proceed to a sealed box which it would be verboten to open. If such a thing did happen, let me say at once that I should immediately take to the Cave of Adullam and proceed to turn out on a wet night and queue in the rain in the hope of securing a seat, which may or may not be suitable viewing angle, in the local Amatorium.

By FREE GRID

Things to Come

THE Editor and I have always set our faces against the adoption by the authorities of any systems of broadcasting, such as the so-called wired-wireless or carrier-current methods, whereby listeners would be denied the freedom of the ether and be compelled to listen to piped programmes, no matter whether they were to their liking or not. I am sorry, therefore, to see a writer in a prominent newspaper talking of the possibility of high-level deliberations on, among other things, "the control of the receiving range of [television] sets manufactured for sale to the public."

Such a control of receiver range would, of course, be impossible unless the public were compelled to buy a television volksprogramm in a sealed box which it would be verboten to open. If such a thing did happen, let me say at once that I should immediately take to the Cave of Adullam and proceed to the local Amatorium. I hope many W.W. readers would join me, not because the Programme, which it would be restricted-range receiver, or in other words, a Hitlerian yolks-empfänger.

As for the idea of distributing films by television, I personally look forward to the day when they will be sent out from a central transmitter, not for local cinemas, but for the home viewer. I would much prefer to see a film from the comfort of my fireside armchair than to turn out on a wet night and queue in the rain in the hope of securing a seat, which may or may not be suitable viewing angle, in the local Amatorium.
Controversy on Quality
and Inter-modulation

High-Level Detection

In querying the power handling capabilities of the stages in my high-level detection set your correspondent E. F. Good (your Nov. issue) puts forward suggestions that were actually tried by myself and others as long ago as 1934 when you published the first H.L.D. set. At that time I preferred the transformer coupling between the final R.F. stage and the diode because it simplified the design, provided a very convenient means of permitting proper coupling with diodes and seemed to admit of greater stability on the R.F. side. During the intervening years I have not found that there is anything to be gained by varying my original circuit.

I have not tried an EF55 in the third R.F. stage and use the Osram KT6f because I have found it entirely satisfactory. If instruments are adequate indicators, this valve is more than capable of fully loading the PX25s but I agree that 120 volts R.F. is on the high side. Normally the output demanded from the KT6f is not more than 30 to 50 volts as, operating the PX25s with 400 volts on the anodes and 600 ohm bias resistors, the maximum input (grid to grid) is 76V for the full 15 watts output.

It is pertinent to say here that the set on which I am now working is more in line with standardized practice in that six-volt Osram KT66s (triode connected) are in the output stage. The operating conditions for these are almost identical with those of the PX25s.

Concerning feedback. I quite agree with Mr. Good. It is using a small amount of negative feedback I was bowing to the conventions of some of my friends who ought to know more about it than I do. When trying out a new speaker and using an output transformer without a feedback winding I found that there was some increase in the top note response and, as is well known, there was a decrease in the required voltage across the grids of the output valves which would naturally result in lessening the danger of overloading the KT6f.

Kensington. W. MACLANACHAN.

Direct-coupled Amplifiers

I SHOULD be most grateful if you could publish this reply to P. J. Baxandall's letter in your October, 1948, issue.

I am in a position to answer P. J. Baxandall's query as to the conditions of comparison between N. Bonavia Hunt's direct-coupled amplifier and other modern P.P. amplifiers.

Comparisons have been made by me on a twin L.S. system using a folded bass horn and high-note diffusor for which the makers claim a smooth response from 40 c/s to 20,000 c/s with a P.P. amplifier using tubes with feedback on the lines of P. J. B.'s amplifier (W.W., Jan., 1948) and a Williamson amplifier (W.W., May, 1947). Both these were preceded by a tone control circuit of similar characteristics.

A quick switch over was arranged and several enthusiasts have all agreed that for complete absence of any form of distortion, separation of parts, and extreme clarity, the N. B. H. amplifier could be picked out every time.

The potentiometer referred to is not, as pointed out, part of the tone control network, but used as a preset load in connection with the 5kΩ transistor in the cathode of the 6AK5 to ensure that the correct current is passed. Although as a matter of convenience I am using an amplifier of P. J. B. pattern, I think it is most unfair to try to deter enthusiasts who are prepared to go to any lengths to obtain the best possible solution to this complex business of Hi-Fidelity.

Chorley, Lancs.

N. BONAVIA HUNT'S direct-coupled amplifier is only a link at the end of a long chain of amplifiers used by the B.B.C. from microphone to transmitting aerial. He would do well to ponder the fact that as far as he is concerned the only D.C. amplifier in the complete chain to his loudspeaker is Mr. Hunt's.

I have no desire, nor is there need, to prove theoretically that a capacitance can deal with alternating currents of complex wave-form with adequate fidelity; but if capacitors have not this property, the B.B.C. are transmitting sounds of inferior quality, which of course they sometimes do, I am sure entirely to other considerations.

Perhaps Mr. Hunt would be kind enough to divulge the secrets of his loudspeaker system which can with
Letters to the Editor—

so much accuracy reveal on the one hand the perfection of his D.C. amplifier and on the other the defects of a well-designed R.C. coupled amplifier with feedback.

In all fairness it could be argued that even distorted programmes should be reproduced with the utmost fidelity, and no doubt Mr. Hunt will continue to use his wasteful D.C. amplifier regardless.

But Sir, is it worth it?

ALEXANDER SHACKMAN.
New Barnet, 
Herts.

MAY I be allowed to put forward the following points in reference to Mr. P. J. Baxandall’s letter criticizing my amplifier?

(1) The circuit published in the July issue gave only one form of the amplifier, mainly intended for gramophone work.

(2) The potentiometer connected in the grid circuit of the second A.F. valve does not form part of the variable tone control network but is intended to be pre-set to the optimum point and not altered.

(3) A later circuit incorporates a fixed resistance with a choke in series between grid and earth.

(4) A big undistorted wattage output cannot alone guarantee good quality reproduction of orchestral music; this amplifier can do so when using PX4s in the output stage.

(5) Two or three watts is not really a sufficient output for reproducing the lower frequencies without distortion even in a small room.

(6) There is no question as to the excellence of the Williamson and the Baxandall push-pull amplifiers recently described in Wireless World. But if used in the average home, tone control filters are desirable for correcting at the lower volume levels.

(7) Following orchestral performances with an orchestral score quickly shows a musical listener like myself how much of the actual playing is lost even with the best amplifiers and loudspeakers. My amplifier was designed for the express purpose of picking up these missing parts, one of the essential conditions of success being the elimination as far as possible of the blocking condenser. On this latter principle I take my stand against all criticism.

N. BONAVIA HUNT.
Stagsden, Bedford.

The correspondence on “High-level Detection” and “Direct-Coupled Amplifiers” must now be closed.—Ed.

Assessing Distortion

It is remarkable, indeed, what harm one single wrong article can do. In your August issue (p. 299) H. S. Casey advocates the use of A.F. amplifiers with very poor low-frequency performances, I have followed up the sources of this clear disagreement between theory and practice, and your readers may be interested in what I found.

Back in 1936 Dr. Fritz G. Lüchen wrote about “Die nichtlineare Verzerrung in langen Fernsprechkabeln und ihr Einfluss auf die Verständlichkeit der Sprache” (Telegraphen- und Fernsprechtchnik, Feb., 1936, p. 27). He used a distorting network consisting of two paths, one linear, and one non-linear, and mixed their outputs to get different amounts of non-linearity. Both paths were independent of frequencies (Fig. 1).

This apparatus is used by Hans Joachim von Braunmühl and Walter Weber. (“Über die Störfähigkeit nichtlinearen Verzerrungen,” Akustische Zeitschrift, May, 1937; p. 135) for the production of distortion dependent of frequency. These frequencies then are caused to modulate the whole complex in the other path. The distortion thus obtained has a good correlation to the second-order distortion encountered in most kinds of AF apparatus. For the production of third and higher order distortion, non-linear circuits must be inserted in the modulating path.

K. SMITH.

Lidingö, Stockholm, 
Sweden.

Resistor Ratings

As a footnote to the above article in your November issue, the following points may be of interest.

In commercial use a life expectation of some 10,000 hours has to be envisaged, whereas Service requirements merely call for a minimum of 1,000 hours at the present time, which has a large bearing on the relatively high wattage ratings at

Fig. 1

Fig. 2
Reducing Heater Hum

THE method of reducing heater hum described by Dr. K. G. Britten in your October issue may be satisfactory for a high-gain laboratory amplifier, but has disadvantages for ordinary practical purposes.

For perfect cancellation the hum neutralizing voltage must be in exact antiphase to the hum and of the same amplitude. If the hum which is to be removed is at all large a slight unbalance in either respect will cause a serious increase. In addition the hum neutralized by most valves is far from sinusoidal, so that the hum-neutralizing voltage should properly be of a similar waveform, which is difficult to achieve in practice. I would also expect the setting of the controls to alter as the amplifier warmed up.

An alternative to D.C. heating of the early stages, not mentioned in the article, is to supply the heaters from a small R.F. oscillator. As only a few watts are required, this can easily be obtained from a KT61 or KT66 valve in a Hartley circuit, with only a few additional components, compared with the bulky equipment of a D.C. power supply. The oscillator can be supplied from the main H.T. line of the amplifier without the necessity for extra rectifiers, chokes and smoothing condensers. The regulation of the oscillator output may not be very good, and if one valve is removed, the heater volts will rise on the remaining valves, but this is not usually a serious objection.

However, with a suitable type of valve in the early stages, and care in the method of earthing, it should be possible to keep the hum in the neighbourhood of the level of the valve and circuit noise without resorting to complications.

Wembley Park, R. TOWNSEND.
Middlesex.

Mercury for Dry Cells

I WOULD like to correct an erroneous impression in the last paragraph of the article "Fresh Progress in Dry Batteries" in your October issue. First, mercury is not scarcer; in fact is is very readily available. Secondly, comparatively speaking, mercury is cheap, being the only metal that is today cheaper than pre-war. Mercury in 1939 was £17 per bottle of 76 lb, whereas today it is only £15 per bottle.

Of course, red oxide of mercury in a dry battery is not necessarily a cheap raw material.

W. J. TUFFIN.
Manager, Mercury Dept.,
F. W. Berk and Co., Ltd.
London, W.C.

MANUFACTURERS' LITERATURE

Illustrated leaflets giving technical details of the Type 413A pulse generator, Type 120A frequency meter and photo-electric pick-up, and Type 150A dynamic balancing machine from Dawe Instruments, 130, Uxbridge Road, Hanwell, London, W.7.

Application Data Book, Issue 3, giving technical details of Type 100 high-stability resistors, etc., from Erle Resistor, Ltd., Carlisle Road, Hendon, London, N.W.9.

Catalogue of W.B. loudspeakers and components including radio sound apparatus, from Whitley Electrical Radio, Victoria Street, Mansfield, Notts.

New leaflets dealing with the following products: Ref. SP/7/2, Transmitting Valves; Ref. SP/8/2, Receiving Valves; Ref. A8, Valve Type DEF; Ref. SL/112, Receiver Type CR.100/2; Ref. RL/4/2, Receiver Type CR.306; Ref. SL/17/2, Transmitters; Types TCG and TGM.51; Ref. SL/13, Transmitter Type TGM.61; Ref. SL/30, AXBT Microphone; Ref. SL/37, Airborne Receiver Type 4A.96 from Marconi's Wireless Telegraph Co., Marconi House, Chelmsford.

Leaflet giving technical details and dimensions of the Type "A" automatic record changer made by the Plessey Co., Ilford, Essex.

Descriptive lists of transmitters, accessories and components, from Radiocraft Ltd., 91, Church Road, London, S.E.19.

Standard stock size list of aluminium, brass, copper and other non-ferrous metals from H. Rollett & Co., 6, Henry Hughes & Son, New North Road, Barkingside, Ilford.

Illustrated catalogue of "Minirack" oscillograph equipment and recording camera, from Southern Instruments, Fernhill, Hawley, Camberley, Surrey.

Illustrated lists of sound amplifying equipment from the Trix Electrical Co., 15, Maple Place, Tottenham Court Road, London, W.1.

Illustrated leaflet describing the Hughes supersonic flow detector, from Henry Hughes & Son, New North Road, Barkingside, Ilford.
A Poser

A while ago I received from an editor (not of this journal) a request for "a short account of the Vipuri tube." Completely floored but feeling that it might be something I ought to know about, I spent a busy morning in searching through text books, encyclopedias and even catalogues and in ringing up erudite friends, all without the slightest success. I was convinced at length that "their ain't no sech thing" (though it looks quite a likely name or doesn't it—for something in success. I was convinced at length catalogues and in ringing up erudite text books, encyclopœdias and even friends, all without the slightest busy morning in searching through RANDOM RADIATIONS a bow at a Venturi. The " short typist's or printer's error; my cor much hard work was in fact invented by the famous Finnish named by him in honour of his native town, Viipuri. The omission of the second "i" in the name was deliberate and is believed to be a covert allusion to the coccide apparatus consists of a glass envelope, 2.00625 metres in length and of inverted-O section, which contains a cathode, an anode, a hyrode, a hyrode and eighteen grids, connected in series—paranoia, in a high-pressure vacuum. A length of hoaxial cable, attached to the eastern end of the envelope is provided to form the connection with a source of uni-directional A.C. The purpose which the Vipuri tube is intended to serve is not known.

The Big Black-Out

The radio black-out on the evening of November 2nd seems to have been one of the most complete that has ever happened. The North American short-wave stations were just wiped right out and not even the most powerful transmitters could get their messages across to this country. It must have been an exasperating time for those who were trying to get the latest electric news from the States. These things so often happen at times when you'd give anything for clear reception. I recall the day when Hitler was carrying out his greatest pre-war purge and all communication with Germany was cut off. During the day the only German radio stations working were medium-wavers of moderate power, which were sending out short news bulletins at intervals. I had a communication receiver in use at the time with which I could normally get intelligible daytime reception from one or two of them. But on that day atmospherics were simply maddening.

At Last

The provisions of the new Wireless Telegraphy Bill regarding interference with broadcasting and television reception seem to be just what the doctor ordered so long ago that he must almost have forgotten writing the original prescription. For about a quarter of a century W.W. has been urging that the Postmaster General should be given authority to exercise something more than his powers of persuasion on those who operated commercial or domestic electrical apparatus which marred (or even completely wrecked) reception in neighbouring homes. When the bill has become an act, as no doubt it will, the P.M.G. will be able to serve notice on offenders to abate the nuisance within 28 days. He's no longer tied down to polite requests, which too often proved ineffective. Now he can up and at 'em. And that's what I hope he will do. The user of apparatus capable of radiating interference will at last be compelled to make sure that it does not in fact do so. But I've always contended that the real fault probably lay less with the user than with the manufacturer of the apparatus. The ordinary man or woman, for example, who bought an electrical gadget for the home could not be expected to think about its interference-radiating powers. That was an aspect which seldom occurred to his or her non-technical mind. But the manufacturers jolly well did know and one of the queer things is that some firms making and selling radio or television receivers also made and sold other kinds of domestic apparatus certain to spoil the enjoyment obtainable from these. I profoundly hope that before long people will insist themselves against trouble by refusing to buy apparatus that is not guaranteed to conform to the P.M.G.'s requirements.

Television in the U.S.A.

From American industrial sources comes the information that the number of television sets now in use in the U.S.A. is over half a million and that it is confidently expected that three times as many as that will be working by the end of next year. I'm told that television is not getting so much into private homes as into bars, hot dog stands, restaurant lounges and so on. The reason given is that the programmes are not often of the kind likely to make a strong appeal to the fireside viewer, but consist too largely of prize fights, race meetings and so on. As there is no receiving licence in the States, and therefore no direct revenue from listeners, all programmes must be provided ultimately by proceeds from advertising. The system works fairly well on the whole so far as "sound" broadcasting is concerned; but there is something of an impasse at the moment in television. Business concerns won't buy "time on the air" from owners of television transmitters until they feel that there are sufficient viewers in the homes of the service area. The owners of these homes, on the other hand, say that they won't buy receivers until they are guaranteed the right kind of programmes. Matters will probably sort themselves out in time.

Metering Programme Appeal

Talking of programmes and their popularity or otherwise reminds me of an account I read recently of a remarkable new method developed in Denmark for ascertaining the number of sets in use in a particular area at any moment. At first blush the method used appears to have a distinctly Heath Robinson touch; but its genuineness and the fact that it works are vouched for by the Journal of the International Broadcasting Organization. The principle
is this. The switching on of a radio receiver connected to an A.C. supply circuit causes a minute distortion of the waveform in the circuit to occur owing to the action of the rectifier in the set. The harmonics resulting from such distortion can be selected and made to appear as a voltage proportional to the number of sets in use. Apply this to a recording voltmeter of suitable type and the result is a graph showing pretty accurately the amount of listening that was being done at any moment. Graphs covering the period from the fourth to the eighth of August this year show, amongst other things, that Copenhagen listeners switched on in large numbers when commentaries on the Olympic Games were being sent out. The system has a good few limitations. It can be used only on A.C. mains and a separate recorder is needed to keep account of events in the circuit served by the output of each transformer station. It does not indicate to what station the sets are tuned. At the same time it should give some very useful information when the records are carefully analysed. One interesting point is that the fact that each recorder deals with only one supply circuit is not altogether a drawback. Such a circuit is likely to serve an area the majority of whose inhabitants are of much the same social type.

HAYNES RADIO HR88 table-model television receiver with 12-in. tube. The vision channel has six R.F. stages while in the sound channel there is a push-pull triode output stage. An E.H.T. supply of 7 kV is used and the deflector coils, both line and frame, are fed from the time bases without transformers. A table is supplied with the set which together cost £120, plus £26 P.T.

The already extensive Bulgin Range is now still further increased to a total of over 400! These new ‘long-bush’ Toggle Switches fix by 15/32in. hole to cabinets, panels, &c. (or to chassis behind thick fronts) of 9/16in. thickness instead of the standard 3/16in. A three-fold increase in mounting usefulness.

All types, as listed above, are for 6-250v. circuits, with 3-1A ratings (based on Unity P.F.) at 250v., or 6-1A, at 6v. Threetimes working=test v., and guaranteed life of 25,000 four-minute operations, on full load . . . 70 TIMES A DAY FOR A YEAR!

The Choice of Critics

A. F. BULGIN & Co. Ltd., - BARKING - ESSEX
Large-scale Television

To avoid restricting the size of the picture to that of the C.R. tube, it has already been suggested to replace the ordinary fluorescent screen by one having a point-to-point transparency which is controlled by the electron scanning stream. Such a screen could be used to modulate the light passed through it from a powerful lamp, and so project the picture directly upon an external viewing screen.

A screen intended for this purpose is prepared by depositing a thin layer of potassium bromide crystals upon a normally transparent surface in closely set parallel lines to form a diffraction grating, preferably through a wire mask which is subsequently removed. By the so-called Toepler-Schlieren effect, a beam of light projected on to the screen will then suffer diffraction to an extent that varies from zero to a maximum in accordance with the intensity of the scanning stream of electrons. The screen is stated to give a high contrast of light and shade in the projected picture, and to have a sufficiently quick rate of recovery to cope with normal scanning speeds.

Short-wave Aerials

The so-called slot aerial is formed by cutting out from a conducting sheet or plate an aperture having a length and width determined by the wavelength it is intended to handle. One of its properties is that of polarizing a wave passing in or out of it, so that the electric field of the wave is at right angles to the length of the slot. Conversely, the slot aerial is opaque to waves where the electric field lies parallel with the slot length. Inventions in combining these characteristics of the slot aerial with the directional properties of other aerials, such as the wave-guide horn, are described showing how the invention can be applied to controlling the frequency and polarization, as well as the relative phase relation and power distribution over the cross-sectional area of a beam of short-wave energy.

Super-regenerative Receivers

This type of circuit is very liable to cause interference with neighbouring sets by radiating parasitic oscillations, particularly during the intervals when it is not actually receiving signals. According to the present invention, the receiver is coupled only intermittently to the aerial, the make-and-break periods being substantially in step with the quenching frequency, though slightly de-phased from it. Preferably the aerial coupling is established at the instant when the oscillations in the regenerative circuits start to build up, and is maintained until their amplitude is almost equal to that of the incoming signal. The coupling is then broken, and is kept open until the local oscillations are damped out by the quenching valve. In effect, the switching cycle maintains a one-way path, which allows signals from the aerial to reach the receiver, but prevents re-radiation of the locally generated oscillations. The switching is performed by a valve which is controlled by blocking voltages derived from the quenching oscillator through a phasing device.

Panel Mountings

The usual circular hole bored through the panel of a wireless set to take the spindle of a rheostat or similar control unit soldering iron in a slot which is expanded at one end into an aperture of sufficient size to allow the internal component to be withdrawn bodily, after the external fixing screw for the spindle has first been slackened to permit the necessary sliding movement.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.1, price 2/- each.
NEW LOW COST HIGH VOLTAGE R.F. POWER UNITS

Designed for use in equipment requiring a high voltage at low current, this type of power unit consists of an H.F. oscillator and transformer. Fully screened units are now available for outputs between 5KV and 25KV, the illustration being of the 8KV transformer, 5 in. high.

Amongst the more obvious applications are:
- Television
- Paint Spraying
- Dust Removal in air-conditioning plant
- Electron Microscopes
- Diffraction Cameras
- Nuclear Research
- Radar
- Breakdown Testing

Full design and production facilities are at the service of the Trade, from whom enquiries are welcomed.

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For first-class performance, and utter reliability, you can safely recommend 'AERIALITE' Radio and Television Aerials and equipment. These two together with 'ASHTON' Cables for radio and general electrical needs are all designed and produced by AERIALITE LTD at their CASTLE WORKS, STALYBRIDGE, CHESHIRE.

AN UNSOLICITED LETTER

Highcliffe-on-Sea, Hants.
Oct. 18th, 1948.

Dear Sirs,

Regarding the "£5 Television Receiver" for which I obtained data from you I thought you might be interested to know that I have made up a receiver exactly to the instructions and the results are to say the least amazing.

I have had the set working now for about three weeks and have had quite worthwhile entertainment every night, which considering the distance from London (90 to 100 miles) I think is pretty good.

You are quite at liberty to quote this or refer anyone to me who may be in doubt as to whether the set is a practical job as I can assure them that it is really worth while.

Yours faithfully,

M. Cowdley.

Constructional data for the improved MARK 2 version is now ready, price 7/6 post free. All necessary parts are available ex-stock but we advise you to order the three main items (Radar Receiver, Radar Indicator and Mains Transformer combined h.t. & E.H.T.) immediately as these may become unobtainable later, and in any case you should get started now if you want your T.V. Receiver finished by Xmas. The price of the three main items is £11 10s., plus 12/6 carriage plus 7/6 (returnable) packing case. A list of the other additional items is included with the data.

A made-up receiver can be seen working during transmitting times. We are open on Sats. until 5 p.m. Hire purchase terms available on these and other goods. Send for our winter list.

BULL'S EX-GOVERNMENT DEPOT,
42-46 WINDMILL HILL, RUISLIP MANOR, MIDDX.
At last a gramophone motor to match the performance of the famous Connoisseur Pick-up.

Specification:
- Voltage: 200-250 volts A.C., 50 cycles.
- Rim drive with speed variation. No governors and no gearing. Heavy non-ferrous turn-table, machined to run dead true, fly-wheel action — no "WOW." Main turn-table spindle hardened, ground and lapped to mirror finish, running in special phosphor-bronze bearings. Motor runs in needle-point, self-adjusting bearing Motor.

Board 1in. plastic. Pressure on Drive-Wheel released when not in use, to obviate forming flats and noisy action.

Retail Price, complete with Pick-up £15 19s. Od plus £6 18s. 2d. P.T.
" " without Pick-up £13 5s. 0d " £5 14s. 10d. P.T.
Coupling Transformer when required 13s. Od.

Made by:
A. R. SUGDEN & CO. (ENGINEERS) LTD., BRIGHOUSE, YORKS.

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AMATEURS! SERVICE MEN! ENGINEERS!

Don't be patient. You are wasting your time. Use the Burgoyne Seven Second Solder Gun and take the patience and waiting period out of your soldering. The wonderful clean heat which you get with the Solder Gun will ensure that you do not get dry joints, no fussy re-tinning required. Use like an ordinary iron but press the trigger and solder immediately.

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PRICE COMPLETE
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With Two spare Bits and 4 yards of Finex. Model S.471 for 100-130v. A.C.
Model S.472 for 200-250v. A.C.
The "Aristocrat"

Planned for the connoisseur requiring a high quality cabinet suitable for a quality receiver. As good as pre-war and embodying all that is best in British craftsmanship and design. For export or for those holding or who can obtain timber permits. Private enquiries are invited and those interested will have their names entered on our lists. Various makes of pick-ups can be supplied as an extra, also Collaro Gram. Units. No charge is made for fitting. We shall be pleased to give any assistance and advice you may require.


Interviews by appointment only.
Export Enquiries Invited.

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THE MOST OUTSTANDING BARGAIN OF THE YEAR

NEW BC454B.
6-valve Superhet complete with valves. Line-up: 3 12SK7's, 1 125R7, 1 12K8, 1 12A6. All GT Types. Frequency range 3-6 Mc/s I.F. Valve 1415 kcs.

NEW BC455.
Same specification but frequency range 6-9 Mc/s. I.F. 2830 kcs.

ALL 25/- EACH.
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THE DOUBLE SUPERHET FOUNDATION AT A SENSATIONALLY LOW PRICE. Plan of basic connections free with each order. Special press-in tuning spindle and knob. 2/6 (precision medium wave coil assembly for the 453, price 10/- not suitable for 454B or 455B).

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Staff Call Signs: G3DLV, G3DGL.

Black Crackle Cabinet. Size 20” x 8” x 5” Input 115 v., 400-2,600 c/s. Output 730 v.-380 mA., 935 v.-370 mA., 370 v.-130 mA., 6-3.v.-2 amps. Fitted four 5RG (similar U50) Rectifying Valves. Power Transformer makes fine multi-ratio 200 watt Modulation Transformer. Oil Filled 1,000 v. 4 mfd. Condensers, 1,500 v. 1 mfd. Condensers. Heavy Duty Chokes, etc. In original wooden unopened crates, 30/-. Carriage paid per rail (state name of nearest railway station). Available in Gt. Britain only.

BO456B. 40 watt Modulator Unit contains 1625 (same as an 807 with 12 v. heater), 12J5 Triode and VT150 Neon Stabiliser. 3 Super-sensitive relays. Modulation Transformer, Driver Transformer, Output Transformer, Precision Resistors, Condensers, etc. Brand New in original cartons.

PRICE 19/6 each, carriage paid.
Some Notable Selling Features of the
GRAMPOLA
AMPLIFIED ELECTRIC GRAMOPHONE

1. Strong, handsome cabinet, covered with leather cloth wins immediate approval. 2. Full sized 8" diameter loud speaker greatly enhances tone. 3. Provision for storing a number of records. Other important features are: scratch filter to reduce needle hiss; takes 10" or 12" records. A.C. mains operated. Garrard Electric Motor and magnetic pick-up connected to 2-stage amplifier with 4 watts output. Price £8. Inc. P.T.

APPLY TO YOUR WHOLESALER FOR SAMPLE AND DEMONSTRATION.
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Superspeed
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1. Maximum "Wetting" Capacity.
2. Accelerated Fluidity.
3. Moderate soldering bit temperatures.
4. Mechanical bonding and perfect Electrical conductivity ensured.
5. Minimum amount of solder used per joint.

Supplied in a wide range of Gauges and Alloys on 1 lb and 71/2 lb reels, works coils, or as required. Prices on application.

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Resistors produced by the cracked carbon process remain stable to ± 1% of initial value.
★ Tolerance ± 1%
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Low temperature coefficient.

OXLEY DEVELOPMENTS CO., LTD.,
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Complete in every detail, including beautiful walnut cabinets, 12" x 8" x 6" deep. All main components mounted on chassis and wired. Simplest instructions for completing in one hour. 3 valves: Rex. AC/DC mains. 4 controls:— Vol/Off-Tone—W/C—Tuning (slow motion).

For £7—17—6

12 WATT QUALITY AMPLIFIER
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A New Constant Impedance MICROPHONE MIXER UNIT

Permits the controlled mixing and fading of microphone and/or gramophone inputs. Is valveless, and requires no power supply. Elegantly finished in matt gold and black. Silent in action, and long lasting.

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Amplifier, instructions supplied; or and new, 2½- £1 moreis, built for continuous rating and rack employing 3 EF60, 1 EA50, and adjustable iron cores for the units, 6d each: 0.25mfd. 2 kvw. 1/3 phones, 8, 6; slit)  Vis., 5/- each, dust iron cores and other quality amplifiers built strictly to specification with finest components available; with any television receiver, enjoys great popularity. Several of these installed before the war will still give first-class performance. We aim to ensure that you are not disappointed with any product manufactured by Radio Trades Manufacturing Co. (Ealing), Ltd., is definitely acknowledged as one of the world's finest manufacturers of, and is reasonably priced. L.H. Wilkinson, 204, Lower Addiscombe Rd., Croydon.

THE present is a most opportune time for the introduction of equipment to your own special requirements. Write for descriptive leaflets of our range of equipment to your own special requirements.

RECEIVERS, AMPLIFIERS, HIFI, etc., a very few views of high fidelity and full details. Write for descriptive leaflets of our range of equipment to your own special requirements.

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TALENT station high fidelity tuner units. £5/5; 6-watt push-pull h.f. amplifier, £5; 6-watt single, £2½; 1½-watt double, £1½; large control unit, will work with any amplifier, bass and treble controls (boost and cut), gain input, new panel, and other refinements, detailed technical description on request. — A. D. Bartley, Bartley, Barley.

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Some recent letters of appreciation have suggested to us that we don’t say much about our attitude to the job we are doing and our relations with our customers. We have never thought of doing so because these things are taken for granted.

The equipment we design, make, and sell is intended to give the best possible musical quality of reproduction. We are constantly told that we succeed to quite an exceptional degree. So far, so good; but the thing doesn’t rest there, for it is, to our way of thinking, a silly sort of procedure to sell a man some goods and then forget about him until he wants some more goods.

The mechanic way of avoiding this is to send out "sales letters," "brochures," "mailing pieces" and whatever else the advertise is supposed to do. This, however, is altogether a mechanisation because we are convinced that you can’t mechanise what is virtually a fine art. So when you make contact with Hartley-Turner you meet a new idea—the idea that the manufacturer and the customer are partners in an adventure, where each party makes his intelligent contribution to a joint effort.

The apparatus involved is only the (necessary) means to an end; the end is pleasure to the customer through music in his home, and pleasure to us because we have to please you.

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The Hartley-Turner 215 Speaker £9.


Complete catalogue of data sheets free on request.

Home construction of the T.R.F. unit and amplifier is quite easy with the aid of our Technical Bulletins (10/- each) and a complete understanding of the subject of high-fidelity will be found, as its a complete understanding of these things are taken for granted.

We can offer, FOR IMMEDIATE DELIVERY from very generous stocks, a wide range of ultra-high quality fixed paper Condensers, from .001μF to 8μF. Also STOCKS of small, genuine MICA Condensers from .0001μF to 10μF.

Enquiries are invited for manufacturers’ requirements, wholesale and export only for bulk deliveries, and for scheduled deliveries over a period, as required.

Condensers of close or very close tolerance can be supplied within about one week.

Please request our 4-page bulletin CON52E051114

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THE FAMOUS LUXURY FASHIONABLE CRYSTAL
SET IN BAKELITE CASE WITH ADJUSTABLE BAND
NORMALLY EXTRACTED WOOLLY PERSIMMON
TRANSPARENT SEMI-TRANS. DETECTOR AND TERMINALS.
17½ HIGH QUALITY FITTED BOUND LEATHER CASE.
SUITABLE FOR TEST CRYSTAL RECEP.
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MADE IN 1923

ROTARY AERIALS.
Positional remote control units for Rotary aerials, totally enclosed for
maximum protection. 1½ turns of handle will lock and unlock.
A specially designed gear, turned gun, 60/1 with 100 division diagonal and folding handle, 1½?, post free.

CONDUCTORS.
200 mfd. £15; 1,000 mfd. £35; 6,000 mfd. £55; 10,000 mfd. £85.

MICROPHONES.
The Leader table model, bakelite case, carbon inset, metal grill, on polished
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PHONES for the Deaf.
S. G. Brown single ear, bakelite case, carbon inset, metal grill, on polished
brass base, £25. Incomplete, £10.

MOTOR GENERATORS.
210 volts D.C. input, 23/2 volts 138 amps D.C. output.
1,000 volts A.C., £105.

MOTOR PRESSOR.
230 volts, 1½ h.p., 2,000 r.p.m., £45. Motor belt driving Curtis compressors.
1½ tons, 210 lb. pressure, 400 r.p.m. on C.I. base, £18.

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230 volts, 1½ h.p., 2,000 r.p.m., £45. Motor belt driving Curtis compressors.
1½ tons, 210 lb. pressure, 400 r.p.m. on C.I. base, £18.

MOTOR GENERATORS.
210 volts D.C. input, 23/2 volts 138 amps D.C. output.
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1½ tons, 210 lb. pressure, 400 r.p.m. on C.I. base, £18.
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INDICATOR UNITS TYPE 6-8, contain VCR-97
AUTO GENERATORS, 3 phase, 200 volt, 3-phase, 2000 VA.
MAIN MOTORS, 120-240 volt, 1.5 hp, 3/4 hp, 1/2 hp.
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DIRECT CURRENT GENERATORS, 1.5 hp, 3/4 hp, 1/2 hp.

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ARMSTRONG

ADDITIONAL REFINEMENTS have been incorporated in Armstrong Model RF103 for the Coming Season as under:

2 stages of I.F. amplification with variable selectivity, a remodelled coil pack with permeability iron core coils and a tuning indicator of the correct type. The chassis in future will be known as:

Model RF103 Type 2. 10-VALVE ALL WAVE CHASSIS WITH VARIABLE SELECTIVITY. 10-valve (including C.R. valve) circuit. R.F. Pre-amplifier, 2 stages each with variable selectivity. Wave band expansion (short wave band covers over 20), large glass scale. 10 watts pussh-pull output. For 200-250 v. A.C. mains. Price £19 gns. plus tax.

SPECIAL NOTICE

MODELS EXP83 and UNI83 briefly described hereunder now incorporate a remodelled coil pack with permeability iron core coils giving increased selectivity and sensitivity and a new tone compensating circuit to still further increase quality of reproduction.


Model UNI83. 8-VALVE ALL-WAVE RADIO RADIATION incorporating waveband expansion, e.g. the 16-50 m. band covers just over 20 inches on the large glass scale, treble boost control, high quality push-pull output giving 8 watts audio. For 200-250 v. D.C. or A.C. mains. Price £15 8. 8. Plus Tax.

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December, 1948

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sin. Flush, 0-40 volt

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These brand new equipments were made for the A.M.L 1946 installation and comprise a complete tuning unit covering 4.9-32.5 metres. Band 1, 425-0-425 v. 180 na. 4 v. 8 A. C.T., 4 v. 4 A. etc. 6 v. 2 a rectifier, with trans. and ballast bulb, 6 v. 2 a rectifier, with trans. and ballast bulb, 15 v. 6 a rectifier, with trans. and ballast bulb. 30 v. 1.6 a rectifier, with trans. and ballast bulb. 40 v. 1.0 a rectifier, with trans. and ballast bulb. 60 v. 0.5 a rectifier, with trans. and ballast bulb. 100 v. 0.5 a rectifier, with trans. and ballast bulb. 250 v. 0.5 a rectifier, with trans. and ballast bulb. 500 v. 0.5 a rectifier, with trans. and ballast bulb. 1000 v. 0.5 a rectifier, with trans. and ballast bulb. £1.09. Total, £2.02 (5). Carriage paid.

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Cable "Duraferco" Ltd.

COULPHOEN RADIO

"The Return of Poirot" and "Service"

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<table>
<thead>
<tr>
<th>Item Description</th>
<th>Price</th>
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<tr>
<td>10-300v condensers tub.</td>
<td>2/6 ea.</td>
</tr>
<tr>
<td>10-150v condensers tub.</td>
<td>3/6 ea.</td>
</tr>
<tr>
<td>10-400v condensers tub.</td>
<td>5/6 ea.</td>
</tr>
<tr>
<td>10-600v condensers tub.</td>
<td>8/6 ea.</td>
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<tr>
<td>10-800v condensers tub.</td>
<td>10/6 ea.</td>
</tr>
<tr>
<td>10-1000v condensers tub.</td>
<td>12/6 ea.</td>
</tr>
<tr>
<td>10-1500v condensers tub.</td>
<td>15/6 ea.</td>
</tr>
<tr>
<td>10-2000v condensers tub.</td>
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<td>10-3000v condensers tub.</td>
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<td>10-5000v condensers tub.</td>
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<tr>
<td>10-10000v condensers tub.</td>
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<td>10-25000v condensers tub.</td>
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<td>10-100000v condensers tub.</td>
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As from Monday, November 8th, 1946, list prices of most Erie & E.R. components are reduced by 30% in the shilling, e.g.

**CARBON RESISTORS**

<table>
<thead>
<tr>
<th>Type</th>
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<th>Price</th>
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<td>5A</td>
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<td>6d.</td>
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<tr>
<td>6A</td>
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<td>8A</td>
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</tr>
<tr>
<td>10A</td>
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<td>3/6</td>
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<tr>
<td>15A</td>
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<td>20A</td>
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**MINIATURE RESISTORS**

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<td>6d.</td>
</tr>
<tr>
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<td>1/6</td>
</tr>
<tr>
<td>8A</td>
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<td>2/6</td>
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<tr>
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<td>2.0 ea.</td>
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<td>15A</td>
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<tr>
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<td>4.0 ea.</td>
<td>8/6</td>
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**RESISTOR KITS**

<table>
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<tr>
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<tbody>
<tr>
<td>12</td>
<td>24/-</td>
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<tr>
<td>15</td>
<td>32/-</td>
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**CARBON TRACK POTENTIOMETERS**

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<th>Price</th>
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<tr>
<td>SKC.2021</td>
<td>4/6 ea.</td>
</tr>
<tr>
<td>SKC.2023</td>
<td>7/6 ea.</td>
</tr>
</tbody>
</table>

**but, wholesale and retail discounts remain unaltered.**

A full list of the reductions can be obtained from all leading wholesalers, or directly from the manufacturers.

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A STONISHING bargains in Supacolts! 3-wave superhet super-regenerative coil packs, only 2/-, with R.F. stage £2/2! Pull-up button, coil pack and R.F. stage £6/6. Two coils, with 3-wave reg stage only 2/6! This pack is the last word in high efficiency 3-wave superhet units; comprehensive range of 3-wave superhet coil packs, in radio and television components, in the lowest prices; full range of performances tuned iron-core coils. Each coil: manufactures range from 25/-; complete superhet 4-valve plus rec. stage, a wonderful bargain under £2/2! Mail order only—Supacolts, 98, Greenway Ave., London. E.C.1.

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Wireless World

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<td>5 Watt Max. 1250 ohm.</td>
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<tr>
<th>Capacitance (in Mfd.)</th>
<th>Max. Working Volts (at 50°C)</th>
<th>Dimensions (in Inches)</th>
<th>Type Number</th>
<th>List Price each</th>
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<tr>
<td>0.0005</td>
<td>25000</td>
<td>Overall Length: 5 1/2</td>
<td>CP57H00</td>
<td>13-6</td>
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<tr>
<td>0.001</td>
<td>12500</td>
<td>Overall Diameter: 1 1/4</td>
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<td>7-6</td>
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<td>0.002</td>
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<td>CP57XO</td>
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Since buyers overseas find it advantageous to import British Made Ersin Multicore Solder, paying freight and, in many cases, import duties, it must pay you to use only Ersin Multicore, for the difference in initial cost between The Finest Cored Solder in the World and single core solder is greater overseas than here.

Avoid dry and “H.R.” joints and save money by using only Ersin Multicore Solder.

ERSIN Multicore Solder is supplied in a wide range of alloys and gauges: on nominal 7 lb. reels for use by manufacturers. Technical information, samples and bulk prices gladly sent on application.

Specifications of Size I cartons available from most factors and retailers are as detailed below:

<table>
<thead>
<tr>
<th>Catalogue Ref. No</th>
<th>Alloy</th>
<th>S.W.G.</th>
<th>Approx. length per carton</th>
<th>List price per carton (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 16014</td>
<td>60:40</td>
<td>14</td>
<td>34 feet</td>
<td>6 0</td>
</tr>
<tr>
<td>C 16018</td>
<td>60:40</td>
<td>18</td>
<td>88 feet</td>
<td>6 9</td>
</tr>
<tr>
<td>C 14013</td>
<td>40:60</td>
<td>13</td>
<td>21 feet</td>
<td>4 10</td>
</tr>
<tr>
<td>C 14016</td>
<td>40:60</td>
<td>16</td>
<td>46 feet</td>
<td>5 3</td>
</tr>
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