Wireless World
RADIO and ELECTRONICS

APRIL 1946
1/6
Vol. LII. No. 4

IN THIS ISSUE:
REVIEW OF POST-WAR COMPONENTS

www.americanradiohistory.com
AH! BUT THAT ONE WAS A ROLA

Rola SPEAKERS
SELL THEMSELVES ON THEIR REPUTATION

and the Receivers in which they have been installed!

BRITISH ROLA LTD. • GEORGIAN HOUSE • BURY STREET • ST. JAMES'S • LONDON S.W.1, ENG.
THE Services and war-time industry are familiar with the high standard of dependable accuracy of "AVC" Electrical Testing Instruments. They will be an equally dominant factor in the post-war rebuilding of our great industries and the advancement of amenities worthy of a world at well-earned peace.

The instrument illustrated is the well-known and widely-used Model 7 Universal AvoMeter, a compact multi-range A.C./D.C. meter of B.S. 1st grade accuracy. It provides on a 5-inch hand calibrated scale direct readings of A.C. and D.C. volts, A.C. and D.C. amperes, resistance, capacity, audio-frequency power output and decibels. Range selection is effected by means of two rotary switches.

Current consumption is 1 mA. or 2 mA. at full scale deflection, and the total resistance of the meter is 500,000 ohms. An automatic cut-out affords protection against damage through severe overload, and compensation is provided for variations in ambient temperature. Full details of the 50 ranges of readings are set out in a fully descriptive pamphlet which will be sent free on application.
NON-HYGROSCOPIC

Just one point which the wise set-maker has to consider when selecting cored solder. The export drive makes it imperative that a radio receiver, which may be used 2,000 or more miles from the place it was made, should have sound, soldered joints. The flux-residue must not absorb moisture under tropical conditions. Now, more than ever, it is a true economy to use "The finest cored solder in the World." It is an insurance against faulty joints to standardise on

ERSIN MULTICORE SOLDER

<table>
<thead>
<tr>
<th>CATALOGUE</th>
<th>ALLOY</th>
<th>S.W.G.</th>
<th>APPROX. LENGTH PER NOMINAL 1-LB. REEL</th>
<th>PbCE PER NOMINAL 1-LB. REEL (SUBJECT TO USUAL DISCOUNT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFERENCE NO.</td>
<td>TIN/LEAD.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16014</td>
<td>60/40</td>
<td>14</td>
<td>64 feet</td>
<td>6/-</td>
</tr>
<tr>
<td>16018</td>
<td>60/40</td>
<td>18</td>
<td>178 feet</td>
<td>6/-</td>
</tr>
<tr>
<td>14513</td>
<td>45/55</td>
<td>13</td>
<td>45 feet</td>
<td>4/10</td>
</tr>
<tr>
<td>14516</td>
<td>45/55</td>
<td>16</td>
<td>94 feet</td>
<td>5/3</td>
</tr>
</tbody>
</table>

Above are specifications available for Service Engineers. Bulk prices and additional specifications are available for Manufacturers. Manufacturers, Factors and Service Engineers are invited to write for technical information and free sample of Ersin Multicore Solder 60/40 alloy.

MULTICORE SOLDER LTD.

MELLIER HOUSE, ALBEMARLE STREET, LONDON, W.1.

(Tel.: REGENT 1411 P.B.X. 4 lines)

Your new STENTORIAN is being made now...

Extension Speakers, inc. Cabinet and Volume Control, available from 29'6

It may even be waiting for you at your local Radio Dealer's. Keep in touch with him; these attractive extension speakers with their superb reproduction offer such amazing value that they are being bought faster than they can be produced. More and more people appreciate the convenience of not being confined for their radio to the room the set occupies.

PRICES

- Minor Type MX (for Low Impedance Extension) - 29/6
- Minor Type MC (with Universal Transformer) - 35/6
- Baby Type BX (for Low Impedance Extension) - 43/6
- Baby Type BC (with Universal Transformer) - 49/6

M.R. SUPPLIES

promisingly maintain their reputation for SUPERIOR QUALITY RADIO AND ELECTRICAL MATERIAL and prompt despatch. All prices nett.

POWER TRANSFORMERS: Prim. (on terminal board). 45/6/80/200/4000 v. Per set. £2.00-£5.00. 45/6. Also Prim. 25/6/50/200/4000 v. Per set. £3.00-£6.00. 45/6. Also Prim. 10/6/50/200/4000 v. Per set. £3.00-£6.00. 45/6.

S.T.C. METAL RECTIFIERS (Solenoids). Per set, charged up to 15 rolls. In conjunction with suitable transformers (see below). 3amps. 22/6; 6amps. 49/6.

OUTPUT TRANSFORMERS: Heavy duty model handling 25 watts. Improved "Wireless World" spec., providing 11 ratios from 15pf. to 75 pf. with C.T., for push-pull, in cast brackets, with terminal boards, weight 9 lbs. 5/6. Also Prim. 25/6. Also Prim. 10/6. Also Prim. 6/6. Also Prim. 6/6.

BRAMFORD MOVING COIL MICROPHONES (highly recommended). Type M39 (12 mm). 1.2v. in recommended frame. Weight 2/6. • Type M24, a very fine instrument, in all-plated housing, with internal cord-switch (15 mm). Weight 2/6. • Type M21, a gold-finish instrument, in all-plated housing, with external cord-switch (15 mm). Weight 5/6.

MICRO-AMMETERS (special limited supply only), 50, 100, 200 and 1000 m. a.c. and d.c.

M.R. SUPPLIES, 68, New Oxford Street, London, W.C.1

Telephone: MUSEUM 2958

WB Stentorian

THE PERFECT EXTRA SPEAKER FOR ANY SET

WHITELEY ELECTRICAL RADIO CO. LTD., MANSFIELD, NOTTS.
Now! 
a full range

"DRILITIC"
ELECTROLYTIC CAPACITORS

Physically small, these B.R. and C.T. capacitors embody many technical advantages and their comprehensive coverage of every electrolytic requirement will be readily appreciated by users. The electrical characteristics of these capacitors are a marked advance in electrolytic design, the leakage current and equivalent series resistance are reduced, the audio and radio frequency impedance improved, breakdown voltage and life expectancy have been increased together with an improvement in temperature characteristics. They are contained in seamless drawn aluminium containers hermetically sealed and the container is always negative.

---

**DRILITIC**

**CAPACITORS**

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Maximum Working Voltage</th>
<th>Size</th>
<th>Maximum Ripple Current mA</th>
<th>Type Number</th>
<th>Retail Price Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>D. 12</td>
<td>5/1</td>
<td>55</td>
<td>BR501</td>
<td>2s. 6d.</td>
</tr>
<tr>
<td>25</td>
<td>D. 25</td>
<td>5/2</td>
<td>75</td>
<td>BR252A</td>
<td>2s. 6d.</td>
</tr>
<tr>
<td>50</td>
<td>D. 50</td>
<td>2/2</td>
<td>75</td>
<td>BR505</td>
<td>3s. 6d.</td>
</tr>
<tr>
<td>8</td>
<td>D. 150</td>
<td>1/2</td>
<td>110</td>
<td>BR815</td>
<td>4s. 9d.</td>
</tr>
<tr>
<td>8</td>
<td>D. 500</td>
<td>1/2</td>
<td>100</td>
<td>BR850</td>
<td>4s. 0d.</td>
</tr>
<tr>
<td>16</td>
<td>D. 500</td>
<td>2</td>
<td>100</td>
<td>CT850</td>
<td>4s. 6d.</td>
</tr>
<tr>
<td>8-8</td>
<td>D. 500-500</td>
<td>1/2</td>
<td>110</td>
<td>CT1650</td>
<td>6s. 6d.</td>
</tr>
<tr>
<td>16-8</td>
<td>D. 500-500</td>
<td>1/2</td>
<td>100-100</td>
<td>CT8850</td>
<td>6s. 6d.</td>
</tr>
</tbody>
</table>

Vertical mounting clips supplied with C.T. types. *The total max. ripple current for both sections must not exceed the larger figure.*

---

DUBILIER CONDENSER CO. (1925) LTD. · DUCON WORKS · VICTORIA RD. · NORTH ACTON LONDON · W.3
STATIC TWO-DIMENSIONAL visual delineation of any recurrent law.

RELATIVE TIMING OF EVENTS and other comparative measurements with extreme accuracy.

PHOTOGRAPHIC RECORDING of transient phenomena.

SIMULTANEOUS INDICATION of two variables on a common time axis.

INDUSTRIAL INDICATING and TESTING afford increasing scope for the Cathode Ray Tube as the only device with the above inherent features of which the last is unique in the Cossor DOUBLE BEAM Tube.

The Model 339 Cossor Oscillograph thus equipped is invaluable on all problems of research, production or operational testing, when the effect examined is applied as a voltage. When recurrent the traces are studied visually and when transient are recorded photographically, using Model 427 camera.

A. C. COSSOR LTD.,
INSTRUMENT DEPT.
Cossor House, London, N.5
Phone: CANonbury 1234 (33 lines).
Grams: Amplifiers Phone London.

IF YOU USE WAX
We Are At Your Service
THE WIDE RANGE OF OKERIN DI-ELECTRICS
created in our own laboratories, fulfils almost every need of the Electrical Industries. Grades have been designed for the most severe and varied conditions. Most are resistant to mould and fungus growth, whilst special types are evolved whenever new applications arise.
We invite technical discussion on difficult problems.

ASTOR BOISSELIER & LAWRENCE LTD.
(Sales Dept.), Norfolk House, Norfolk Street, Strand, W.C.2
Telephone: Temple Bar 5927.
Rugged mechanical construction
Outstanding electrical efficiency

In the new 3X2500A3, Eimac engineers have developed a highly efficient external anode triode which, in Class C service, delivers up to 5 KW output at a plate voltage of only 3,500 volts. The mechanical design is radically simple, incorporating a "clean construction" which gives short, low inductance heavy current connections that become an integral part of the external circuits at the higher frequencies.

The external anode, conservatively rated at 2500 watts dissipation, has enclosed fins so as to facilitate the required forced air cooling.

Non-emitting vertical bar grid does not cause anode shadows ordinarily created by heavy supports in the grid structure.

Thoriated tungsten filament. Note unusually large filament area, and close spacing.

Filament alignment is maintained throughout life of the valve by special Eimac tensioning method.

New glass-to-metal seals do not have the RF resistance common to iron alloy seals, nor the mechanical weaknesses of the feather-edged types.

Grid ring terminal mounts a cone grid support which acts as a shield between plate and filament.

A coaxial filament stem structure forms the base of the valve. This makes possible proper connections to the filament lines.

Grid and filament terminal arrangements make it possible to install or remove the 3X2500A3 without the aid of tools.

The new mechanical and electrical features of the Eimac 3X2500A3 external anode triode make it valuable for use on the VHF as well as low frequencies. More complete data and information yours for the asking.

FOLLOW THE LEADERS TO

EIMAC VALVES

EITEL-McCULLOUGH, INC., 1123 San Mateo Ave., San Bruno, Calif.
Plants located at: San Bruno, Calif. and Salt Lake City, Utah
Export Agents: Fraser and Hansen, 301 Clay St., San Francisco 11, Calif. U S A

TYPE 3X2500A3 — MEDIUM MU TRIODE
ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament: Thoriated Tungsten</td>
<td>7.5 volts</td>
</tr>
<tr>
<td>Voltage</td>
<td>7.5 volts</td>
</tr>
<tr>
<td>Current</td>
<td>48 amperes</td>
</tr>
<tr>
<td>Amplification Factor (Average)</td>
<td>20</td>
</tr>
<tr>
<td>Direct Inter-electrode Capacitance (Average)</td>
<td>20 μfd</td>
</tr>
<tr>
<td>Grid Plate</td>
<td>48 μfd</td>
</tr>
<tr>
<td>Grid Filament</td>
<td>48 μfd</td>
</tr>
<tr>
<td>Plate Filament</td>
<td>1.2 μfd</td>
</tr>
<tr>
<td>Transconductance (Ib=830 ma, Vb=3000 v)</td>
<td>20,000 μhos</td>
</tr>
</tbody>
</table>

www.americanradiohistory.com
STRATTON & Co., Ltd.
Manufacturers of UHF, VHF & HF Radio Communication Equipment
WEST HEATH, BIRMINGHAM, 31

EDDYSTONE
Radio Products

Stratton & Co., Ltd., West Heath, Birmingham, makers of the well-known "EDDYSTONE" SHORT AND ULTRA SHORTWAVE RECEIVERS, TRANSMITTERS AND COMPONENTS have pleasure in announcing that they are now commencing to deliver components, and in the near future will be in production with a new Communications Receiver—the "504."

Priority is at present being given to Overseas orders, and the "556" Receiver (for Export only) is on the production lines. Limited supplies of components for the Home trade will be evenly distributed to accredited Registered Dealers throughout Great Britain and Eire.

In addition to the new model "504" Communications Receiver there will be a wide range of HF, VHF and UHF components and new editions of the popular "Eddystone" shortwave Manual and ultra shortwave Guide. Developments are in hand to cater for the needs of all branches of the shortwave field—the Listener, the "Amateur" Experimenter and the Specialist Expert—and we shall always be glad to co-operate with Manufacturers in producing parts for Set and Instrument construction. Watch the Technical Press for further announcements of "Eddystone" Radio Products.

STRATTON & Co., Ltd.
Manufacturers of UHF, VHF & HF Radio Communication Equipment
WEST HEATH, BIRMINGHAM, 31

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Let's leave nothing to chance

It is almost impossible, in this changing age, for any single user to keep abreast of every development in instrumentation. This particularly applies to measuring apparatus, where, to order any but the most elementary requirements without reference to Marconi Instruments, is to hazard both man-hours and money. A preliminary discussion will often disclose a better way of making an essential test or a solution of your most troublesome problems. It will probably introduce you to new instruments, improved techniques and novel applications. It will ensure the planned efficiency of your laboratory in equipment, convenience and economy. Consult Marconi Instruments Ltd., from the start—there is nothing to lose and there may be much to gain.

MARCONI INSTRUMENTS LTD.
ST. ALBANS, HERTFORDSHIRE. 'Phone: ST. ALBANS 4323/6.
Northern Office: 30, ALBION STREET, HULL. 'Phone: HULL 16144.
A low impedance power triode, the OSRAM PX4 has achieved an almost unique popularity as an output valve (usually in push-pull pairs) for high quality Audio Frequency amplifiers at moderate power. Its outstanding features include:

- Large undistorted power output — ample for all domestic purposes — up to 13.5 watts per push-pull pair.
- Very low harmonic content — only 2% distortion in push-pull at full output.
- Long life at a continuous anode dissipation up to 15 watts per valve.

A detailed technical data sheet is available on request.
TECHNICAL DATA that

Here is one of the most popular of the Goodmans Loudspeakers now available—the T2/1205/15. A medium heavy duty reproducer with a frequency response ideal for small cinemas, Public Address systems and high power radiogramophones. A robust, precision made instrument under all conditions.

BRIEF TECHNICAL DATA

Overall Diam. 12" Overall Depth 6 1/2"
Fundamental Resonance 75 c.p.s.
Max. Power Capacity 12 w. peak A.C. on 4 ft. baffle
(15 w. horn loaded)
15 ohms at 400 c.p.s.
13,000 gauss 11 1/2 lb.

Voice Coil Imp.
Flux Density
Net weight

GOODMANS Type T2/1205/15
Loudspeaker

Price £6 15s. (Subject)
NOW AVAILABLE

MINIATURE or MIDGET

We specialise in their manufacture

MICROPHONE or MIDGET

We specialise in their manufacture

HIVAC THE SCIENTIFIC VALVE

BRITISH MADE

We specialise in their manufacture

HIVAC LIMITED, Greenhill Crescent, Harrow on the Hill, Middx. Phone: 08408

RADIOMART ‘SPECIAL’ OFFERS!

The following list of goods have been purchased ex-Government Stores. These goods are all perfect stock to A.I.D. standards.

HIGH VOLTAGE OIL FILLED CONDENSERS.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 mfd, 250 v. working</td>
<td>15/-</td>
</tr>
<tr>
<td>4 mfd, 500 v. working</td>
<td>14/-</td>
</tr>
</tbody>
</table>

TRANSMISSION Bypass and COUPLING CONDENSERS.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mfd, 2,500 v. Bypass, 2½</td>
<td>2/6</td>
</tr>
<tr>
<td>0.01 mfd, 3,000 v. Bypass</td>
<td>2/6</td>
</tr>
<tr>
<td>0.01 mfd, 1,000 v. Sprague Screened Byp.</td>
<td>1/-</td>
</tr>
<tr>
<td>1 mfd, 1,000 v. Tubular decoupling</td>
<td>1/-</td>
</tr>
<tr>
<td>1 mfd, 400 v. Tubular decoupling</td>
<td>1/-</td>
</tr>
<tr>
<td>0.001 mfd, 2,500 v. Tropical Mica Coupling</td>
<td>1/-</td>
</tr>
<tr>
<td>60 pf, 7,500 v. Ceramic low loss Coupling</td>
<td>1/-</td>
</tr>
</tbody>
</table>

TRIMMING and TUNING CONDENSERS (Ceramic, silver-plated vanes).

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pf. Double spaced 1 ¼&quot; spindles</td>
<td>2/-11</td>
</tr>
<tr>
<td>20 pf. Single spaced with rotor lock</td>
<td>2/-</td>
</tr>
<tr>
<td>40 pf. Single spaced with rotor lock</td>
<td>3/-</td>
</tr>
<tr>
<td>All above fit inside our standard coil formers, CF, CF6, CT4, CT6, etc.</td>
<td>3/-</td>
</tr>
</tbody>
</table>

15-28 pf. Midget Circular-plate Trimmer | 1/- |

15-15 pf. Split-stator and Series Gap Condenser | 3/-

ELECTRICAL CONDENSERS (NOT WD, but as these are in short supply they are offered).

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mfd, 500 v. Cardboard, 4/6</td>
<td>4/-</td>
</tr>
<tr>
<td>4 mfd, 500 v. Aluminium can Midget</td>
<td>4/-</td>
</tr>
<tr>
<td>25 mfd, 50 v. Aluminium can Midget, 2/6</td>
<td>2/-</td>
</tr>
</tbody>
</table>

All ABOVE CAN BE Bought from 'RAYMART' DISTRIBUTORS
(See page 8 February issue and page 10 March issue).
WORLD'S LARGEST RADIO COIL MANUFACTURERS

RADIO FREQUENCY INDUCTORS
INTERMEDIATE FREQUENCY TRANSFORMERS
RADIO FREQUENCY COILS
MICA COMPRESSION
AIR DIELECTRIC CAPS
MICA MOULDED CAPS
SICKLES SILVER CAPS
GANGED PERMEABILITY TUNING EQUIPMENT
F.M. EQUIPMENT PARTS
U.H.F. RADIO EQUIPMENT
SPECIAL ELECTRONIC EQUIPMENT

The F. W. SICKLES Co.
CHICOPEE, MASS., U.S.A.

MALLORY VIBRATORS
ARE ALWAYS DEPENDABLE

A long every front Mallory has pioneered in Vibrator design to ensure safety, dependability and long service. Mallory offers synchronous and non-synchronous Vibrators for 6, 12 and 32 volt inputs, also a complete range of "STRATOSPHERE" Vibrators plus the world-famous Mallory "VIBRAPACK" (Reg. Trade Mark).

Vibrapack is a registered trade mark, the property of P. R. Mallory & Co., Inc. Indianapolis, U.S.A. Units which do not bear this trade mark are not genuine Mallory manufacture.

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA, U.S.A.
Radio and Electronics Division

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"MYKROY" CERAMIC INSULATING MATERIALS
GENERAL ELECTRONIC VACUUM CONDENSERS

FOR THE FUTURE
These Manufacturers will help solve your post-war problems.
Register your name now for full details which will be sent you when supply conditions again permit.

FRANK HEAVER LIMITED
Kingsley Road, BIDEFORD, N. Devon

G.I.
VICTORY PRODUCTION

TYPE 2600 MIDGET VARIABLE CONDENSER

WE are now ready to help win the peace by making the best use of the still greater knowledge and experience gained in the manufacture of variable condensers, mechanical tuners, drives, etc.

THE GENERAL INSTRUMENT CORPORATION
ELIZABETH, N.J., U.S.A.

RADIO
AIR CONDITIONING
HEATING AND
REFRIGERATION
EQUIPMENT
DOMESTIC
APPLIANCES
etc., etc.

Ad. Auriema, Inc.
Manufacturers' Export Managers
89 BROAD STREET,
NEW YORK, 4 N.Y.
U.S.A.
The

TAYLOR A.C. BRIDGE
MODEL II0A

These instruments give quick and accurate measurements of Capacity and Resistance. There are six Capacity ranges covering from .00001 to 120 mfd. and the Power factor can also be measured on each range. Six Resistance ranges are available measuring from 1 ohm to 12 megohms. This bridge is A.C. mains operated and a leakage test is also available for detecting leaky paper or mica condensers. Price £14 14s. 0d.

Please write for technical leaflet.

Taylor electrical instruments ltd

RANGES OF CAPACITY RANGES OF RESISTANCE

Send your enquiries to:
TAYLOR ELECTRICAL INSTRUMENTS LTD
419-424 MONTROSE AVE., SLOUGH, BUCKS.
Tel: Slough 21381 (4 lines) Grams: "Taylor", Slough.

NEW ROMAC RADIO & ORAL COMMUNICATION COMBINED

25 Watt, Model 25/Hll.

Incorporated Radio Tuning Unit, Provision for Moving Coil or Crystal Microphone and High Impedance Gramophone Pick-up to meet the demand of the present day for High Grade Equipment.
Delivery Ex Stock

Also our Model 25/Hl. Amplifier for Microphone and Gramophone input only, also with high quality output of 25 watt.
Delivery Ex Stock.

Gramophone Playing Desk Unit in attractive case with lid available with either Amplifier.

ROMAC RADIO CORPN. LTD.
THE HYDE • HENDON • LONDON, N.W.9

Wharfedale
BIJOU
Extension Speaker

With Standard
8-in. Unit
60/-

With Bronze
8-in. Unit
65/-

The production of Wharfedale Cabinet Speakers is still restricted, but the Quality and Finish are up to the highest standards. The BIJOU is outstanding in appearance and performance.

WHARFEDALE WIRELESS WORKS
HUTCHINSON LANE, BRIGHOUSE, YORKS.
"Phone: Brighouse 50. "Grams: "Wharfdel, Brighouse."
The better they are made the more outstanding the results

Bullers

Specialize in PRECISION Manufacture

MADE IN THREE PRINCIPAL MATERIALS

FREQUELEX
An insulating material of Low Di-electric Loss, for Coil Formers, Aerial Insulators, Valve Holders, etc.

PERMALEX
A High Permittivity Material. For the construction of Condensers of the smallest possible dimensions.

TEMPLEX
A Condenser material of medium permittivity. For the construction of Condensers having a constant capacity at all temperatures.

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Manchester Office: 196, Deansgate, Manchester

Telegams: "Bullers, Cannon, London"
PORTABLE SUB-STANDARD INSTRUMENTS

BY

PULLIN

These instruments have been primarily developed for use in Meter Test Rooms, Research Laboratories and Works Testing Departments. They are sufficiently robust to withstand severe industrial use.

The movements are of the iron-free dynamo-meter type or of the D’Arsonval moving coil type, and have a high torque to weight ratio. They are well damped, but will respond to minute changes of supply. They are effectively shielded from the influence of external magnetic fields, by means of double mu-metal shield.

THE STATIC CONDENSER Co. Ltd.

*Manufacturers of STATIC CONDENSERS

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Telephone: WOKINGHAM 708
Double Purpose AERIALS

If you are erecting an aerial now, you must seriously consider two important facts:
(a) The coming of television in the very near future.
(b) An anti-interference aerial for normal broadcast reception.

You can cover both these important points by using a combined system. The method of installation is shown in the diagram. It will be a permanent system designed on sound engineering principles, and, remember, you will be saving 25% on the price.

SPECIFICATION

A "combined" television and anti-interference aerial for use when separate aerial and earth terminals are correctly provided for medium and long wave.

By using the reflector of a television aerial as a collector, one aerial can be used for vision reception and normal broadcast reception, with all the advantages of an "Eliminoise" anti-interference installation.

PRICES

Combined Television and Broadcast Aerials with 100 ft. cable, but without wooden masts:
L.502 and L.392/100 ... Price £13 : 0 : 0

Combined Television and Broadcast Aerials with 120 ft. cable, but without wooden masts:
L.502 and L.392/120 ... Price £13 : 16 : 0
L.336 Balanced twin feeder Price 9d. per yard
WEBS'S Radio

FOR HIGH GRADE TEST GEAR

We introduce two instruments of exceptional merit and interest for both laboratory work and home experimentation.

"RADIO AID" VALVE VOMETER MODEL A

Gives high stability, suggesting the performance of a D.C. moving coil instrument. The ranges and probe-unit combine to make the meter of universal application.

FEATURES:

Desk-type steel case, instrument grey, 9in. x 9in. x 8in. Miniature H.F. diode rectifier fitted in specialised probe-unit, balanced valve-bridge circuit. Ranges 2, 10, 100 and 500 volts. The detachable probe-unit allows H.F. measurements to 100 mc/s, and can be used for comparative work at considerably higher frequencies.

Price (complete with Probe) £27.10.0

The probe-unit is also available as a separate item. Complete with diode, screened lead and 4-pin British plug. Price £3.15.0

"RADIO AID" OSCILLOGRAPH MODEL IA

An excellent general purpose scope of GUARANTEED RELIABILITY. Portable in size and weight combining accuracy and flexibility of use for the serious industrial investigator and the amateur. Waveform can be studied up to 100/150 kc/s, carrier envelopes, modulation characteristics and frequency comparisons up to 100 Mc/s.

FEATURES:

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Drawings not to scale.

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Code No. GCTBA01.

R. 50728.

R. 50764.

PORCELAIN BUSHES

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Wearite "Stratosil Sealed" Vibrators operate efficiently and with the utmost reliability in all situations irrespective of climatic conditions. They embody many features exclusive to this type of component and are available just now only for purposes directly connected with the war effort.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.
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Recommended Types for A.C./D.C. Mains Operated Receiver.

- CCH 35 Frequency changer.
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- CY 31 Rectifier.

Other recommended types are available for A.C., battery and portable receivers.

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THE MULLARD WIRELESS SERVICE COMPANY LIMITED, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2.
Monthly Commentary

Lessons from U.S.A.

A new article from a contributor in America, printed in this issue, gives food for thought, especially as it comes at a time when the new B.B.C. Charter is under consideration. Of course, there is no serious suggestion at the present time that we should adopt the American system of financing broadcasting by advertising revenue, but, in spite of the wide difference between conditions in the two countries, we here can learn something from the problems of transition from war to peace which are facing broadcasting in the U.S.A. At the start, one conclusion is inescapable; in that country so many conflicting financial and commercial considerations come into operation that purely technical factors must play a secondary part.

In America the over-riding consideration is "how can the public be made to pay for any technical development?" Here the problem is much simpler; having decided that a certain development is in the public interest, it can be put into use at once, provided B.B.C. revenue is sufficient. On these latter grounds there should be little difficulty; a correspondent whose letter is published elsewhere in this issue makes a good case in support of the opinion that the projected £1 licence fee should provide a large surplus of revenue. Even in 1937 there was no difficulty in financing a full-dress television service—which is still "around the corner" in America.

Arguing on the same lines, there seems no reason why we should not have ultra-short-wave broadcasting quite soon. The eternal problem of the chicken and the egg need not worry us; the service could be started without waiting for listeners to equip themselves with special receiving equipment before the transmissions start. But before we are committed to this new venture we should like to know a little more about the uses to which U-S-W broadcasting might profitably be put.

Many responsible critics of British broadcasting urge that one of its weaknesses is over-centralization; that new life would be infused into it if we were to have a multiplicity of stations catering for local groups and for listeners with rather specialised interests. Though we hear such views with respect, we are far from convinced that they are correct. Broadcasting of any kind—certainly medium-frequency broadcasting—seems a most unsuitable medium of distribution for material of merely parochial interest. On purely technical grounds, U-H-F, with its restricted range, is more suitable, but even here we think that the whole idea is out of sympathy with the true concept of radio distribution. But in this matter, again, we might learn much from studying the activities of the American low-powered "small-town" stations. It is perhaps significant that the number of such independent stations (not taking network programmes), seems to be declining.

B.B.C. and Government

TIMIDITY is widely held to be an inherent shortcoming of a public-service corporation like the B.B.C. The fear of giving offence overrides the desire to please. Although that weakness can be exaggerated, we believe that it is responsible for a certain colourlessness in the way that the B.B.C. handles many highly controversial topics, particularly those of a political nature. It has long been considered abroad that the Corporation reflects the views of the British Government; not unnaturally, that opinion has been strengthened by the effects of the war, during which a large measure of official control was inevitable. As a result, it is necessary to consider both the susceptibilities of the home listener and the probable reactions of the foreigner to something that the latter will certainly regard as Government-inspired. The programme director would be rather more than human if he always resisted the urge to play for safety.

To some extent the matter is just another regrettable hangover from the war. But it goes rather deeper than that, and we hope that the new B.B.C. Charter will emphasise the principle of freedom of expression for broadcasting.
POST-WAR COMPONENTS
Parts and Accessories Now in Production

DURING the latter part of the war the activities of the British radio components industry was not entirely veiled in secrecy; a limited amount of information could be published on what was being done in turning out the more standardized kinds of parts and accessories for war purposes. Exhibitions—"private," but nevertheless well attended—were held by the Radio Component Manufacturers' Federation in 1944 and 1945. But everything then shown was intended for the Services; it was not until the first post-war Exhibition was held in February this year that we had a first glimpse of how peace-time production by member-firms of the R.C.M.F. was taking shape.

This short review of the Exhibition illustrates some of the changing trends in design of components; also, incidentally, tendencies in such accessories as were shown.

Resistors, fixed.—In general appearance the various types of fixed resistors now in production do not differ greatly from their pre-war counterparts. Improvements there have been, of course, but they are mainly in the manufacturing processes; these are reflected in the performance of the component rather than in its appearance.

In many cases the permissible maximum operating temperatures have been increased, these high-temperature resistors being mainly of the vitreous-enamelled type. They are produced by practically all makers, the Berco, Erg, Goldman, Painton and Welwyn ranges typifying this style.

Carbon composition resistors probably still hold pride of place as the most widely used variety in the average radio receiver. The demand for really miniature sizes induced Erie to produce a 1/4-watt model during the war, and this is retained for the post-war market. Other examples of miniature style are included among the products of Bulgin, Dubilier, Morgan Crucible Co. and Welwyn.

In the Dubilier series of high-stability resistors the resistance compound is deposited in the form of a spiral on a ceramic rod.

Potentiometers and Rheostats.—The principal improvements effected in the design of variable type resistances lie mainly in the engineering of the moving parts. Smooth motion coupled with reduced wear on wire-wound elements are the two main advantages that result. British Electric Resistance (Berco) employ a floating brush, and provision is made for ganging several units.

Ganged units are included also in the Reliance range of wire-wound potentiometers and a feature of this make is that concentric spindles, separately operated, can be fitted to the two-gang models. This company are producing wire-wound potentiometers up to 500 kilohms.

Colvern have extended their range of cam-corrected potentiometers to include models of lower wattage than hitherto. Precision wire-wound potentiometers, and rheostats with sliding contacts, as well as a series of attenuators and faders, are made by Painton; some are totally enclosed for tropical use. The normal range extends from a 2-watt miniature type to one of 25 watts dissipation and up to 100 kilohms in value.

Toroidal potentiometers are made by P. X. Fox, some of whose models are designed for continuous rotation.

Varley make a range of variable and semi-variable wire-wound rheostats and potentiometers, while the carbon track volume-control types are now included among the products of British N.S.F., Dubilier, Morgan Crucible Co. and Plessey.

Capacitors, fixed.—The widespread adoption of a tropical form of construction and a general reduction in physical dimensions are the two most outstanding changes effected in the design of the more popular varieties of fixed capacitors.

One form of construction consists of enclosing the capacitor element in a metal tube, usually aluminium, and sealing the ends with a synthetic rubber plug. Lead-out wires are brought through these plugs.

In some makes the element is of the rolled paper-foil variety such as the T.C.C. Metalmite series and those made by Ferranti, Hunt, B.I.-Callenders and Static Condensers. In another form a ceramic dielectric is used; examples are the Dubilier series and the T.C.C. Metalicon.

Dubilier Nitrogol capacitor

T.C.C. Cathoderay capacitor

www.americanradiohistory.com
Metal-glass sealing is being applied by Ferranti to small tubulars to provide a sealed component for tropical use.

A small by-pass capacitor taking the form of a lead-through bush combined with a by-pass capacitor has been developed for use in VHF and television equipment. The outer metal case forms one plate of the capacitor and an enclosed insulated element the other. The T.C.C. Mica-disc Type CM30 has mica insulation while the Dubilier model is in the form of a bush with ceramic insulation. Another example is the Erie Feed-Thru Ceramicon.

The miniature styles made by British Electrolytic Condensers and the T.C.C. Picopack typify the miniaturisation technique in dry electrolytics, while Dubilier's Dritics and Hunt's models are excellent examples of the general reduction in size that has been effected.

Metal-cased paper capacitors for high voltages are well in evidence, some typical examples being the Dubilier Nitrogol range, Hunt's, Static Condensers, T.C.C. and Wego ranges.

Capacitors, variable.—The reduction in size of the popular types of variable condenser assemblies which began just before the war has been greatly accelerated by the insistent demand for smaller and still smaller models. As this reduction is only possible by closer spacing of the vanes manufacturing processes have had to be geared for extremely close tolerances.

These changes can be seen in the products of Jackson Bros., Plessey and Wingrove & Rogers.

In some cases development has been directed to the evolution of ganged variable condensers able to withstand severe vibration. The Polar Type C6064/1 which is a three-gang model having split rotor sections is a typical example. The frame is massive and it can be supplied-if required with a ceramic spindle.

Sydney S. Bird continues to produce the high grade Cyldon range of variable capacitors to which has been added some new wide spaced vane transmitting types as well as special miniature VHF models. Short and ultra-short wave types are also included among the products of Jackson Bros. and Stratton & Co.

Coils, R.F. and I.F.—A neat three-waveband coil pack for superheterodynes has been produced by Wright and Weaire for set manufacturers. It is permeability tuned and is available in two types for short, medium and long waves (15-50, 200-550 and 800-2,000 metres) or with two short-wave ranges and medium waves only (12-35, 35-100 and 200-550 metres). A mains on-off switch is incorporated with the central waverrange switch, the virtue of this arrangement being that the waverrange contacts are wiped every time the set is used.

In addition to their IF transformers with mica trimmers, Wright and Weaire now make for export a permeability-tuned type.

Although not strictly speaking radio-frequency the toroidally wound dust core coils for carrier frequencies made by the Telephone Manufacturing Co. are worthy of mention, as is the 20-kc/s quench coil for super-regenerative receivers made by Bulgin.

Transformers and Chokes.—The influence of wartime standards of reliability is nowhere better exemplified than in the specifications of mains transformers and chokes, the windings of which are now in most cases vacuum impregnated as well as paper interleaved. Woden produce a "de Luxe" series in die-cast shrouds, and the "potted" type made by the same firm are notable for the fact that the steel cans are completely filled with insulating compound which not only excludes moisture but en-

VHF variable capacitors made by Stratton.

Three-gang capacitor with ceramic spindle (Polar).

Three-waveband coil pack (Wright and Weaire).
Post-War Components—
sures silent operation. Mummata
screened microphone transformers
suitable for single-hole chassis
mounting are made by this firm,
and also by Parmeko.

Woden screened microphone
transformer.

A very wide range of trans-
mformers and chokes is offered by
Parmeko. Type 5080 is designed
for radio receivers and small am-
plifiers and includes power trans-
mformers from 15 to 250 VA, chokes
and audio output transformers
handling up to 65 watts of A.F.
power. In the Type 5081 series
the power transformers are rated
up to 2 kVA and the output or
modulation transformers up to
750 watts. Small power trans-
mformers up to 15 VA for pilot
bulbs, etc., are included in the
5082 range which is primarily an
audio-frequency group comprising
intervalve transformers, micro-
phone input transformers, tone
control and small smoothing
chokes. Finally, the Types 5084
and 5085 are set manufacturers'
components for sub-chassis wiring
with power handling capacities
from 4 to 60 VA.

The "Astronic" interlock coil
winding bobbins produced by
Associated Electronic Engineers
provided a wide choice of sizes for
transformer manufacturers. No
cement is used and the cheeks are
locked mechanically to the centre
former. For export the bobbins
can be packed flat, when they
occupy only one sixth of their
normal volume. Pressed steel
clamping assemblies are also avail-
able and the firm produces a range
of complete transformers using
these components in sizes from
5 VA to 5 kVA.

An interesting miniature output
transformer suitable for use in per-
sonal portable sets has been added
to the range of "Hyperloy" trans-
mformers made by Wright and
Wearie.

Chassis Fitments.—Metal
chassis manufacture demands con-
siderable skill and knowledge of
the behaviour of metals. This
work is one of the specialties of
J. and H. Walter, who manufac-
ture chassis of all kinds in steel,
aluminium, copper and brass.

Specialised items of presswork
and stampings and the host of
small parts used in the manufac-
ture of radio apparatus and com-
ponents are produced for the radio
industry by Carr Fastener.

That metal cabinets for hous-
ing such apparatus as PA ampli-
fiers, battery chargers, laboratory
gear and test equipment need not
be unattractive is very conclusi-
ively proved by the modern de-
signs prepared and manufactured
by Alfred Imhof.

Retaining devices for holding
valves firmly in their holders are
now becoming generally available.
Those made by Electrothermal
Engineering are fabricated from
woven glass material, plastics and
steel springs, while a simple
saddle-type retainer is produced
by Long and Hamby. This firm
also make rubber and synthetic
rubber masks and supports for
CR tubes, rubber grommets and a
variety of rubber- and metal-
bonded items, some of which are
for use as shock-proof mountings.

Materials employed in plugs. The
new ceramic co-axial models de-
developed by Belling-Lee are of the
type used as R.F. outlets on H.F.
and V.H.F. receivers and trans-
mitters. They are fully screened
designed for use with solid
dielectric and air-spaced cables.

Examples of the miniature
types are included among Clix,
Belling-Lee and Bulgin products.

Valveholders.—The main im-
provements effected to valve-
holders are in manufacture and
have been directed to increasing
the resilience in the sockets and
decreasing the contact resistance,
sometimes by the use of silver-
plated springs.

These features are now to be
found in all the latest Clix, Bell-
ing-Lee and Celestion models.

The chassis style is now almost
universal, and high-grade insula-
tors, such as ceramics and silico-
loaded polystyrene are now being
pressed into service for valve-
holder plates, the last mentioned
being used for the BoG 9-pin
models made by Clix.

The Belling-Lee range also in-
cludes a 9-pin model for the new
all-glass valves, as well as special
types of top-cap connectors of
anti-corona design.

Switches.—The trend of switch
development is by no means ob-
vious on a casual inspection for
it is confined more to details than
to the general form. A better
In general form the switches fall into three categories. There are the rotary stud switches employed chiefly in attenuators and high-grade potentiometers. The developments here are the adoption of a floating mounting for the wiper arm and the use of contact studs moulded into the insulant to avoid their loosen ing with age.

The well-known Q.M.B. switches are now commonly made with open sides, permitting access to the interior for cleaning.

Rotary wafer-type switches are now almost universally employed for wave-band switching and in appearance are little, if any, different from the pre-war patterns. Detailed improvements in materials have been made, however, and the types now in production should give much better service.

Some near-miniature types are made and should find great application in compact equipment. Push-button operated types, too, are made with a great variety of contact arrangement and are finding their way into test equipment as well as broadcast sets.

Cables and Wires.—By reason of the bright and clean colours in which it is obtainable, the most striking of the new radio materials is connecting wire with polyvinyl-chloride insulation. This plastic is remarkable in being unaffected by water, salt solutions, inorganic acids and alkalis, and oils. It will also withstand a wide range of temperature. The exact figures vary somewhat with the grade but a typical range is $-25^\circ$ C to $+70^\circ$ C.

P.V.C., as it is usually abbreviated, is now very commonly used for insulated connecting wires and is made with both solid and flexible conductors. It is also frequently employed as an outer protective covering for co-axial cables. Most of the wire and cable manufacturers now adopt this insulant. Although it is also made in the form of insulating sleeving, the older fabric types of sleeving are by no means dead, and silk-base tubing in both tropical and non-tropical grades is made by Symons in sizes ranging from 0.75 mm bore.

For radio-frequency cables the most usual insulant is now polyethylene, which is available under various trade names, such as Polythene and Telcothene. The coaxial type is probably the most widely used, but twin screened feeders are also made. A solid or stranded centre conductor is embedded in polyethylene which is surrounded by the outer conductor. In the non-flexible types this takes the form of a lead sheath, but in the flexible it is copper-braiding covered by P.V.C.

The twin types have two conductors embedded in polyethylene and the whole is usually covered with a copper-braided screen. The impedance is around 70 ohms for coaxial and about 80-130 ohms for the twin types.

Cable development has not been confined to the communications and radar patterns, for special kinds are now made for radio-heating purposes. B.I.-Callender's, for instance, produce a water-cooled coaxial cable in which the centre conductor is a tube carrying the cooling water. The main purpose of this is to convey the water to the work circuit in a neat and tidy manner rather than to cool the cable itself, although the cable may be expected to heat up somewhat since it carries up to 300 A.

For some applications, particularly on centimetre waves, special cable connectors are needed to avoid an impedance mismatch. These are obtainable in moulded polyethylene from the cable manufacturers.

Protected moulded rubber junction sleeves are available for more ordinary purposes from Hellerman Electric, who also have special tools for use with them.

Metal Rectifiers.—An entirely new range of small selenium rectifiers, described as the Sentercel Uniplate series, has been introduced by Standard Telephones. Their main application is in A.F. and V.F. circuits, but there are also assemblies for incorporating in measuring instruments. Four sizes are available, with ratings of 1 to 40mA. Television and CRT types are also included in the Sentercel series.

To the Westinghouse range of Westalite selenium rectifiers has now been added some new models designed primarily for use in A.C./D.C. apparatus. They are half-wave rectifiers, and are intended to be used in the same manner as a valve rectifier. Three sizes are made with current handling capacities of 30, 60 and 120mA.

Vibrators.—Vibrators were, of course, well-known before the war when they provided the standard means of obtaining the H.T. supply in car sets. They have been widely used by the Services and considerable detail development has taken place which has resulted mainly in increased reliability. These improvements have been chiefly in spring and contact materials and in methods of manufacture.

Six-volt and 12-volt types are the most common, but the Wimbledon Engineering Co., include 24-volt types in their range. All types have a maximum input current rating of 5A, so that the power rating is proportional to the input voltage.

British N.S.F., the Plessey Co., and Wright & Weare also market ranges of vibrators; this last film also produces a Vibrate power unit, consisting of a transformer, vibrator socket and the RF filtering.

Loudspeakers.—The phenomenal performance of modern...
Post-War Components—
magnet steels has influenced the
design of loudspeakers in many
ways, not the least important

being the reduction in physical
size. Goodmans are producing a
range of 5-in and 6-in shallow-
angle moving coil units for midget
and car radio sets which take up
little more space than a saucer.
At the other end of the scale they
have a series of cinema and PA
speakers up to 18-in diameter and
50 watts power handling capacity
in which the permanent magnets
are little heavier than those re-
quired for pre-war 10- or 12-in
cones.

In some of the Celestion loud-
speakers using the new magnet
steels it had been found possible to
dispense with clamping bolts for
the magnet end-plates; de-
liberate mishandling fails to pro-
duce the slightest relative move-
ment between the parts. Celestion
have also designed a system of
dust-proofing which permits an
air relief behind the corrugated
centering diaphragm. By flanging
the relief holes and disposing
them correctly it has been found
possible to trap all magnetic dust
particles before they can find their
way into the speech-coil gap.

New loudspeakers for 360-
degree sound distribution have been in-
roduced. In the
Tannoy Type LS/394/CIR bowl loud-
speaker the unit is
mounted in an ellip-
soidal casing sus-
pended from a cone
reflector and can be
quickly detached for inspection or
cleaning. Two standard sizes are
available with 4-in and 8-in units
respectively. In the Film In-
dustries "Circorn" the efficiency
of horn loading has been com-
bined with 360-degree radiation.

Gramophone Equipment.—The
range of Garrard gramophone
motor units has been extended
and now includes a heavy duty
transcription motor—model 201B.
This is a governor-controlled in-
duction motor which can be run
at 78 or 33⅓ rpm. Special precau-
tions have been taken to ensure
constancy of speed, and the main
thrust bearing is an optically
finished ball race. The motor
windings are designed to reduce
stray fields. A 12-in turntable is
used, but there is a model with an
extended speed indicator plate for
16-in discs.

The Garrard Model V radio-
gram units employ a new coil
spring suspension designed to
eliminate acoustic feedback.
The Model RC60 record-changer
plays up to eight mixed recor-
dds, the time of the record-
changing cycle being only
six seconds.

A record-
changer of un-
usual design was
shown by Ples-
sey. In this the
records are stacked on retractable
pawls on a vertical centre spindle
of simple design.

Cosmocord are now supplying
piezo-crystal recording cutters in
addition to a range of magnetic
and crystal pick-up reproducing
heads and tone arms.

Materials.—One of the most
obvious developments is in the in-
creasing use of ceramic materials.
At one time confined almost
deducted for sealing elements. A
bush has a deposited metal coa-
ting and can be soldered in place.
As an alternative, metal-glass
seals for hermetically sealed com-
ponents are coming into favour.
In these a bead of glass carries a
lead-through wire and an external
metal flange, both of which are
sealed to the glass by a technique
similar to that adopted by the
valve manufacturer. The flange
is soldered into a hole in the metal
case of the component. Ferranti
have a copper-glass seal, other
firms have Kovar-glass types, and
T.C. & M. Co. use Telcoseal—a
material developed for this work.

The older insulators have by no
means been ousted by the latest
developments and many of them
have been considerably improved.
Mycalex, for instance, is not only
easily machined, but can now be
moulded. It is a mica-glass com-
pound which will withstand tem-
peratures up to 400° C without
deformation. Micanite consists of
mica splittings bonded with insu-
lating cement and is obtainable in

Garrard Model 201B
transcription motor.
large sheets and in flexible form. It can also be moulded.

For that most important process in all wireless assembly, soldering, the use of resin-cored solder is now very common. It is usual to employ an activated form of resin, but different forms of core and different solder alloys themselves are available to suit various kinds of work. Multicore Solders produce a solder having three cores of Ersin flux, but most firms adopt a single core. Dubois and B.I.-Callender’s both manufacture the latter, and B.I.-C. also market a range of fluxes separately.

In discussing switches it was said that one of the improvements had been in the spring material. One of these materials is beryllium copper, an alloy which becomes as hard as steel with suitable heat treatment. Its outstanding quality is its fatigue strength, particularly under corrosive conditions, but it also has high wear resistance when running against hard steel; making it particularly useful for cams. It is produced by T.C. & M. Co. who also manufacture the well-known magnetic alloys, Radiometal, Mumetal and Rhometal.

Magnetic & Electric Alloys also produce Mumetal and Rhometal as well as Laminic and Permalloy, and various types of Silcor and Vicor among the silicon alloys.

Permanent magnets have undergone great strides in recent years and some alloys now have phenomenal characteristics. The Mullard Ticonal, for instance, has a saturation value of B of 17,000 gauss and a normal working value of 10,000 gauss.

Aerial Equipment.—Active preparations are being made for the resumption of the television service and many reflector dipole aerials are now available. The “Aerialite” adjustable universal reflector makes use of flexible cable conductors stretched on a diagonal wooden frame. The advantage is that the length can be adjusted easily to any required wavelength present or future.

Transmission line spreaders (Labgear).

In the “Antiference” television dipole, Type WD3R, a simple swivel mounting facilitates the work of erection. The dipole elements are detachable and the various parts can be taken up the ladder in easy instalments.

A 50-ft. “Skytower” lattice mast has been designed by Belling and Lee for mounting their “Skyrod” aerials. The lattice structure is of galvanised steel and is divided electrically by porcelain compression insulators.

For amateur transmitters, Labgear have introduced a rotatable beam antenna suitable for mast mounting. Reflector and director elements are placed on either side of the dipole which is folded to compensate for the change of impedance introduced by the parasitic elements. Spreaders for spaced transmission lines are another new product of this firm. They are made from light extruded tubing of low-loss insulating material and are provided with snap-action clips for ease of assembly.

LIST OF MANUFACTURERS

SHOWING AT R.C.M.F. EXHIBITION

A.B. Metal Products, Ltd., Hatton Works, Feltham, Middx.
Aerials, Ltd., Castle Works, Stalybridge, Cheshire.
Aeronautical & General Instruments, Ltd., Purley Way, Croydon, Surrey.
Associated Electronic Engineers, Ltd., Dalston Lane, Stannmore, Middx.
Associated Technical Manufacturers, Ltd., Vincent Works, New Islington, Manchester, 4, Lancs.
Belling & Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.
Bird, Sydney S., & Sons, Ltd., Cambridge Arterial Road, Enfield, Middx.
Bray, Geo., & Co., Ltd., Leicester Place, Blackman Lane, Leeds, 2, Yorks.
British Electric Resistance Co., Ltd., Queensway, Ponders End, Middx.
British Electrolytic Condenser Co., Ltd., 52, Vicarage Lane, Ilford, Essex.
British Mechanical Productions, Ltd., 1, Church Road, Leatherhead, Surrey.
British N.S.F. Co., Ltd., Dalton, Mill, Dalton Lane, Keighley, Yorks.
Bulgins, A. F., & Co., Ltd., By-pass Road, Barking, Essex.
Bullers, Ltd., The Hall, Oatlands Drive, Weybridge, Surrey.

Carr Fastener Co., Ltd., Nottingham Road, Stapleford, Notts.

Celeston, Ltd., London Road, Kingston, Surrey.
Colvern, Ltd., Mawneys Road, Romford, Essex.
Cosmocord, Ltd., 700, Great Cambridge Road, Enfield, Middx.

Duratube & Mure, Ltd., Faggs Road, Feltham, Middx.

ERG Resistors, Ltd., 102a, Finchley Road, London, N.W.11.

Ferranti, Ltd., Hollingwood, Lancs.
Film Industries, Ltd., 60, Paddington Street, London, W.1.
Fox, F. X., Ltd., No. 2 Factory, Hawksworth Road, Horsforth, Yorks.

Garrard Engineering & Manufacturing Co., Ltd., Newcastle Street, Swindon, Wilts.
Goodmans Industries, Ltd., Lancelot Road, Wembridge, Middx.

Hellerian Electric Co., Ltd., Goodrich Works, Brewer Street, Oxford.

Post-War Components—
Jackson Bros. (London), Ltd., Kingsway, Waddon, Surrey.
Labgear, Ltd., Willow Place, Fair Street, Cambridge.
Morgans Crucible Co., Ltd., Battersea Church Road, London, S.W.11.
Mycalex & Co., Ltd., Ashcroft Road, Cirencester, Glos.
Parmelo, Ltd., Percy Road, Aylestone Road, Leicester.
Plessey Co., Ltd., Vicarage Lane, Ilford, Essex.
Reliance Manufacturing Co. (Southwark), Ltd., Sutherland Road, Higham Hill, London, E.17.
Reproducers & Amplifiers, Ltd., Frederick Street, Wolverhampton, Staffs.
Ripaults, Ltd., Southbury Road, Enfield, Middx.
Sifam Electrical Instrument Co., Ltd., Leigh Court, Hr. Lincombe Road, Torquay, Devon.
Static Condenser Co., Ltd., Tootley Works, Wokingham, Berks.
Steatite & Porcelain Products, Ltd., Standard-Seven, Wors.
Stratton & Co., Ltd., 2/5, Station Street, Birmingham, 5.
Tannoy Products (Guy R. Fountain), Ltd., 10, Canterbury Grove, London, S.E.27.
Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3.
Varley Dry Accumulators, Ltd., By-pass Road, Barking, Essex.

Wego Condenser Co., Ltd., Bideford Avenue, Perviale, Middx.
Welwyn Electrical Laboratories, Ltd., 79, Bishop's Road, East Welwyn Garden City, Herts.
Wimbledon Engineering Co., Ltd., Garth Road, Lower Morden, Surrey.
Woolf & Rogers, Ltd., Broadway Court, Broadway, London, S.W.1.
Woolen Transformer Co., Ltd., Moxley Road, Bilston, Staffs.
Wright & Weare, Ltd., 740, High Road, Tottenham, London, N.17.

CLASSIFIED LIST OF PRODUCTS
Shown at R.C.M.F. Exhibition

Aerial Equipment. Aerialite; Antenna; Belling-Lee; I.abea; Ripaults; T.C. & M.
Alloys. Magnetic & Electrical Alloys; T.C. & M.
Attenuators. Aeronautical & General; Labgear; Painton.
Cables and Wires. Aerialite; Associated Tech. Mfrs.; B.I.-Callenders; Ripaults; Reliance Electrical Wire; Ripaults, Standard Telephones; T.C. & M.
Capacitors. Fixed. British Electrolytic Condenser; B.I.-Callenders; British N.S.F.; Bulgin; Daly; Dubilier; Erié; Ferranti; Hunt; London Electric Mfg.; Mycalex; Static Condenser; T.C.C.; T.M.C.; United Insulator; Wego.
Capacitors, Variable and Preset. Aeronautical & General; Syndal Bird; Erié; Jackson; Painton; Mullard; Plessey; Stratton; United Insulator; Walter Instruments; Win groove & Rogers.
Ceramics. Geo. Bray; Bullers; Steatite; Taylor, Tunnicliffe.
Chassis. Imhof; J. & H. Walters.
Chokes. Iron-cored. Aeronautical & General; Bulgin; Ferranti; Labgear; Parmelo; Plessey; Reproducers & Amplifiers; Stratton; Varley; Wright & Weare.
Chokes, R.F. Aeronautical & General; Bulgin; Labgear; Plessey; Stratton; Varley; Wright & Weare.
Cables. Belling-Lee; British Aeronautical & General; B.I.-Callenders; Bulgin; Cass Fastener.
Crystals, Quartz. Standard Telephones.
Ear Phones. Crystal Cosmocord.
Fuses and Fuseholders. Belling-Lee; British Mfg.; Productions; Bulgin; Carr Fastener.
Gramophone Motors, Units, Record Changers. Garrard; Plessey.
Instruments, Measuring and Test. Automatic Coil Winder; Ferranti; Labgear; Sifam.
Insulators. Belling-Lee; Geo. Bray; Bullers; Steatite; Stratton; Taylor, Tunncliffe.
Insulating Materials and Sleeving. Associated Tech. Mfrs.; Durature; Helleman; Long & Hamby; Mycalex; Spicers; Symons; T.C. & M.
Interference Suppressors. Antenna; Belling-Lee; Dubilier; Morgan Crucible.
Laminations. Iron-core. British Rola; Magnetic & Electrical Alloys; T.C. & M.
Loudspeakers. British Rola; Celestion; Film Industries; Goodmans; Plessey; Reproducers & Amplifiers; Tannoy.
Microphones. Cosmocord; Film Industries; Tannoy.
Pick-ups. Cosmocord; Garrard.
Plug & Socket. Belling-Lee; British Mechanical Productions; Bulgin; Carr Fastener; Long & Hamby; Painton; Plessey; T.M.C.; Wright & Weare.
Potentiometers and Rheostats. British Electric Resistance; British N.S.F.; Bulgin; Colvern; Dubilier; Erié; Fox; Goldsman; Morgan Crucible; Painton; Plessey; Reliance Mig.; Varley, Welwyn Laboratories.
Recording Heads. Crystal Cosmocord.
Relays. Labgear; Standard Telephones; T.M.C.
Resistors. Fixed. British Electric Resistance; British N.S.F.; Bulgin; Colvern; Dubilier; Erié Resistors; Erié; Goldsman; Morgan Crucible; Mullard; Painton; Varley, Welwyn Laboratories.
Rubber, Moulded. Long & Hamby; Painton.
Solder. B.I.-Callenders; Du Bois; Multicore.
Switches. A.B. Metal Products; Aeronautical & General; British Electric Resistance; British N.S.F.; Bulgin; Painton; Plessey; T.M.C.; Walter Instruments; Wright & Weare.
Thermal Switches, Power and R.F. Belling-Lee; British and CUT-OUTS.
Thermistors. Electrothermal.
Transformers, A.F. Aeronautical & General; Associated Electronic Engrs.; British Rola; Bulgin; Celestion; Ferranti; Goodmans; Labgear; Parmelo; Plessey; Reproducers & Amplifiers; Varley; Woden; Wright & Weare.
Transformers, I.F. and R.F. Bulgin; Labgear; Plessey; Stratton; Wright & Weare.

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A THING we are hearing about quite a lot nowadays, and will certainly hear much more about before long, is pulse modulation. When pulses are mentioned one tends to think, if not of doctors, then of radar. They also come, though incidentally, into television. They are beginning to come into radio communication of many different kinds, and that is what you may be finding rather confusing. Perhaps the best thing is to take a general view of the whole subject.

Until recently, "modulation" to most people has meant amplitude modulation of a carrier wave. It is the sort that has always been used by the B.B.C. In America it is now strongly challenged by frequency modulation, to which is closely related a third method—phase modulation. All of these have their counterparts in pulse modulation, so we had better be sure first of all that the distinctions between them are quite clear.

Fig. 1(a) is how a brief sample of plain unmodulated carrier wave is represented. Below, at (b) is one cycle of a simple audio-frequency modulating wave. (In practice there are generally far more carrier-frequency cycles per audio-frequency cycle than are shown here, but one does get so tired of drawing them). Amplitude modulation of (a) by (b) is shown at (c). Deeper modulation, corresponding for example to sound of the same pitch but greater volume, is illustrated at (d). If the modulating waveform is more complicated than (b), the variations in amplitude of the carrier correspond. So far we are on familiar ground.

Frequency and phase modulation are more difficult to show clearly in an amplitude/time diagram, which may partly be why they are less generally understood. Phase modulation is represented by (e), and for convenience the unmodulated carrier (a) is repeated just below it, so that the phase shifts (that is to say the amounts by which the modulated cycles start earlier or later than they would if unmodulated) can be measured by the lengths of the horizontal kinks in the lines joining corresponding cycles. These phase shifts can be seen to be proportional to the varying height of the modulating waveform (b), it being conventionally assumed that distance above the base line in (b), and phase advance in (e), are positive; and vice-versa. The maximum phase displacement in (e) happens to be half a cycle, or 180 deg. To double the depth of modulation, all the phase shifts would have to be doubled, giving a maximum displacement of one whole cycle.

It is easy enough to guess that in frequency modulation the modulating waveform is made to vary the frequency of the carrier wave, instead of its amplitude of phase. Unfortunately, in the sort of diagram we have been using, frequency is not shown directly, but it can to some extent be estimated (Fig. 1(f)) because frequency and phase are close relations. For example, if the frequency of a wave is raised by some fixed amount, a steadily increasing phase advance begins, and lasts as long as the frequency rise. The cycles are thus packed more closely. To anybody who has gone as far as the first few lessons of the Calculus, the relationship between phase and frequency shifts, such as those due to the correspondingly named methods of modulation, is something quite simple and definite: frequency shift is rate of change of phase shift, and, conversely, phase shift is frequency shift integrated with respect to time. But it is not at all necessary to have studied any calculus or be able to put the matter in these particular terms to see what

![Fig. 1. Comparison of different ways of modulating a continuous carrier wave.](www.americanradiohistory.com)
Pulse Modulation—

Phase and frequency modulation mean. It is clear from Fig. 1 (e) and (f) that when either is present both must be, but they cannot both at the same time correctly represent the modulating waveform. For example, Fig. 1 (e) may be regarded as either phase modulation or frequency modulation: if the former, then it is an undistorted representation of the modulating waveform (b); if the latter, then it is a distorted representation of (b), but one could draw another waveform, of which it would be a faithful frequency-modulated version. I'm afraid that sounds rather involved, but I hope not too much so to follow.

![Fig. 2](image.png)

Fig. 2. The same series as in Fig. 1 but with a morse modulating waveform (b) instead of a single sine wave. (e) is omitted, because modulation by morse signals is almost invariably 100 per cent. Phase and frequency modulation are shown for comparison, but the latter is seldom used now for morse, and the former is of little or no practical importance. Note that as the modulating wave has a D.C. component a phase shift is likely to accumulate when the frequency is modulated.

In passing, it may be noted that both phase and frequency methods are less liable to over-modulation than the amplitude method, which suddenly reaches its limit when the amplitude touches zero as in Fig. 1 (d).

Another important feature of phase and frequency modulation is that as the amplitude is normally constant the transmitter can work at full power all the time, and many of the things that cause distortion and noise in amplitude modulation receivers are avoided.

Readers (except, of course, you) have no doubt been thinking exclusively in terms of modulation derived from telephony, sound, speech, music or what you will. You, with exceptional perspicacity, have realized that Fig. 1 (b) stands not only for these, but for morse and other "on/off" signals. To emphasize the point, and also to give a further demonstration of the different sorts of modulation, the Fig. 2 series does for a morse "A" what Fig. 1 does for one audio frequency sine wave.

So much for the three main methods of modulating continuous carrier waves. For reasons which will be gone into soon, it is sometimes advantageous to complicate the issue by pulse modulation. This is not just a fourth name to add to the list of types of modulation we have already compiled, although it may sound like it. What makes things still more confusing is that "pulse modulation" has two meanings, which we shall consider presently, but first—what is a pulse? It is a very short-lived current or voltage, usually repeated at more or less regular and relatively long intervals. Fig. 3 (a) is a typical amplitude/time diagram of a train of pulses. There is general agreement that in order to quality for the name "pulse" the ratio of length to period, $p/P$ in Fig. 3 (a),

![Fig. 3](image.png)

Fig. 3. All except the last of these ways of modulating pulses can be compared with modulation of a carrier wave in Figs. 1 and 2. Method (g) is used in the Pye system of combined vision and sound with a single transmitter.
The number of pulses per second is the pulse recurrence frequency.

In the first meaning of pulse modulation a train of pulses such as is shown in Fig. 3 (a) is substituted for a train of high-frequency waves (Figs. 1 (a) or 2 (a)) as raw material available for modulation. Fig. 3 (c - f) corresponds with Fig. 1 (c - f) in showing the results of such modulation. These, and Fig. 3 (g) I will comment on later; in the meantime, according to the second meaning of pulse modulation a train of pulses (Fig. 4 (b)) is used to modulate our familiar continuous carrier wave (Fig. 4 (a)), the result being shown at (c). In this sense it is merely a case of amplitude modulation of a carrier wave, and Fig. 4 (a - c) corresponds with Figs. 1 and 2 (a - c), especially Fig. 2.

The products, Fig. 4 (c), are often called pulses, but this is asking for confusion with Fig. 4 (b). In the absence of any lead from authorities, I intend to call the things shown at (c) wave pulses.

Pulse modulation as illustrated in Fig. 4 is the sort used in radar, and calls for no further comment here. Pulse modulation as used in communications may be confined to what is shown in Fig. 3, but more often is a combination of the two, finally yielding modulated wave pulses. There are two ways of arriving at this result: either the modulated pulses shown in Fig. 3 (c - g) can be used in place of Fig. 4 (b) to modulate a carrier wave, or the uniform wave pulses, Fig. 4 (e), can be modulated. The latter method suffers from practical limitations, so the former is the one generally used. It is just a matter of design, anyway, so we are not going to bother about the processes of production but will concentrate on the final product—a series of wave pulses, modulated by the audio-frequency "intelligence" it is desired to convey.

Compared to the simpler modulated carrier wave, the modulated wave pulses may be considered to be the result of sampling, just as in a factory every hundredth unit (say) coming off a production line may be sent up for inspection. Such samples are taken to represent the bulk production, and any gradual changes ("modulation") in the dimensions or other qualities of the product are reflected in the samples. This procedure is justifiable (both in the factory and in the pulse modulator) provided that changes are not liable to occur rapidly between one sample and the next. Applied to modulation this means that it would never do for several cycles of the modulation frequency to occur between successive pulses; there would be nothing in those great blank spaces, to represent them. In extreme cases, and with special care in design, it is possible for the pulse recurrence frequency to be not much more than double the modulation frequency, but things are easier if it is much greater.

When the modulated pulses are in turn used to modulate a carrier wave there must be another and even bigger step-up in frequency. Each wave pulse consists of carrier-frequency cycles, and in practice they cannot be made, like Venus, to start life full grown. When the transmitter is "switched on" by the pulse it takes a considerable number of cycles to build up to full amplitude, and a further number to die away at the end, besides the main body in between. It tends to be difficult if there are much fewer than a hundred cycles per pulse. Remembering that the periods between pulses may last a hundred or more times as long as the pulses themselves, we see that the carrier frequency may easily be of the order of 10,000 times the pulse frequency, which in turn is at least several times the highest modulation frequency. From this it appears that to handle speech or music by a pulsed carrier-wave system the carrier frequency is likely to be at least of the V.H.F. order. On the other hand, for morse signals, in which the highest modulation frequency is much lower, there is a wider choice for both pulse and carrier frequencies.

Summing up; you take the highest modulation frequency, multiply it by at least 2½ and preferably much more to get the pulse frequency, multiply that by the ratio f/P (Fig. 3 (a)) and again by the number of carrier cycles in each wave pulse, and that gives the carrier frequency.

An alternative to the sampling way of looking at pulse modulation (and one that fits some cases better) is to imagine the continuous carrier to be swept up into heaps at regularly spaced intervals, like fallen leaves along an avenue. Any modulation that the original carrier carried will appear also in the heaps or wave pulses; again provided that the heaps are not spaced too widely in relation to the modulation frequency. Fig. 5, a picture of a row of heaps, tells us that the tail of leaves was below average at the left-hand end and above it at the right, but it cannot indicate the variations from tree to tree, because they are smoothed out in the sweeping process.

Now we shall examine the different ways in which pulses can be modulated. (It goes without saying that any of the rows of pulses in Fig. 3 can be supposed to represent wave pulses).

First there is amplitude modulation (Fig. 3 (c) and (d)), which hardly needs explanation. The only thing you may be worrying about is what happens at the receiver. What about all the
Pulse Modulation—

long gaps in between the pulses? Well, of course, we have already stipulated that they must not be long in relation to the shortest cycles of music or morse or whatever is ultimately put out by the receiver, and therefore after the wave pulses have been rectified into pulses (Fig. 3 (d)) by the detector they can be smoothed out by a filter to yield a reconstituted modulation waveform (Fig. 3 (b)). In fact, there is nothing special about the receiver at all, unless the pulse frequency is near its lower limit, necessitating a rather more elaborate filter than one finds in the ordinary receiver.

Phase modulation, too (Fig. 3 (e)), corresponds closely with its continuous wave counterpart (Figs. 1 (e) and 2 (e)). As a matter of fact, it is easier to see in a diagram, because the pulses are more obvious "marks" than any points on sine waves. In practice, phase modulation may be arranged to make all the shifts delays, instead of as shown.

Pulse frequency modulation is shown at Fig. 3 (f). Unlike CW frequency modulation, it does not seem to have been used much, if at all; whereas the reverse situation exists with phase modulation. Although there is no law to the effect that in frequency modulation the variation in frequency must amount to many cycles per second each side of normal whereas in phase modulation the maximum variation must be less than one cycle, it generally seems to work out that way. There are technical reasons why wide variations of frequency suit CW systems and narrow variations of phase suit pulse systems.

Pulses can be modulated in a fourth way, not available to CW; it is shown in Fig. 3 (g). This is often called pulse width, but perhaps more appropriately pulse length, modulation. Our road sweeper, faced with gradual variations in leaf density, could deal with the situation either by making the evenly-spaced heaps of differing heights (amplitude modulation) or alternatively, adopting a standard height, could accommodate the varying quantities of leaves by corresponding variations in the lengths of the heaps. (He might also be intrigued by the problem of keeping the size of the heaps constant and adopting either phase or frequency modulation, but if so he would obviously be misemployed as a road sweeper.)

To dispel a possibly growing suspicion that all this is a mere outlet for doing simple things in a complicated way, it may be as well at this stage to consider the reasons why. There is no need to justify the use of wave pulses (unmodulated) in radio; it is fundamental to the echo method of range finding. The use of synchronizing pulses in television is equally obvious. But for communications, either morse or phone, which can quite well be done by modulating a carrier wave directly, it may seem an unnecessary complication to insert pulses as an intermediate stage. One reason for doing so is that the spaces between the pulses may be occupied by something else. A good example is the new Fye method of making one television transmitter do for both vision and sound.* In between successive lines of vision there is a short interval—10 microseconds to be exact—to allow the scanning beam to flash back to the beginning of the next line. This interval constitutes the line synchronizing pulse, but inside it there is room for a modulated pulse to carry the sound. Pulse length modulation (Fig. 3 (g)) is the type adopted, with a mean length of 3 microseconds, varying between 1 and 5 at maximum depth of modulation. To the receiver, these are equivalent to amplitude modulated pulses.

Another example is the Army Set Type 101, in which the spaces in one set of speech-modulated pulses are interlaced with seven other sets, thus enabling eight conversations to go on at once over the same carrier wave. Pulse length modulation is again the favoured method. At the receiving end the sets of pulses have, of course, to be sorted out, but that is just a matter of routine circuitry.

The G.P.O. have been experimenting with a similar system but with pulse amplitude modulation†.

All of these examples come into the category of multiplex; that is to say, methods of making one line or carrier wave bear several communications at once. Pulse multiplex is described as a time allocation system, because each communication gets the whole channel to itself in turn, like the three mythical sisters with only one eye between them, in contrast to frequency allocation systems, in which all share the same channel all the time but each must be on a different sub-carrier frequency.

Another reason for pulse modulation is that in the centimetre wave bands the available generators—principally magnetrons—like to work at full power or nothing, so do not lend themselves to amplitude modulation. Neither do they like frequency modulation. Pulse length modulation suits them admirably, however.

A third object of pulse modulation is noise reduction. Benefit is obtained in this respect by

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† Wireless World, December, 1945.
GOVERNMENT SURPLUS

It seems that facilities for the purchase of ex-Government surplus radio equipment by members of the Radio Society of Great Britain are not to be granted. Protracted negotiations between the R.S.G.B. and Government departments have culminated in the asking of questions in Parliament. It has been officially decided that generally it is preferable and no statement having been made as to the findings of the Conference, Garry Allighan raised the question in the House of Commons on Feb. 21st.

The communiqué issued by the British Information Service in Washington by members of the conference has now been made available in this country. It states:

"By the agreements reached at the Conference a great step forward has been taken to bring order out of the chaotic telecommunications system; and ensure a balanced combination of cable and wireless services for the world. The interest of the United States is primarily in the radio field, with a lesser interest in cable communications; while in the British Commonwealth the emphasis is on cables. But the United States delegation accepted the British view that the reckless and unrestricted use of new radio circuits would unbalance the world system and deprive the United States themselves of the certain services and the security of the Commonwealth cable systems."

Reduction of all telecommunications rates between the U.S. and nations of the British Commonwealth were also agreed upon. The gold franc as the measure of telecommunications charges has been abandoned as impracticable and a dollar basis agreed on.

A protocol has been signed discouraging the principle of one country obtaining exclusive concessions for conducting the external telecommunications for another.

TELEVISION SETS

The Board of Trade announced on March 7th that licences had been issued to fourteen manufacturers to produce 78,300 television receivers. The licences have also been granted for the production of a total of 937,100 broadcast sets for the home market and 583,380 for export.

During the last five months of 1945 nearly 73,000 sets were manufactured. Of this number 12,000 were for export.

"AIRMET" BROADCASTS

Weather reports, forecasts and navigational warnings for civil aviation are now broadcast daily from Daventry on 245 kc/s (1,224 metres). Transmissions are continuous from 0700 to 1800 G.M.T. in winter and from 0600 to 2100 G.M.T. in summer.

Navigational warnings providing urgent information regarding the unserviceability of aerodromes, radio facilities and air light beacons are given during the first ten minutes of each hour. Weather reports and forecasts follow every ten minutes. Each transmission is prefaced by "This is Airmet."

RESEARCH

The need for a central electronic research organisation supported by the Government and engaged on regular work for the Services, but with freedom also to study and meet industrial demands, is stressed by Charles Davy, writing in The Observer for March 10th. Doubts are expressed by the writer as to the possibility of any one industry being competent or having the necessary incentive to undertake comprehensive electronic research.

The article has been written to answer the question: "What is going to happen to the scientific research units built up under Government direction during the war?" which has been brought to the fore by a decision to reduce the staff at
World of Wireless—the Royal Aircraft Establishment at Farnborough. After outlining briefly some of the projects in hand, or in view, at the Telecommunications Research Establishment at Malvern, he expresses the hope that T.R.E.—perhaps rechristened Electronics Research Establishment—might become the centre of electronic research.

WHAT THEY SAY

RADAR PATENTS.—The patent situation in radar is said to be so complicated that no company on earth could safely proceed to manufacture radar with any confidence that it would be immune from suits of infringement.—Paul A. Porter, Chairman, U.S. Federal Communications Commission.

ADMINISTRATIVE TECHNICIANS.—Refresher courses would provide an opportunity for engineers whose main duties were administrative to bring their technical knowledge up to date, and would prevent any tendency towards control of staff by seniors whose knowledge of modern techniques is inadequate.—A speaker at the I.E.E. discussion on "Post-Graduate Courses in Electrical Engineering."

MANUFACTURING COSTS.—The [American] Office of Price Administration is attempting to force what they call a reconversion formula down the unwilling throats of the parts manufacturers. The O.P.A. contends that this "reconversion pricing formula" is fair because war-born technological advances have created so many improvements in manufacturing efficiency that any increase in labour and material prices can be fully absorbed by the manufacturer.—The Editor, "Parts Jobber," New York.

PERSONALITIES

Lord Louis Mountbatten has accepted election as President of the British Institution of Radio Engineers for the year 1949-50, in succession to Leslie McMichael. He has been a member of the Institution since 1935 and was elected Vice-President in 1938.

Vice-Admiral J. W. S. Doring, C.B., R.N. (retd.) has been appointed Director of the Radio Industry Council. He has been connected with radio since 1912 and during the first world war was chiefly concerned with high-power continuous-wave installations in shore stations and warships. During the years between the two wars he served as Fleet Wireless Officer, Director of Signal Department, Adm Irty, and Captain of H.M. Signal School, Portsmouth.

T. W. Bearup, who has been Assistant Manager of the Australian Broadcasting Commission since 1943, is now acting as its London representative. He will also supervise A.B.C.'s New York office.

M. J. Smith, O.B.E., B.Sc., has been appointed Electrical Engineer to the Copper Development Association. As a Wing Commander in the R.A.F., he was Senior Training Officer at the R.A.F. School of Electrical and Instrument Training.

L. R. Vincent rejoins Ritchie Vincent and Tellord, consultors, of Harrow, as Managing Director, having been released from his appointment as Technical Specialist (Communications and Broadcasting), Ministry of Information.


IN BRIEF

Ten Million.—It was announced by the G.P.O. on February 20th that the number of wireless licence holders in Great Britain and Northern Ireland was 10,260,300. This figure includes 47,300 licences issued free to the blind. It is of interest to note that the 5,000,000 mark had been reached in the first ten years of broadcasting—by 1932.

Another Record?—C. G. Allen asks if he set up another record at his station, G8IG, on Saturday, March 9th, when he worked, on 20 metres, all continents in 47 hours and the British Empire in 3 hours 20 minutes. His log was: 0245, W4KDA (Okinawa); 1100, VK4AL (Australia); 1128, XABY (Greece); 1203, SU1USA (Egypt); 1320, W3BDL (New Jersey); 1300, HK4AX (Colombia); 1355, VE46K (Canada).

Canadian FM.—Canada's first broadcast FM transmitter started operating a few months ago from Mount Royal, Montreal. The transmitter, employing a frequency of 46.8 Mc/s with a power of 25 W, uses the call WBGM.

A.R.R.L. Bulletins giving the latest official information regarding U.S. amateur activities are broadcast regularly by the League's headquarters station W1AW at West Hartford, Connecticut. The frequencies used are 3.555, 7.145, 14.280, 28.245 and 56.068 Mc/s, and the times of operation are odd hours and odd G.M.T. from 9 to 17, 21 to Saturday. Transmissions on each of the above frequencies open with a bulletin in morse at 15 w.p.m., which, with the exception of that on 28.245 Mc/s, is followed by 'phone announcements.

Burma.—English transmissions from the short-wave station of the Burma Broadcasting Service are now radiated on 44 Mc/s, and on 6510-6000 G.M.T. and on 11.85 Mc/s from 0200-0230, 0615-0615 and 1230-1400.

Servicing Examination.—Applications to sit for the next examination of the Radio Trades Examination Board must be received by the Secretary of the Board at 9, Bedford Square, London, W.C.1, not later than March 1st. It will be held at various centres on May 4th. Copies of the papers set by the Board for the last two examinations may be obtained from the Secretary, price 2s per set.

Radar Stations.—Experimental licences for stations undertaking development and research of radar navigational aids are being issued by the American F.C.C.

Policing the Ether.—The checking centre of the International Broadcasting Union, which was removed from Brussels during the war and set up at the Union's headquarters in Geneva, has now returned to its original home in the Belgian capital.

New I.E.E. Group.—The Council of the I.E.E. has sanctioned the formation of a Radio and Measurement Group at the Institution's North-Eastern Centre.

Research Endowment.—A new laboratory is to be constructed at McGill University, Montreal, equipped with the latest apparatus for research in radio, radar, atomic energy and other scientific fields. The money is to be provided out of an endowment to be known as the Eaton Electronics Research Laboratory.

Our Cover.—The revolutionized television aerial arrays on the 300 ft mast at Alexandra Palace are illustrated on this month's cover. The vision aerial is uppermost. Test transmissions are still being radiated from 11.30 to 12.00, 4 to 5 and 5 to 6 on 45 Mc/s (vision) and 41.5 Mc/s (sound).

W.W. Index.—Copies of the Index for Vol LI, 1945, of Wireless World will shortly be available from our Publishers; price 1d by post.

Back Numbers.—Our Publishers are anxious to obtain copies of Wireless World for December, 1945, and January and February, 1946. Readers who are prepared to dispose of these back issues are asked to communicate with our Publishers.

"Code of Practice" for Valves.—A new edition (1945) of British Standards publication B.S.1106, issued during the war and reprinted in this journal in September and October, 1943, has just been published. The precautions necessary to ensure reliable operation and long life in all types of electronic valves.

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other than cathode-ray tubes are dealt with, and copies can be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 6d, postage paid.

"Radio Valves, Vade Mecum."—Many readers have asked if this valve data book of British, Continental and American valves, by P. H. Braas, of Antwerp, mentioned in our February issue, is obtainable in this country. We understand that arrangements have now been made to distribute a limited number and that copies will be obtainable from A. F. Bird, 60, Clarendon Place, London, W.C.2, price 12s. 6d, postage 7d.

Installing Car Radio.—Useful hints on the installation of car radio receivers, including the suppression of vehicle-generated static as well as all types of ignition interference, are contained in a booklet written by S. L. Robinson, A.M.Brit.I.R.E., and issued by Masteradio, Ltd., 193, Rickmansworth Road, Watford. Copies are available to radio dealers free of charge.

"Britain Can Make It."—A committee has been appointed to assist the Council of Industrial Design in arranging for the submission of radio, television and gramophone designs for the "Britain Can Make It" Exhibition in September. The members of the committee are: G. J. Freshwater (E.M.I.), H. J. Dyer (Philips), G. P. Weidman-Leig (Bush) and A. Middleton (Ferranti).

An Appeal has been made by Field-Marshall Lord Chetwode to the radio and electrical industries in aid of the Victory (Ex-Service) Club, a social, cultural and welfare centre which is to be established as industry's memorial to those who fought in the 1939-15 war. Enquiries should be addressed to M. A. Browning, 15, King Street, London, S.W.1.

Rehabilitation.—Cable and Wireless and Marconi's have each promised £1,000 towards the training and research sections of the Roffey Park Rehabilitation Centre, Horsham, Sussex.

Webb's Radio.—Through a printer's error the two lines heading the Webb's Radio advertisement in our March issue were transposed. The heading should have read "The hub of the 'ham' world."

H.M.V. Works.—Among the Government factories recently allocated by the Board of Trade to various firms for civilian production is one at Treorchy, Wales, to be used by the Gramophone Co.

Bulpin has issued a brochure outlining the war work undertaken by their factories. Whereas the output of components in 1940 was 1,991,903, by December 1, 1944, it had risen to 4,378,797.

Philo.—Among the latest allocation of Government factories to industry is one at Ossett, Yorks, which is to be taken over by the Radio and Television Trust—Philo's new name.

Ekco are to open 5, Vigo Street, in the vicinity of Regent Street, as their London showrooms.

THE JELLY FISH or radar marker buoy. When launched into the sea two operations, one mechanical and the other electrical, are automatically performed. The first is concerned with the buoyancy and extension of the telescopic aerial and the second, accomplished by the action of a "sea-cell" and "corrosion cell", provides power for, and switches on, the radar gear and arms the buoy for self-destruction. The bulk of the development on the buoy was done by Ferranti.

B.S.W.L.—The first post-war transmission to be arranged by the British Short-wave League will be radiated from the Ankara short-wave station, TAP, on 9.65 Mc/s at 2100 G.M.T. on Thursday, April 14th. Receiver circuits should be sent to Box A3, B.S.W.L., 53, Madeley Road, London, W.5.

Short-wave Enthusiasts are invited by Arthur E. Bear, European and Colonial Representative of the International Short-wave Club, to communicate with him at 100, Adams Gardens Estate, London, S.E.16, for details of membership. Members receive the Club's publications, "On the Air" and "Short-wave News Letter."

MEETINGS

Institution of Electrical Engineers

Radiolocation Convention.—The four-day convention arranged by the I.E.E. opens on March 29th at 5.30. The meetings on each of the following days will begin at 9.30 a.m.


Discussion on "Interference Problems arising from Industrial Electronics," opened by R. R. Gavin, on April 16th.


The above meetings commence at 5.30 and will be held at the I.E.E., Savoy Place, London, W.C.2.


British Institution of Radio Engineers


North-Eastern Section.—"Ship's Distress Automatic Alarm Apparatus," by H. Armstrong, at 6 on April 14th at Newcastle Hall, Westgate Road, Newcastle-on-Tyne.

Institute of Physics


Institution of Electronics

North-West Branch.—"Recent Advances in Electronics Applied to Medicine," by C. F. Parkes, at 6.30 on March 29th at Reynolds Hall, College of Technology, Manchester.

Radio Society of Great Britain

CONTRAST EXPANSION
Some Practical Results Using Negative Feedback

By J. G. WHITE

that across the anode load of $V_2$. However, not only is it introduced into the input of $V_1$, but also into that of $V_2$. Examination of the circuit will show that in each case the feedback is negative. Thus, subsidiary feedback still occurs, but, unlike the current feedback of the circuit in Fig. 9, it varies in the same ratio as the main feedback when the impedance of $V_2$ is changed.

Assuming the same terminology as applied to the amplifier in Fig. 7 (October issue) the expression for the gain of the amplifier in Fig. 2 may be written

$$M_2 = \frac{M_0}{1 + \beta M_0 + \beta \frac{\mu_2 R_s}{R_4 + R_5}}$$

When $V_1$ and $V_2$ in Fig. 2 are RF pentodes, equation (1) may be written

$$M_2 = \frac{g_{m1} R_3 g_{m2} R'_5}{1 + \beta g_{m1} R_3 g_{m2} R'_5 + \beta g_{m2} R'_5}$$

(2)

In practice, $\beta$ is unlikely to exceed 0.04, so that the subsidiary feedback may be neglected in the majority of cases, and the expression given in the original a short grid base; thus, widely different values of anode resistance may be obtained within a comparatively small range of control grid volts. With the particular valve used, the AC resistance was about 10,000 ohms at a bias of 1 volt negative, and rose to some 5 megohms at 8 volts negative. As this latter value is exceedingly high compared with $R_4$, the gain of the amplifier under these conditions is not reduced to any great extent and the expansion range obtainable is greater than with the values of impedance suggested in the original article.

The mutual conductance of the
SP41 valve under working conditions is higher than that assumed for the EF 50, and, when \( R_3 \) and \( R_4 \) were 50,000 ohms and any degree of feedback in the range quoted above. This output is sufficient to load a push-pull output stage consisting of two PX4 or PX25 valves through a phase-splitting stage.

This circuit requires a negative bias increasing as the signal amplitude increases. Thus the problem is similar to that of producing AVC bias and similar circuits may be employed.

The question of time-constants is one which has been dealt with at some length, notably in D. T. N. Williamson’s article in *Wireless World*, September, 1943. The provision of a suitably slow decline in gain is quite straightforward, and it may easily be arranged to be variable at will. Difficulties arise, however, when an attempt is made to produce the rapid rise in gain which is generally agreed to be desirable. If the time-constant of the circuit is too long, a sudden crescendo will be drawn out and the programme will lose the necessary qualities of attack and brilliance.

Fig. 2. Revised circuit of negative feedback contrast expander.

5,000 ohms, respectively, an overall gain of 6,300 times was obtained without feedback. Using the circuit of Fig. 9 (October issue) the maximum and minimum gains with 8 volts and 1 volt negative on the grid of \( V_3 \), were 2,240 and 200 times, respectively. This represents an expansion of 21 db. When current feedback was eliminated by use of the circuit of Fig. 2, the extremes of gain obtained were 5,600 and 200 times respectively, giving an expansion of 29 db. The elimination of current feedback is therefore well worthwhile. It will be noted that the minimum gain is the same in each case (within the limits of experimental accuracy). That this may be expected is apparent from equations (7) and (8), in which the term for current feedback diminishes in importance as \( b \) increases, becoming negligible for high values of \( bM_0 \).

The output waveform was examined on an oscilloscope and, with an output of 30 volts RMS maintained across \( R_5 \) by increasing the input as the gain decreased, no distortion was noticeable with

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**Control Circuit.**—We now have an amplifier with gain variable over the required range and a satisfactory level of distortion. It only remains to produce the control bias from the signal and to apply it to the grid of \( V_3 \) so that the desired effect may be obtained. Unlike most other valve-operated expanders, the control bias increases, becoming negligible as feedback diminishes (8).

In which the term for current feedback diminishes in importance as \( b \) increases, becoming negligible for high values of \( bM_0 \).

*Fig. 3. Measured expansion curves for various working conditions. (a) and (b), with voltage feedback only; (c) and (d), with current and voltage feedback. For curves (a) and (b), \( R_3 \) is 15,000 ohms and for curves (c) and (d), 50,000 ohms. \( R_5 \) consists of 3,000 ohms (nearest anode) and 2,000 ohms in series giving a gain at zero expansion of 200. If 5,000 ohms is substituted for the 3,000-ohm resistor the expansion curve is not affected, but the gain at 0 db is 280.*

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April, 1946 Wireless World
Contrast Expansion—
If the time-constant is too short, the gain of the amplifier will vary at the frequency of the applied signal, with unpleasant results that must be heard to be fully appreciated. Thus, a compromise is necessary and is a feature common to the majority of expansion circuits. In addition, with the amplifier under consideration, another factor makes a very short time-constant difficult to use.

Examination of the circuit of Fig. 2 shows that any superimposed audio frequencies applied with the control bias to the grid of \( V_3 \) will appear in the cathode circuit of that valve, and therefore of \( V_1 \), amplified by a factor approximately equal to the product of \( R_1 \) and the mutual conductance of \( V_3 \). At low gain, that is, when the bias on \( V_3 \) is at a minimum, this factor is appreciable, and the result is that very quiet passages are distorted. The effect may be reduced either by increased filtering of the control bias, which reduces the rate of rise of gain, or by setting the initial bias of \( V_3 \) at such a point that the gain from its grid to cathode is negligible. The latter method may restrict the expansion range.

The theoretical circuit of an auxiliary amplifier and rectifier to produce the control bias is shown in Fig. 4, and has proved satisfactory when used with the amplifier of Fig. 2. \( V_4 \) is an SP41 type valve and \( V_5 \) and \( V_6 \) may be the two sections of a 6H6 type duo-diode. The time of rise of gain is appreciably less than 0.05 second and the time of fall is about one second. By making \( R_{10} \) variable, it is possible to adjust the rate of fall of gain to suit the programme which is being heard. The audio-frequency component passed to the grid of \( V_3 \) is negligible, no measurable AF voltage appearing across \( R_1 \) when the grid of \( V_1 \) was connected to earth. This result was obtained without increasing the initial bias on \( V_3 \). The control bias developed across \( C_1 \) was measured for a range of AF inputs to \( V_4 \), and this is plotted in Fig. 5. It is considered desirable to reduce the effect of the initial curved portion, the DC output may be taken from a tapping on \( R_9 \) instead of from the junction of \( R_9 \) and the anode of \( V_5 \). This necessitates a higher voltage across \( R_9 \), but the curve of Fig. 5 shows that this may easily be achieved. If the tapping on \( R_9 \) is made adjustable, a method of varying the degree of expansion is obtained which is preferable to using \( R_9 \) as the control, because the input to the diode \( V_5 \) may then always be maintained at a high value. The effect on the discharge time-constant of the circuit as the tapping is adjusted may be neglected.

The value of the initial bias on \( V_5 \) will largely determine the shape of the expansion curve for the amplifier, and attention may now be directed to the curves in

Fig. 4. Circuit for providing control bias for the expansion amplifier.

Fig. 5. Characteristic of control bias circuit.

Fig. 3. It will be seen that, as the control bias increases, the rise in gain is at first very slight and then becomes very high. Thus a change of bias from \(-2\) to \(-4\) volts may produce an increase in gain of 2 db. and a further change from \(-4\) to \(-6\) volts, an increase of 18 db. Assuming a linear rectifier system, this means that changes of input level to the amplifier of 6 db. and 9.5 db., referred to the signal input corresponding to a bias of \(-2\) volts, appear at the output as changes of 8 db. and 27.5 db. respectively. The effect is completely to ruin the reproduction of any broadcast programme or record by the completely unnatural contrasts introduced.

It is desirable that the expansion be more nearly linear, and this may be achieved by increasing the standing bias on \( V_5 \) to the value at which the expansion curves begin to rise rapidly, i.e., about 3.5 to 4 volts negative. The simplest method of doing this is to increase the current in \( R_1 \) by connecting a resistor between HT positive and the cathode of \( V_3 \). If the resistor is made variable, it may be adjusted quite simply to the correct value. The control grid of \( V_5 \) is connected to earth and the resistor decreased in value until a slight increase in volume is apparent. The resistance may then be increased slightly and left at that value. This same adjustment obviously may also be used to introduce delay if this is con-
sidered desirable, but that is a matter which must be decided by the individual listener.

The oscillograms in Fig. 6 are included to illustrate the action of the expander, and show a 6 db.

Parnum,* foresaw the possibility that an unacceptable degree of distortion might be introduced because $V_3$ is a non-linear resistance. Most of the work described had been completed before Dr. Parnum's valuable comments were received, but further experiments were carried out to ascertain as far as possible the distortion introduced by this characteristic of $V_3$. Apparatus of the standard necessary to make reliable quantitative results possible was unfortunately not available, but it is felt that an estimate of not more than 2 per cent. total distortion at the output quoted earlier is fully justified by the observations made. This is no doubt partly due to the very small value of $\beta$ at maximum gain, which ensures that only a negligibly small fraction of any distortion due to the non-linearity of $V_3$ appears across $R_1$. A check was also made that distortion does not increase at intermediate levels, where $\beta$ is considerably larger.

In conclusion, an error which unfortunately occurred in the second part of the original article must be pointed out. The last line of the second column on page 309, following equation (3), should read "If $R_1$ is much less than $R_2$..."

The writer is indebted to Mr. P. L. Stride for suggestions and assistance in carrying out the practical work on which this article is based.

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NEW MOVING-COIL PICK-UPS

THE "Coil" pick-up is now being made by Wilkins and Wright, Holyhead Road, Birmingham, 21. It employs a circular coil working between shaped pole-pieces and a centre core similar to a d'Arsonval galvo.; the coil is suspended by a stretched flat metal strip. No rubber is used and the damping medium is thick grease. It is designed to take miniature chromium-plated needles such as the "99" or "Silent Stylus." The weight of the head is counter-balanced by a coil spring inside the pick-up arm which can be adjusted to give weights at the needle point ranging from 1/4 to 1 oz. A screened coupling transformer and bass equalizer unit is supplied for mounting between the pick-up and the amplifier. The output is 0.5 V (average) into an impedance of 100,000 ohms, and the makers state that the response is flat within 3 db between 30 and 9,000 c/s. The price complete is £5 15s exclusive of purchase tax.

The output transformer and bass compensating filter are incorporated in the arm of the "Valradio" pick-up. No organic damping material is used in the movement of the "Coil" pick-up made by Wilkins and Wright.

...
SHORT-WAVE CONDITIONS

Expectations for April

By T. W. BENNINGTON
(Engineering Division, B.B.C.)

The feature of short-wave conditions during February was the effect upon propagation of the very large sunspot group—the one which received all the publicity—which, appearing on the sun's east limb on January 29th, crossed the central meridian on February 5th and reached the west limb on February 11th. It then survived the journey across the "reverse" side of the sun and reappeared on the east limb on February 27th, being due on the central meridian again on March 6th, but it now appears to have considerably decreased both in size and in activity.

First, as to the general conditions during February. These, themselves dominated by the influence of the above sunspot group, were such that the average maximum usable frequencies for this latitude were somewhat higher than for January, both for noon and midnight. During those periods of the month, however, when the sunspot group "faced" the earth, its general effect was to increase the atmospheric ionisation considerably and so to give rise to very high-frequency conditions. Thus, between February 1st and 10th, and again from February 27th to the end of the month, maximum usable frequencies were much above the average and some remarkably good communication was achieved on the higher frequencies. Conditions on the higher frequencies were also good from 15th to 17th.

Now for the disturbing effects produced by the solar activity. A very remarkable number of "Dellinger" fade-outs occurred in connection with the large sunspot, some 20 or more of these having been reported from various parts of the world during the month, whilst the "hissing" phenomenon was several times observed. These fade-outs were reported as occurring mainly between February 1st and 14th and from February 27th to the end of the month.

After the sunspot crossed the central meridian the expected ionosphere storm occurred. It appeared to start on February 6th, but, strangely enough, cleared up again very quickly, re-starting with great severity about 11.00 G.M.T. on February 7th and lasting till about 13.00 G.M.T. on February 9th. This period therefore made a break in the first period of "high frequency" conditions above referred to. Another disturbance occurred during the period February 20th-22nd.

Forecast.—Conditions during April—apart from ionosphere storm effects—should be such that somewhat higher night-time and somewhat lower daytime frequencies than during March will be generally usable. The daytime frequencies will, of course, be usable over a longer period than during March, and, furthermore, there will be a tendency for peak usable frequencies to occur later in the day. Sporadic E—that unpredictable phenomenon which often makes possible communication on frequencies much higher than those usable by way of the regular layers—should begin to increase in the frequency of its occurrence in April, but more about this in the forecast for May, when this phenomenon should begin to become really prevalent.

Now a word of explanation about the tables of predicted best frequencies for use during April which are given below for various directions from this country. For certain significant times of day the unbracketed figures give the best frequencies, in terms of the broadcast bands. These are based on the average predicted MUF for the month, and indicate the frequencies which could reasonably safely be used by a communication or broadcasting organisation which has to operate services on every day throughout the month. But it is known that the average MUF is exceeded on many days during the month, and, furthermore, it is possible roughly to estimate the amount by which it will be exceeded during a given percentage of the total time; that is, unless some very exceptional variations in solar activity occur. Whilst attempted operation on such higher frequencies would not be a useful expedient for regular services there are others whose interest lies, not in the continuous operation of a service, but in the exploitation of a particular frequency band. Furthermore, because the power at the disposal of such experimenters is usually limited, the very highest frequency will practically always yield the best results while and if it is open, because the absorption is there the lowest.

In order to meet these requirements a figure in brackets is therefore included for each significant hour, indicating the highest frequency likely to be usable for about 25% of the time during the month, for communication by way of the regular layers, not by way of Sporadic E.

Montreal: 0000, 11 or 9 Mc/s (16 Mc/s); 0900, 9 Mc/s (14 Mc/s); 0700, 12 Mc/s (16 Mc/s); 1100, 15 Mc/s (21 Mc/s); 1500, 17 or 15 Mc/s (24 Mc/s); 2000, 15 Mc/s (22 Mc/s); 2200, 11 Mc/s (17 Mc/s).

Buenos Aires: 0000, 11 or 9 Mc/s (14 Mc/s); 0900, 7 Mc/s (13 Mc/s); 0800, 11 Mc/s (17 Mc/s); 1000, 17 Mc/s (24 Mc/s); 1400, 21 or 17 Mc/s (28 Mc/s); 2100, 17 or 15 Mc/s (23 Mc/s); 2200, 11 Mc/s (17 Mc/s).

Capetown: 0000, 11 Mc/s (17 Mc/s); 0600, 15 Mc/s (21 Mc/s); 0700, 17 Mc/s (25 Mc/s); 0900, 21 Mc/s (30 Mc/s); 1800, 17 Mc/s (24 Mc/s); 2000, 11 Mc/s (17 Mc/s).

Chungking: 0000, 9 Mc/s (13 Mc/s); 0900, 11 Mc/s (17 Mc/s); 0700, 15 Mc/s (22 Mc/s); 1100, 17 or 15 Mc/s (24 Mc/s); 1500, 15 Mc/s (21 Mc/s); 1700, 11 Mc/s (17 Mc/s); 2000, 9 Mc/s (14 Mc/s).

A moderate amount of ionosphere storminess is usual during April, and although one cannot be at all certain, it would appear at the time of writing that during the periods 3rd-6th, 14th-18th and on 30th conditions are likely to be more disturbed than on other days.
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Design Data (3)

WIDE-BAND AMPLIFIERS

II.—Single-Circuit Couplings : Stagger Tuning

If the band-width of a multi-stage amplifier employing single resonant circuits as inter-valve couplings, is too narrow, it can be broadened either by increasing the damping of the circuits or by staggering their individual resonance frequencies about the mid-band frequency. It is found that the latter method leads to a considerably higher gain per stage and is consequently usually to be preferred.

The possible ways of achieving stagger-tuning are very large, for each circuit has two variables—its damping and its degree of mistuning. The most generally satisfactory result is obtained, however, when the amplifier is divided into pairs of stages, each pair having identical response characteristics. Each pair of stages comprises two valves and two couplings employing single tuned circuits, one being mistuned to one side of the mid-band frequency and the other being mistuned to the other. The circuits are equally damped, but need not have identical capacitance or resistance, nor need the valves be the same.

Such a circuit with coincidence tuning gives a performance calculable by the formulae of Design Data No. 2. If the circuits are tuned away from coincidence in opposite directions the response curve broadens and the amplification falls. There is a critical degree of mistuning beyond which the response curve becomes double-humped and similar to that given by a pair of over-coupled tuned circuits. This critical degree of stagger is analogous to critical coupling in such a pair of coupled circuits. Only the case of this critical stagger is considered here.

Higher gain for a given band-width can be secured with greater stagger, especially if the pair of stages is combined with a third tuned to the mean frequency. The system then becomes much more critical in its adjustment, however, and more liable to be seriously affected by small changes in circuit constants, notably the input capacitance of the valves. It is usually better, therefore, to adopt critical stagger.

Practical Example

The formulae given enable the circuit values to be calculated and their use is best illustrated by an example. Suppose \( C_1 = C_2 = C = 30 \text{ pF} \), \( g_{m1} = g_{m2} = 8 \text{ mA/V} \), \( n = 5 \text{ Mc/s} \), \( f_m = 13 \text{ Mc/s} \); and \( S = 1.414 \) (−3 db), then from equation (2) or the curve \( nCR = 225/k \). From (3) \( f_r = 12.75 \text{ Mc/s} \), and from

\[
(9) \quad k = \frac{1}{512.75} = 0.908; \quad \text{therefore,} \quad nCR = 248 \text{ and } R = 1.65 \text{ k} \Omega. \]

From (4) \( L = 5.0 \mu \text{H} \) and from (5) \( y = 0.2975. \)

Consequently \( a^2 = 2 + \frac{0.2975 \sqrt{4 - 0.0886}}{2 - 0.0886} = 1.355 \) and \( a = 1.16. \)

Then (7) gives \( R_1 = 1.92 \text{ k} \Omega; \quad R_2 = 1.425 \text{ k} \Omega; \quad L_1 = 6.77 \mu \text{H}; \quad L_2 = 3.69 \mu \text{H}; \quad f_{r1} = 11 \text{ Mc/s}; \quad f_{r2} = 14.8 \text{ Mc/s}; \quad \text{lastly } \Delta = 69.2. \)

This should be compared with the gain of two coincident-tuned stages with the same capacitance values, band-width and valves. The figure given in Design Data No. 2 was 26.3 times, so that stagger tuning in this instance gives 62 per cent. more amplification per stage.

If four stages are used with the same overall response, the drop per pair of stages is 1.5 db, so that \( S^2 = 1.414 \) and \( nCR = 200 \). Consequently \( R = 1.33 \text{ k} \Omega \) and \( \Delta = 51.5 \) per pair, or 2,650 times overall. This compares very favourably with the 182 times of four stages with coincidence tuning.

Equation (10) can be used to determine the response at other frequencies. Thus if we wish to know the response at 13 ± 3.5 = 16.5 and 9.5 Mc/s, \( m = 16.5 \quad -12.75 = 3.75 \text{ Mc/s} \) and 9.5 = 12.75 = 3.25 Mc/s in the two cases. Then \( k = 1.294 \) and 0.745, giving \( x^2 + 1/x^2 = 2.276 \) and 2.352.

Then in the first case the relative response is

\[
-10 \log \left[ 1 + \frac{2.276 \times 2.09 - 4 + (2.276 - 2.09)^2}{0.088} \right] = 11.46 \text{ db},
\]

and in the other

\[
-10 \log \left[ 1 + \frac{2.352 \times 2.09 - 4 + (2.352 - 2.09)^2}{0.088} \right] \frac{0.077}{69.2} = -12.6 \text{ db}.
\]

This is the attenuation of two stages at a frequency 3.5 Mc/s different from the mid-band frequency of 13 Mc/s.

Effect of Mid-band Frequency

The circuit constants and performance are to a first approximation independent of the mid-band frequency. When \( n \) becomes an appreciable fraction of \( f_m \), however, the values are affected slightly and the amplification increases somewhat as the frequency is lowered. This is not immediately apparent for in equation (8) \( A \propto k \) and \( k \) decreases with decreasing frequency. However, in equation (2) \( R \propto 1/k \), and \( R^2 = R_1 R_2 \) appears in equation (8); consequently, in reality \( A \propto 1/k \). The effect of \( k \) is to increase the gain of two stages by about 10 per cent. at 13 Mc/s, as compared with, say, 45 Mc/s, so that it is quite small.

It would not influence the choice of intermediate frequency as long as this is above 7 Mc/s and there are usually objections to a lower value. It is usually permissible to take \( k = 1 \), and therefore to ignore it.

In order to reduce computation, a curve is included to show the relation between the attenuation at the
Wide-band Amplifiers—edges of the pass-band and $nCR$ (for $h = 1$). It must be remembered that the data all applies to a pair of valves with two tuned circuits—one resonant at $f_{r1}$ and the other at $f_{r2}$.

**Design Data (3): Wide-Band Amplifiers**

![Diagram of Wide-Band Amplifiers]

Let $f_m$ = required mid-band frequency
$n$ = required band-width
$f_1 = f_m - n/2$ = lower limit of pass-band
$f_n = f_m + n/2$ = upper limit of pass-band
$f_r = f_m \sqrt{1 - n^2/4f_m^2}$ = $\sqrt{f_1f_2} = 159/\sqrt{LC}$ = frequency of maximum response

- $f_{r1}$ = resonance frequency of circuit 1
- $f_{r2}$ = resonance frequency of circuit 2
- $m$ = frequency difference from $f_r$
- $S_n$ = Ratio of $R_{r1}$ in response at $f_r$
- $S_m$ = Ratio of $R_{r2}$ in response at $f_{r1} + m$
- $g_{m1}$ = mutual conductance of $V_1$
- $g_{m2}$ = mutual conductance of $V_2$

**Units**
- Frequency (Mc/s); mutual conductance (mA/V); inductance ($\mu$H); capacitance (pF); resistance (kΩ).

Given $f_m$, $n$, $S_n$, $C_1$, $C_2$, $g_{m1}$ and $g_{m2}$, to determine $R_1$, $R_2$, $L_1$, $L_2$ and $A$:

- $C = \sqrt{C_1C_2}$
- $nCR = \frac{225}{k} \sqrt{(S_n^2 - 1)}$
- $f_r = f_m \sqrt{1 - n^2/4f_m^2}$
- $L = \frac{24,400}{f_r^2}$
- $\gamma = \frac{159}{f_r^2}$

- $A = \frac{e_0/e_1}{g_{m1}R_{c1}g_{m2}R_{c2}}k$

where $k$ = a correction factor

Relative response at any frequency = $-10 \log S_m^2$

$$= -10 \log \left[1 + \frac{1}{\gamma^2} \left(x^2 + 1/x^2\right)\left(a^2 + 1/a^2\right) - 4\right] + \frac{1}{\gamma^4} \left(x^2 + 1/x^2 - a^2 - 1/a^2\right)^2$$

where $x = 1 + m/f_r$
EXPLANATIONS of phase difference between grid and anode signals of a valve stage, which include the subterfuge of an imaginary generator, are apt to leave the student, at least, with a somewhat hazy idea of the effect being explained. Such subterfuges are not essential to a completely accurate explanation, as the writer hopes to show.

It is worth while considering first the case of a valve with no anode load impedance, i.e., where the anode-to-cathode voltage does not fluctuate in accordance with a signal voltage applied between grid and cathode. This point is of some small importance, since otherwise, as will later be shown, the phase relationship between \( I_a \) and \( V_o \) sig. is dependent upon both the nature of the load and the valve amplification factor.

If we consider a resistor placed between grid and cathode, the current through this resistor will be in phase with the voltage across it, i.e., electrons will flow from the cathode end of the resistor towards the grid end at the highest rate at the instant at which the grid end is most positive.

Inside the valve, electrons will flow from the cathode towards and past the grid at the highest rate at the instant at which the grid is most positive (or most nearly positive, i.e., least negative). Thus, in the no load condition where \( I_a \) is varied only by \( V_o \) sig., the current past the grid, i.e., the \( I_a \) sig., is exactly in phase with \( V_o \) sig., if we neglect the time taken for the electrons to travel. This time is so small that it may be ignored unless the input signal is reversing its polarity in less than, say, one twenty millionth of a second.

Dealing now with the case of a valve with a load impedance, the \( I_a \) sig. will develop a signal voltage across the load, causing the anode to cathode voltage to fluctuate. These fluctuations will also affect \( I_a \), which is controlled by both \( V_o \) and \( V_r \), in the ratio of the valve amplification factor. To maintain the simplest possible explanation for the moment, let us now consider only the case of a pentode valve of such high amplification factor that the control over \( I_a \) exerted by \( V_r \) is negligible by comparison with that exerted by \( V_o \).

Considering such a valve in its steady state or DC conditions, with a resistive anode load, there will be a certain voltage dropped across the resistor. The valve anode is negative to the HT+ terminal by this voltage, and positive to its cathode by this amount less than the HT voltage.

When an input signal is applied, at the peak of the half-cycle which makes the grid positive to cathode, the \( I_a \) will be highest, and the voltage dropped across the load resistor will be greatest.

This means that the anode becomes least positive to cathode and most negative to HT+, so that the maximum change of \( V_a \) in a negative direction occurs at the instant of maximum change of \( V_o \) in a positive direction, from which arises the usually accepted, but erroneous statement, that \( V_a \) and \( V_o \) are in antiphase (with a resistive load).

Naturally, the writer is now required to justify the word "erroneous."

Fig. 1 (a) shows a waveform having a large amplitude, short duration positive half-cycle and a small amplitude, long duration negative half-cycle. Fig. 1 (b) shows the same waveform 180 degrees out of phase with the first. A positive peak is still a positive peak, but occurs at a different instant of time. This is certainly not what would be obtained from a valve whose input was represented by Fig. 1 (a).

What would be obtained is shown in Fig. 1 (c), where the large amplitude, short duration half-cycle occurs at the same instant of time as in Fig. 1 (a), but where it has now become a negative half-cycle. This is not

![Figure 1](image-url)

---

**Fig. 1. Illustrating the difference between "phase" and "polarity."**
Phase Relationships

\[ V_x \] and therefore the same relationship between \( V_p \) and \( V_{x}\). In Fig. 2 (b) the connections to \( x \) and \( y \) have been reversed, resulting in exactly the same effect as would be produced by the addition of a valve stage to Fig. 2 (a). This reversal of connections can, however, hardly be said to have changed the phase (or time) relationship between \( V_p \) and \( V_y \).

![Fig. 2. Reversal of the secondary connections of a transformer has a similar effect to the introduction of a valve stage.](image)

We may take the matter a stage further, and consider the input voltages to a Class "B" push-pull stage, where it is normally stated that the two inputs need to be in antiphase. Bearing in mind that a Class "B" (cut-off biased) valve can amplify only the positive half-cycle of an input signal, it should be realised that the application of the signals shown in Fig. 3 would only result in sinusoidal output, though the inputs are far from being sine waves.

The next step is to consider a reactive load, still dealing with the high-mu valve, where \( I_a \) is virtually unaffected by \( V_a \). \( I_a \) is in phase with \( V_g \) sig., and this \( I_a \) flows through both valve and anode load without any change of phase (a general rule of series circuits, irrespective of the nature of the impedances). Thus the current through \( V_a \) is the same as \( I_a \) producing it, resulting in the anode being made positive to \( HT + \). Thus \( V_a \) will rise above the \( HT \) voltage, a possibility which does not often seem to be realised. In fact, where \( I_a \) is suddenly considerably reduced, with a considerable amount of inductance in the anode circuit, \( V_a \) can momentarily rise as high as eight or more times the \( HT \) voltage.

Where the load is capacitive, as would be the case with a parallel tuned circuit resonant to a frequency lower than that of the input signal, the voltage across the load will lag on the \( I_a \) signal.

In conclusion, mention may be made of the case where the amplification factor is sufficiently low that \( V_a \) exerts appreciable control over \( I_a \). With a resistive load, where \( V_a \) sig. and \( V_g \) sig. are in phase but of opposite polarity, the effect is merely a reduction of working mutual conductance. With a reactive load, where \( V_a \) sig. will not be in the same phase as \( V_g \) sig. the net result will be that \( I_a \) sig. is no longer in phase with \( V_g \) sig.

![Fig. 3. "Distorted" signals with 180-degree phase difference applied to the grids of a Class B stage might result in a pure sine wave output.](image)
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RADAR CABLES

Recent Developments in Conductors for Very High Frequencies

By E. W. SMITH, Ph.D., M.I.E.E.
(The Telegraph Construction and Maintenance Co., Ltd.)

The key to progress in radar technique has always been the use of increasingly high frequencies for the exploring wave. It is evident that all the numerous current-carrying components in the equipment have had to keep pace with these increases of frequency so that none imposed undue limitations. It is here proposed to review the development of the cables which, among other components, have performed a vital function throughout. While the rate of this development has been most marked in the period 1935-1945, there is a background, as in radar itself, of theory and manufacturing experience, going back a hundred years to the days when the first cables insulated with extruded plastics were made for submarine use.

Dielectric Loss in Cables.—The chief objective in the drive for better cables has been the reduction of the power factor of the dielectric, for ten years or so ago the lowest figure obtainable in otherwise suitable dielectrics was about 0.005. We can express the attenuation constant in high-frequency cables as \( R/2Z + GZ/2 \), where \( R \) is the high-frequency resistance of the conductors, \( Z \) the characteristic impedance of the cable, and \( G \) the conductance (=power factor x admittance) of the dielectric. Analysis shows that, for the average cable, \( Z \) varies inversely as the square root of the dielectric permittivity, and that this permittivity can only be improved over comparatively narrow limits, and is usually independent of frequency. We know, however, that the resistance \( R \) varies approximately as the square root of the frequency, while \( G \) usually varies directly as the first power of frequency. It will thus be seen that as frequency rises, the dielectric loss can very easily outstrip that due to the resistance of the conductors. An example of this in a pre-1935 cable is shown in Fig. 1, from which it will be seen that the dielectric loss alone could be about 0.7 db./100ft. even at the low frequency of 30 Mc/s, and no less than 5 db./100ft. at 200 Mc/s.

What is the practical significance of losses of this order? The reader will remember that the height of the aerial masts in the original "CH" system was given as 350ft. for transmitting and 240ft. for receiving. The conductor loss in a connection, say, 300ft. from aerial to operating hut by cable of power factor 0.005 would be appreciable (2 db.) at 30 Mc/s and serious (15 db.) at 200 Mc/s, while the use of such a cable at 3,000 Mc/s would be quite out of the question. It should be remembered that cable losses help to determine the signal/noise ratio and therefore cannot be compensated for ad lib. by increasing amplifier gain.

Air Dielectric Cables.—Before the advent of polythene, by the aid of which the solution of most radar cable problems was eventually found, considerable attention was paid to air dielectric cables.

Three types of air dielectric cable are illustrated in Fig. 2, in which A shows the "fin" type, B the "spiral thread" type, and C the "disc spaced" type. Type A was originally made by extruding first the star-shaped fin on to a flexible conductor and then applying the enclosing cylinder of dielectric in a separate operation. In 1935, with this combination of air and materials of the old type, the power factor discussed above was halved, while the effective dielectric constant was reduced from about 3 to about 1.6. Similar electrical results were obtained with Type B, and these types were both characterised by desirable flexibility and robustness.

With Type C it was possible to make the spacing discs of relatively hard inflexible dielectric, and a particularly suitable one, namely polystyrene, had been available for some time. In the cable illustrated the outer conductor consists of an extruded lead sheath, which when required is protected with a steel tape or wire armouring. Owing to the very low loss of polystyrene and the small amount of this material
Radar Cables—

used, the power factor of this type of cable is of the order of 0.0002, while the effective dielectric constant is about 3.1. For a 300ft. connector the dielectric loss would be quite negligible at 30 Mc/s, practically negligible (0.3 db.) at 200 Mc/s and quite tolerable (5 db.) at 3,000 Mc/s, although for frequencies of this order modifications in the normal disc spacing might be required.

The disc-insulated cables were thus electrically suitable for radar use when the art was in the early stages of development, and in fact are still incorporated in many systems. Their disadvantage is in their relative inflexibility, and in the vulnerability of their somewhat delicate construction. As will be seen later, most stringent mechanical requirements must be satisfied by most cables before they are approved for radar use.

Polythene Insulated Cables.—

Readers will be familiar with the properties of polythene (polyethylene), the plastic dielectric material invented by Imperial Chemical Industries, and first produced in appreciable quantities in 1938. It has already been recorded that the construction of polythene insulated cables was undertaken by the Telegraph Construction and Maintenance Company as soon as the material was available. Actually “Telethene,” a mixture of polythene and polyisobutylene (a material of similar electrical characteristics) was used. In 1938 and early 1939 several types of radar cables were made with this dielectric. Very soon the demand grew to such an extent that the Ministry of Aircraft Production sponsored an auxiliary T.C.M. factory, solely for radar cable production, and in 1940 obtained the co-operation of other cable-making firms so that the enormous demands could be satisfied and freed, by the dispersal of plant, from the danger of serious interruption by enemy action.

Types of Radar Cable.—It must not be imagined that the invention of polythene solved all radar cable problems at a stroke. A good deal of work in the processing of the material had to be carried out before its full value could be realised in practice. Thus the prevention of oxidation and the avoidance of air inclusion and of irregularities in extrusion had to be ensured, and it was in the solution of such problems that a long experience of plastic extrusion proved most valuable. By 1940, however, most of the desired refinements in production had been attained, and at this time an inter-Service committee was formed to standardise the variations in cable sizes and characteristics which were required. This committee framed specifications covering between 30 and 40 different cables, based mainly on a pre-war series of coxials, known to many as “PT” types, and on a corresponding series, “BA” types, of balanced twin feeders. Fig. 3 shows, approximately half size, two examples of each type.

Generally speaking, the coaxial types have single or 7-strand centre conductors, insulation applied in two or three layers, outer conductors composed of a braid of fine copper wires, and sheaths of extruded PVC (polyvinyl chloride). On most of the balanced twin types the two separately insulated conductors are twisted and filled with the polythene-polyisobutylene dielectric to circular section.

The most important refinement desired in coaxial cables is regularity in diameter. If this dimension varies along the length of the cable, even by a few thousandths of an inch, reflections will occur and standing waves of undesirable magnitude will be set up. While great progress has been made in uniformity of diameter, work in this direction is still in progress, for dimensional tolerances even as low as ±0.001 in. would be well worth attaining.

In balanced twin cables, the degree of electrical balance to earth of the two conductors is of similar importance. A notable feature in such cables is a double screen, the inner screening component being a helical wrapping of metallised paper, and the outer one a braid of fine wires. Prior to the introduction of this construction by T.C.M. in 1942 the stability and ageing properties of twin cables left much to be desired.

![Fig. 4. Special coaxial cables. A, "delay" cable with helical centre conductor and B, "low impedance" cable with braided cylindrical centre conductor.](image-url)
Special Types.—The impedance of the polythene insulated coaxial cable is normally about 70 ohms, and that of the twin 90-100 ohms. Departures from these average figures have, however, been required for special purposes, and two extreme cases may be mentioned here. One is the "delay" cable, in which a helix of wire takes the place of the single central wire in a coaxial cable, and the other the "low impedance" cable in which the centre conductor, as well as the outer, is a braid of fine wire. These are illustrated in Fig. 4.

The chief features of the "delay" cables are their high characteristic impedance and low propagation velocity. Several types are made, the impedances ranging from 130 to 2,000 ohms and the velocities from one-seventh to one-hundredth that of light. These cables are mainly used to produce artificial echoes for calibration purposes.

Mechanical and Electrical Testing.—Mechanical testing of solid dielectric cables includes tension, bending, twisting, hot deformation, and "cold crack" tests. Tension is applied to short lengths to see that the dielectric tightly embraces the centre conductor and is in turn firmly held within the outer braid. To determine the effects of bending, the cable is wound and unwound several times, the diameter of the winding being normally ten times that of the cable itself. Twisting tests comprise twists and untwists on a short, straight sample through a specified angle. In the hot test the cable is kept under load for 16 hours at a temperature of 70 deg. C.; the temperature generally chosen for the "cold crack" test is -30 deg. C.

The radio-frequency characteristics of radar cables are determined by "resonant line" and "standing wave" methods, details of which have appeared in recent papers. Fig. 5 shows a few typical results. In addition to RF tests, all cable is subjected to DC measurements to determine conductor and dielectric resistances, the latter being usually at least 10 MΩ—100 ft. A high-tension test at 50 c/s is also applied, the voltage chosen being such that the maximum stress in the dielectric is 90 kV(peak)/cm. Radio-frequency characteristics must remain unaffected by this application, and by the mechanical treatment outlined above.

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Fig. 5. Losses in radar cables, diameters 0.13in. (PT1M) to 0.8in. (PT35L).

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BROADCASTING IN U.S.A.

Report on Post-war Trends

By A. DINSDALE

According to the new 1946 Broadcasting Yearbook, the total spent on radio advertising (including station time and talent) in the United States in 1945 (American radio's 25th year) is estimated at $383,450,000, an increase of 7.5 per cent over 1944. That puts radio up in the category of Big Business.

The effects of radio's sensational rise are many and varied. In the first place, at the end of 1945 there were 1,004 standard broadcasting stations in the United States, compared with 943 in 1944. I might explain that the term "standard broadcasting station" has come to be used to describe an A.M. station, as distinct from F.M.

One immediate effect of the radio bonanza is apparent in the numbers of applications on file before the Federal Communications Commission. The F.C.C. was swamped with over 500 applications for new standard broadcasting stations, more than 800

A scene in the studio of the American National Broadcasting Company's television station during the transmission of a programme. Only "a small handful" of Americans have sets with which to receive these transmissions.
broadcasting stations strive to build listeners. The more listeners you have, the more advertising you can attract. Or you can raise your rates. So F.M. has been "sold" to owners as a means of attracting new listeners.

But the catch is that it costs from $50,000 up to build and equip an F.M. station, and until somebody buys a new receiver you have no listeners. The comparatively few F.M. receivers sold before the war are now useless, due to a recent change in the F.M. band, which is now 88-104 Mc/s. But it's the old story of the chicken and the egg. Which came first? Unless somebody puts up an F.M. transmitter there is no incentive for a listener to buy an F.M. receiver. But while waiting for people to buy receivers the station owner has to bear the expense of keeping his F.M. transmitter operating as a sort of auxiliary to his A.M. transmitter. In time, enough people will have bought F.M. receivers (or combination receivers capable of receiving both A.M. and F.M.), so that the station owner will have an audience sufficiently large to attract advertisers. When that happens the owner should begin to get his investment back. At least, that is the theory. Will it work out?

Suppose you own the only station in town. Suppose, for the sake of argument, you have just two listeners. Either they both ignore F.M. and continue to listen to the A.M. station, or they both listen to F.M. and abandon the A.M. station. More likely, they will divide their listening between the two stations. Thus, instead of increasing your audience, all you have done is split your audience, reducing by half the potential advertising value of both stations. You just can't increase your audience, because everyone ever likely to own a radio has one already, and has established his listening habits.

If there's more than one station in town, competition will force the other fellows to build F.M. stations, too, and anyone interested in the novelty of F.M. will continue to listen to the auxiliary of the station he usually tunes in.

From a revenue point of view, (Continued on page 134.)
Broadcasting in U.S.A.—

one advertiser put it to me like this: "Look, Dinsdale. I've got just one advertising dollar to spend. Go ahead and build an F.M. station if you've a mind to. And when you get it built you can put my advertising on either station, or split it between them, according to your judgment of what'll do me the most good. But don't come and ask me for a second advertising dollar for your F.M. station. I just haven't got it."

That is the dilemma facing American station owners and managers to-day. They want to keep in the van of progress, but it means a heavy investment, both in first cost and in operation, and they cannot see clearly where the return is coming from, or when. Splitting the audience between A.M. and F.M. may force a reduction in advertising rates of both stations, with a consequent heavy reduction in overall yield from an increased investment.

In large metropolitan areas like New York or Chicago, the case is different. In such areas there may be radio advertisers who simply can't get on the air because (1) there aren't enough A.M. stations to accommodate them, and (2) the rates are too high. In metropolitan centres there is room for some F.M. stations to accommodate these people. With range, and thus a larger marketing area, limited to the horizon, the rates can be low enough so that service can be extended to thousands of new advertisers.

Why F.M., Anyway?—At this point one is forced to ask the question: "Why introduce F.M., anyway? The only one sure to profit is the manufacturer of transmitters and receivers. The position of the station owner is most dubious, to say the least of it, and the listener doesn't seem to care." So let's take a look at the listener again.

F.M. is being sold to the American public on two counts: (1) It is interference-free (but the word "practically" is now being inserted); (2) it provides unequalled tone quality.

Let's examine this interference-free claim. Since F.M. is limited to the horizon, we can compare an F.M. signal to that provided in the same area by an A.M. station—that is, the so-called primary service area, where the signal strength is not less than a half millivolt. As things stand to-day, with a reasonably good receiver, properly installed, there is no interference to speak of in the primary service area of an A.M. station, unless a thunderstorm is raging in the immediate vicinity. If you get beyond the primary service area of an A.M. station you'll get plenty of interference natural and man-made. But at the same distance from an F.M. station you'll get no signal at all. So wherein lies the value of the argument?

Let's consider quality. I will make the flat statement that if you walk into any number of American homes to-day you'll find that in 95 per cent. of them the tone control on the radio is turned down, to cut out the high frequencies. If you ask about it, you will be told vaguely that they like it better that way. With the tone control up, the radio sounds "harsh," "raspy," or it interferes with conversation or reading.

In that last you have it. The radio is on only to provide a pleasant background. It is only really listened to when a comedy programme comes on, or a news broadcast, or a favourite commentator, or a dramatic programme. And for such programmes high quality is not necessary. Only a few music lovers take the trouble to buy the best radios, and then get the most out of them.

An educational campaign? Futilie. About 12 years or so ago, set manufacturers improved their receivers so that they would reproduce up to 7,500 cycles. They spent millions to advertise the fact. A number of so-called "high-fidelity stations," like WQXR in New York, explained and explained this business of high quality, and demonstrated it for years by playing the highest quality recordings they could get. In fact, they forced improvements in recording quality.

And what happened? People still turned down the tone control as soon as the first novelty wore off.

So now along comes F.M., with transmitters capable of putting out even higher quality, and receivers capable of reproducing it.

However, you can't take out what you don't put in. By that I mean that F.M. transmitters are capable of putting out much higher quality than is readily available to them. At first, much of the programming will come from high-quality electrical transcription and some records. But even the highest quality transcriptions that it is now possible to make cannot equal F.M.'s potentials. Network programmes, received by the station over ordinary telephone lines, will not sound much better than they do over A.M. The cost of a network of high-quality concentric cable would be prohibitive. In the end, networks of F.M. stations will have to be fed network programmes by means of chains of F.M. relay stations.

However, it is the opinion of top network executives that, eventually, service in metropolitan areas will be by F.M. exclusively. Existing A.M. stations in such areas will be scrapped, with the exception of a limited number of high-power A.M. transmitters which will be moved out to the wide open spaces to serve rural areas where the population density is so low that F.M. service would be uneconomical. However, it is expected that about ten years will elapse before this change takes place.

The major factor in forcing this change will be economic. The time will come when broadcasters, one by one, will find it uneconomical to operate two transmitters, one A.M. and one F.M., and they will either scrap the A.M. or move it out into the country.

Gradually, there will be still another economic change. With the range of F.M. limited to the horizon, the number of radio homes which can be covered will be greatly reduced, especially in the case of the higher powered A.M. stations. That means a reduction in circulation, which in turn means that advertising rates will have to be reduced. Yet, first costs and operating expenses will remain about the same. Add to that a vast increase in the total number of broadcasting stations.
when F.M. becomes general, and the result is that the total radio advertising revenue will be spread among many more stations, so that the average revenue per station will be greatly reduced. This factor may discourage many station owners and become the controlling factor which will limit the total number of stations.

The vast potential increase in the number of stations possible with F.M. has already attracted trade unions and other organizations with a special cause to plead, and they are busily filing applications for "non-commercial educational" F.M. stations.

**Television's Future.**—Television's future in America can be summed up in one word—Uncertain.

Technically, black-and-white images, seen under the best conditions, are good. I've just checked on them in New York. The Columbia colour television is very good. To get the colour, they use a revolving colour disc at the receiver, synchronized with a similar disc at the transmitter.

I described this system in its original form in *Wireless World* several years ago.

Programme material cannot be so highly praised. Frankly, producers are still experimenting, searching for the proper material and methods of presentation for television. "Televisioners" are limited to a small handful. Only a few thousand receivers were distributed before the war, and these must be modified before they can be used on to-day's limited transmissions. This is so because, as in F.M., frequency assignments have been changed. A start is being made now on the 60-78 Mc/s band, and eventually, television will move to the 160-288 Mc/s band. Columbia is experimenting with its colour system on frequencies above 450 Mc/s. New television receivers are not yet on the market, although a few of the bigger manufacturers are beginning to advertise combination receivers capable of handling A.M., standard band and short-wave; F.M. and television; they incorporate a phonograph turntable with automatic record-changer.

As to delivery, it is hoped that this may be "some time this

year." No one ventures to quote even an approximate price for these new "all-in" sets.

**Economics of Television.**—Even more so than in the case of F.M., economics seems destined to play an important part in television. About the lowest figure I have heard quoted for a television station is $200,000. But it is generally agreed that the minimum cost of a fully-equipped television station is likely to be closer to $350,000. It is also agreed that the cost of operation for the first year is likely to be in the neighbourhood of $350,000. By the end of the second year, it can be hoped that a substantial number of television receivers will have been purchased within the service area of the station. But by that time, the television broadcaster will have spent *one million dollars.*

Bear in mind that in America, television seems destined to become another advertising medium, like sound broadcasting. Where after two years of operation, is a television broadcaster to find sufficient revenue to make his investment worth while? It is generally agreed that advertising rates over television will have to be several times those now charged for present radio advertising, and programme production costs will also be several times higher. Thoughtful persons in the radio industry are beginning to wonder just who will be able to stand such high advertising costs. In large cities, perhaps a few big department stores will be able to stand it, but the overall revenue possibilities are so doubtful that quite a number of would-be television broadcasters have withdrawn their applications.

Obviously, those who stand to profit most by the development of television are the manufacturers who expect to produce and sell transmitters and receivers. It may be that eventually they will have to shoulder the cost of television broadcasting and accept as their sole return the wide sale of receivers. But before that can happen, present restrictive laws will have to be modified.

So, all in all, I feel justified in saying that the future of television in America can only be described as uncertain.
Letters to the Editor

Expansion Circuits • The £1 Broadcast Licence Quality of B.B.C. Recordings

Contrast Expansion

I HAVE read with much interest Mr. White’s articles on contrast expansion in the September and October, 1945, issues, but there is one important point on which I should like to be re-assured before accepting his final circuit as satisfactory. It is the amount of harmonic distortion introduced by the controlled valve (V₃, Fig. 9) being a non-linear resistance.

Suppose first that the output voltage at the anode of V₃ is applied to V, and R, in series, but that the voltage across R, is not fed back into the amplifier. Since the resistance of V, cannot be strictly linear, the current through the circuit will contain harmonics and so, therefore, will the voltage across R, When R, is connected into the cathode circuit of V₃, these harmonics will be amplified and will appear in the output. Simple analysis indicates that, if the harmonic percentage across R, (before connection to V₃) is ρ, the harmonic percentage in the output will also be not far short of ρ. From this point of view, therefore, the circuit is probably not superior to variable-resistance circuits not using feedback.

Mr. White claims that his expander will drive an output stage directly. The output stage of a quality amplifier will need something like 45V peak for full drive (this means nearly 20V applied to V₃). Since at full drive V₃ has maximum negative bias, its resistance will be in the most non-linear state, and I should have guessed that with 20V applied to the anode it would generate appreciable distortion, which will sound worst at maximum output. But the matter can only be settled by the figures, and if Mr. White can supply these (i.e., output distortion for given amounts of output voltage) I think he should do so, in order to prove his claims that the circuit will drive an output stage directly and that it introduces less distortion than other types (he remarks that push-pull vari- able-gain expanders do not remove the odd harmonics, implying that his circuit is superior).

Although this may not have been intended, the article gives the impression that the distortion produced by a variable-resistance valve is inherently reduced by placing the valve in the feedback path. This is obviously not fundamentally true; negative feedback will reduce the effects of non-linear components in the amplifying path, because this is its function, but it does so by using a feedback path which is strictly linear (usually a resistance divider). If the feedback path is itself non-linear then it will produce distortion even with a strictly linear amplifier.

These remarks are not meant to detract from the value of Mr. White’s article, but rather to add to it. If the distortion figures are satisfactory, the circuit may well prove to be superior to all others on grounds of simplicity, ease of control, and relatively high gain.

D. H. PARNUM.

Helensburgh.

[These comments are referred to on p. 120.—Ed.]

B.B.C. Finance

MAY I be allowed to point out some anomalies which seem to have escaped other commentators on B.B.C. finance?

First, the radio critics in the lay Press seem to have swallowed unquestioningly the extraordinary idea that the £1 licence fee would not now suffice to pay for the home (sound) broadcasting services, and that an increase to £3 is reasonable. Now the B.B.C. in 1938 had only 75 6d out of each of a smaller number of licences than exist now, but was able to pay for the following: The home (sound) broadcasting services; the Empire service (on short waves); the London television service; capital expenditure on new transmitters and buildings; income tax (charged on that part of the Corporation’s revenue which was devoted to capital expenditure). It is therefore my guess that 6s per licence would have covered the maintenance of the home (sound) broadcasting services before the war; allowing for the 50 per cent rise in prices since 1938 the B.B.C. would need 9s now. Out of a £1 licence fee this would still leave the Post Office 1s for cost of collection, compared with 2d which is charged for issuing and cashing a £1 postal Order. An increase in the licence fee to, say, 12s 6d might be within the bounds of reason, but an increase to £3 is not. The additional £1 on the ordinary radio licence is therefore not required to pay for the services which the licensee receives, but is probably intended for one or more of the following purposes:

(i) To pay for the overseas propaganda services, which ought to be charged directly to the Exchequer, on a par with the expenses of the British Council.

(ii) To pay for television, which the Government’s Television Committee has shown cannot be paid for by the owners of television receivers.

(iii) To serve as a tax, pure and simple. (However unpalatable, this is fairly logical, since other forms of entertainment are taxed.)

It seems that many people have been misled by the fact that during the war the B.B.C. has had a total expenditure roughly equal to twice the proceeds of the £1 licence fee. But the reasons for this are now emerging from secrecy: the number of overseas programme hours, the numerous additional high-power stations to carry these programmes, the re-organisation of the home services to meet air-raid dangers. The wartime figures are therefore no guide to future requirements.

One other point deserves mention. In the past, the B.B.C. has financed all capital expenditure out of income; if a substantial step forward in B.B.C. services is re-
required, whether for television or for U.H.F. sound broadcasting stations in sufficient number to provide real "freedom of the air," part at least of the capital expenditure might perhaps be met by a loan secured on the capital assets of the broadcasting system.

D. A. BELL.


Too Many Recordings?

SEVERAL of your correspondents have complained about the poor quality of the B.B.C. transmissions and the excessive use and poor quality of gramophone recordings.

An analysis of the Home Service programme for March 3-9 inclusive shows a total time of 121 hours and 5 minutes, of which 35 hours 5 minutes, or some 29%, was taken up by recordings, of which 14 hours 50 minutes were commercial pressings, and 20 hours 15 minutes B.B.C. recordings. It would therefore appear reasonable to say that the use of recordings is excessive.

Regarding the quality of recorded programmes, commercial pressings are far too often worn and even scratched, and in a number of instances badly presented. But the B.B.C. recordings are, in almost all cases, of really excellent quality, and I cannot help feeling that if the many armchair critics were not made aware of their origin by announcements or printed programmes, it would not occur to them that the programme was recorded.

As regards this type of recorded programme, I disagree entirely, as do very many of my friends, with your correspondents, and consider that the B.B.C. have done, and are doing, a first-class job.

R. W. LOWDEN.

Camberley.

Soldering v. Spot Welding

"DIALLIST," in your March issue, is not quite fair to soldering. We cannot agree that it necessarily produces "too many dry joints," or that "the dry joint is a menace." Also, may we remind your readers that the merits of spot welding, which he seems to advocate as an alternative, have yet to be proved?

There may have been too many dry joints at one time, due to poor solder (incorrectly alloyed or made from reclaimed metal), poor flux, or, in cored solder, lack of flux in lengths of the solder wire. Multicore Solders, Ltd., endeavoured in 1938 to overcome these troubles by producing a cored solder which (a) was made from virgin metal; (b) incorporated non-corrosive activated rosin flux; (c) provided three flux cores, so the risk of absence of flux in appreciable lengths was negligible.

The results of introducing this solder was very encouraging, but after the fall of Malaya there was some increase in the incidence of dry joints in radio equipment. This was because the 45-55 alloy solder used to conserve tin supplies had a higher melting point than the 60-40 alloy mainly used before. Many electric soldering irons had too low a bit temperature for wartime solder. We investigated the matter in collaboration with manufacturers, and as a result of our efforts dry joints again fell to a reassuringly low level.

Cored solder of 60-40 alloy is again available, and if the radio industry will use it in the correct manner with a soldering iron bit temperature of about 250°C there is no reason for any dry joints in bulk production. In fact, it should be practically impossible to make one.

RICHARD ARBIB,
Multicore Solders, Ltd.

CATALOGUES RECEIVED


Abridged illustrated list of amplifiers, loudspeakers and microphones from Trix Electrical Co., 1-5, Maple Place, Torrington Court Road, London, W.1.

Illustrated catalogue of dry electrolytic capacitors in aluminium containers from the Telegraph Condenser Co., Wales Farm Road, North Acton, W.3.


Leaflet describing the "Quixo" battery test meter made by Runbaken Electrical Products, Burtons Buildings, Oxford Road, Manchester, 1.
RANDOM RADIATIONS

By "DIALLIST"

A Sun Spot Effect

When the two enormous spots were passing across the sun's face earlier in the year some very peculiar wireless effects were noticed. One of the queerest that came my way concerned not the short waves but the long waves. On many occasions in the past I have known fading on wavelengths up to 900 metres or a little above though it has seldom been of a very severe kind over about 750-800 metres. During the sun-spot period I found Luxembourg on 1,200 metres behaving almost like a very distant short-wave station. Fading was very marked indeed, the transmission at times almost disappearing amidst the horrible distortion that so often occurs on distant short-wave stations or on stations at the lower end of the medium-wave band during high-speed fading. But fading was sometimes slow and rhythmical; at other times it was found to be a good deal more rapid. I wonder if readers noticed anything of the kind; perhaps some of them found fading on even higher wavelengths during that queer period. I only wish that the data of solar activity which one used to get before the war were now available. They should make interesting reading.

Standard Voltages

There is some chance that we shall have standard main voltages in the distant future. A good many people must have been surprised by the announcement by the Minister of Fuel and Power that it had been decided that the national standard voltage should be 240 volts. This, I suppose, applies to A.C. and there is no suggestion that any alteration is to be made in the frequency. The original aim was to standardise 230 volts, 50 cycles, A.C. throughout the country, but in a good many districts (parts of Scotland for instance) the supply is 240 volts. The figures are in effect surprising. Out of nearly ten million consumers rather more than five and a half million now have supplies at 230 volts and two million, one hundred and seventy thousand supplies at between 240 and 250 volts. The present permitted variation is ±6 per cent., which, as the Minister suggests, probably means that many, if not all, of the 230-volt consumers have at one time or another been working their apparatus, even if they knew it or not, at 240 volts or more. The idea is that a good deal of apparatus designed for 240 volts will therefore prove satisfactory at 230 volts, and as something like seven and three quarter million consumers have hitherto had supplies at 230 volts or more, the choice of 240 volts means the smallest expenditure in replacing apparatus.

Worth Noting

The Minister stated that the cost of replacing or converting existing apparatus which would not work on 240 volts would fall upon the supply authorities when the change-over was made. I am no lawyer, but I think that I am right in saying that supply authorities become liable only if they have been informed of the apparatus that is in use in a particular house and have approved it. I imagine that most of us have any amount of electrical gadgets in our homes whose use has not been reported to our suppliers. I know I have! I suppose the sound thing to do is to make a list of what one has and to send it in with a formal report. Being myself on 200 volts I must remember to do so; much of my gear would not work as it stands on 240 volts.

"All-wave" Receivers

A few of the new receiving sets are beginning to find their way on to the market, and they are appearing in a shape developed by an eager public as soon as they appear. This is not surprising, for the majority of listeners must own sets which are more than five years old, so that replacements are, to say the least, desirable. At present almost any kind of set will sell, so long as it works; but I hope that manufacturers will remember that this cannot go on for ever. To have a ready market in this country the sets will have not only to be good performers on the local stations, but also, if they are of the "all-wave" type, to be easy to use on the short waves. Short-wave listening is so fascinating that it would have caught on as a popular hobby much more markedly than it did if only sets had been made reasonably easy to tune on their short-wave range. Well do I remember some sets many years ago on the tuning dial of which the rich 19-metre band occupied a space of less than one-eighth of an inch. As there were twenty-two stations working in this band at the time when the receiver made its bow to the public you can imagine that it was not exactly a fine short-wave performance in the eyes of the average listener. If the "all-wave" set is to be a success the short-wave range must not be just stuck into it as a sales-talk trill. There is no reason why, with band-sweeping of one kind or the other, short-wave tuning should not be turned into a perfectly simple business. I am sure that the public would be quite willing to pay a bit more for an "all-wave" receiver whose short-wave range was really usable by the ordinary man or woman. I am equally sure that a short-wave range as difficult to handle as some of those of past years is not really an attraction.

The Gas Blowlamp

The little gas blowlamp which I described in these columns recently seems to have been known to only a few readers; those who did know it speak highly of its performances and of its usefulness. A brother of mine, who is not only the owner of a splendidly equipped workshop, but is also a skilled amateur mechanic, has made himself a de luxe model—a lovely thing. You may remember that the essentials of this blowlamp are as follows: a nozzle about 3/4 in diameter is supplied with gas from the mains and gas, issuing from a minute aperture an inch or so away, carries air with considerable velocity into the flame at this nozzle. The result is an intensely hot "blown" flame from six to eight inches in diameter, according to main pressure. The "super" model to which I refer is mounted on a heavy stand with a ball and socket joint. You thus have both hands free to hold the lamp and can direct the flame just where you want it. Another refinement made is to fit the nozzle with a control valve so that the amount of gas issuing from it can be regulated to a nicety. In this way a very hot flame can be obtained from about 1½-6 inches or more in length to suit the work in hand. I have shown this little tool to several people, some of whom were sceptical of its efficiency until they actually saw it in action. But that scepticism does not endure long when you show them how quickly a piece of steel can be brought to bright red heat in the flame. One of the most useful applications that I have found for the lamp is for sweating. You can do the work cleanly and quickly and there is no bother about pumping to maintain pressure.
AMATEUR TRANSMITTER'S EXAMINATION

In view of the changed status of the radio amateur it has been decided that those wishing to operate a transmitting station must either satisfy the Postmaster-General that they possess the required qualifications or alternatively sit for an examination which will be arranged by the City and Guilds of London Institute. The first examination will take place on May 8th, 1946, between the hours of 7 p.m. and 10 p.m. and it may be taken at one of several centres throughout the country, details of which can be obtained from most technical colleges; failing that, from the Superintendent of the Institute, 31, Brechin Place, London, S.W.1. Closing date for entries is March 31st, 1946. A fee of 10s. will be charged by the Institute to cover examination costs. Local centres may also make a small charge for accommodation.

In addition, the Post Office will require applicants to pass a test in Morse at 12 words per minute, which will be held at local Head Post Offices on payment of a fee of 5s.

The following abridged syllabus gives an indication of the subjects covered by the examination:

1. Electricity and Magnetism.—Elementary theory of electricity conductors and insulators (Ohm's Law; resistance and capacitance in series and in parallel.) Permanent magnets and electromagnets in radio. Self and mutual inductance, capacitance.

2. Radio Principles (elementary treatment only).—Alternating currents; series and parallel A.C. circuits incorporating inductance, capacitance and resistance. Coupled circuits, acceptor and rejector circuits. Simple theory of electromagnetic wave propagation.

3. Thermionic valves and circuits.—Principles and characteristics of modern valves, methods of use in receiver and transmitter R.F. and A.F. circuits and power supply equipment.


5. Low-power Transmitters.—Oscillator circuits, use of quartz crystals in oscillators for frequency control, frequency multiplication, R.F. power amplification, modulation and keying technique. Avoidance of interference (over-modulation, harmonic radiation and keying).

6. Aerials.—Simple types of receiving and transmitting aerials, feeder systems and simple directional arrays.

7. Measurements.—Measurement of frequency, use of crystal-controlled frequency meters, artificial aerials and their use in lining up transmitters. Measurement of anode current and voltage; computation of power input to individual stages in a transmitter.

8. Licence Conditions.—Understanding of the conditions laid down for operation and procedure.

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TRANSMISSION LINE ELEMENTS

PAIRS of conductors, having distributed inductance and capacity, are commonly used as impedances and resonators in short-wave technique. A more recent application is to radio-location, where it is necessary to transmit periodic pulses of high-powered energy, at regular intervals, and where the time constant of a transmission line element lends itself to the formation of suitable square-shaped modulating voltages.

"Delay" cable construction

An element which is geometrically short, but electrically long, and therefore well adapted for the purpose in view, is based on the combination of a conductor 1, in the diagram (a), of finite cross-section, placed midway between two infinite parallel conducting planes P.P., This is wound helically about an axis X to give the assembly shown in diagram (b), where 1, 2, 3, are successive turns of the inner conductor, and the parallel planes become two concentric tubes P.P., Further similar windings can be built up around the two shown. The different inner layers are connected in series, and the tubes P.P. are connected together and earthed, to simulate the inner and outer conductors of a coaxial line.


TUNING SYSTEMS

ONE end of an inductance coil is enclosed in a movable sleeve which is connected, directly or through a capacity, to the free end of the winding. If the distance between the inner surface of the sleeve and the coil is small, compared with the distance between consecutive windings, a part of the current will flow through the capacity between the covered windings and the sleeve. The circuit is stated to be equivalent to the inductance of the uncovered windings in series with a pair of Lecher wires formed by stretching out the covered windings, and the bending the straightened wire back on itself to form a Lecher pair, the two wires being separated by a distance equal to that between the sleeve and the coil.

If the Lecher wires are terminated by a load equal to their surge impedance, the transition resistance between the covered and uncovered parts of the coil is independent of the position of the sleeve. Also if the uncovered coil is shunted by a condenser, the resonance resistance of the loaded oscillation-circuit so formed can be made constant over a wide range of movement of the tuning sleeve. The invention is particularly adaptable to gauged tuning control, and to the balancing of push-pull couplings.

The British Thomson-Houston Co., Ltd., Convention date (U.S.A.) March 31st, 1942. No. 571498.

A Selection of the More Interesting Radio Developments

ROMATIC sulphones, mixed with known insulating materials such as those derived from vegetable and mineral oils, are found to possess unexpectedly favourable dielectric properties. When used, for instance, in the type of condenser built up from paper-spaced aluminium foil, the intergrading mixture gives a substantial increase of capacity and reduced power losses.

The preferred sulphones are produced by the addition of an SO, group to selected aromatic hydrocarbon radicals.

The British Thomson-Houston Co., Ltd., Convention date (U.S.A.) March 31st, 1942. No. 571498.

PIEZO-ELECTRIC OSCILLATORS

A SLAB of crystal, cut in the A-T manner, will oscillate so that a number of parallel nodal lines are set up along its surface. The fundamental frequency of such a crystal can be varied to a small but useful degree by employing a pair of narrow exciting electrodes. But these in turn, limit the power that can be taken from the crystal.

According to the invention, the electrodes are made in the form of a number of parallel ribs, spaced apart by the distance that separates the nodal-lines. The ribs are originally placed directly over the nodes, and the maximum change of frequency is secured by adjusting them to lie halfway between. Thus to obtain the full advantage of the frequency-shift, the crystal surface need be very little larger than the effective area of the electrode.


The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, London, W.C.2, price 1/- each.

ADJUSTABLE VALVE ELECTRODES

IN certain types of short-wave valves, such as the grounded-grid triode, the clearance between the grid and cathode may be less than one-tenth of a millimetre, and is a critical factor in performance. It is difficult to meet this requirement in mass production, and the invention provides means for making a final or interim adjustment after the valve has been sealed off.

As shown, the indirectly-heated cathode comprises two coaxial tubes, the flat top of the upper tube A being coated with emissive material. The lower tube B is welded to a metal thimble T, and can expand when heated, so as to adjust the gap between the two grids, F, F, to the correct clearance.
NEW UNIT SYSTEM OF RADIO DESIGN

Last month we announced our new series of Radio Units, which enable you to select any combination to satisfy your own desire with regard to range and power.

UNIT No. 1: A/C. Complete H.F. and L.F. stages, 3-waveband cell unit (16-50, 155-650 and 800-2,000 metres), 2-paing, ceramic insulated rubber-mounted condenser, R.F. stage with R.F. gain control, H.F. and Oscillator all A.V.O. controlled feeding into an L.F. stage of 465 kals, and fitted with L.F. gain control. Cathode-ray tuning indicator (turning eyes), dial lamp, dial and show-motion drive, pointer and knob, mounted on 15 S.W.G. aluminium chassis with output plug. The Unit is complete in itself, ready wired up, calibrated and tested. All parts brand new, standard components, Decal. Delivery Complete.

UNIT No. 2: A/C. Complete L.F. Output and Power stages, comprising 5td detector A.V.O. and 1st L.F. amplifier, feeding into output tetrode 4 separate output complete with mains transformer 360-4-350 v., 50-100 mA., L.F. choke and filter P.M. speaker with multi-ratio transformer.

UNIT No. 3: As No. 1, but with 6-waveband cell unit, 5-2,000 metres.

UNIT No. 4: A second I.F. stage 405 kca.

UNIT No. 5: Second detector A.V.O. and 1st L.F. Phoe Inverter, 3 output tetrodes in push-pull, 15 watts output.

UNIT No. 7: High Fidelity Output and Power Stages—two L.F. valves feeding two PXA valves in push-pull (trioles). Controls: Volume, Mains on/off, radio-gram, switch and Tone.

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LEAK

"POINT ONE" RANGE OF ALMOST DISTORTIONLESS AMPLIFIERS

Here are performance figures, inclusive of output transformer, for the type 15:

TOTAL DISTORTION, including hum and noise, for 15 watts output:
- 1,000 c.p.s. - 0.1% (one-tenth of one per cent)
- 60 c.p.s. - 0.2% (one-fifth of one per cent)

FREQUENCY RESPONSE: level within 0.25 db. 20-20,000 c.p.s.

LOAD DAMPING FACTOR: 20 (10 times better than for average Class A triode).

GAIN: The basic amplifier requires 0.8v RMS at grid impedance. An additional two stages can be supplied built into the chassis, thus reducing the input to 0.005v RMS.

Pull Information on leaflet 5.15

SPECIAL NOTE: The above figures establish such radically new standards that they may occasion some surprise. We therefore wish to stress that no error appears in this announcement. The circuits are original, and result from war-time research in our laboratory.

It is a fact that although VITALVOX K15/10 and K11/10 P.M. Speakers are not available in unlimited quantities, their quality is such that they are well worth waiting for.

It is a fact too that all specification figures are actual and not nominal.

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Partridge News

A 5-DAY WEEK

From March 4th, 1946, our works and offices will be working a five-day week. In future, therefore, we shall be unable to answer technical queries or arrange for the collection of goods on Saturdays.

This change is instituted in the interests of optimum production and the well-being of our staff, and consequently, we trust, in an improved standard of the ultimate benefit of our customers.

SPECIALS

We are gradually getting back to peace-time production, and are able to manufacture special transformers and chokes to your specification in about 28 days.

STANDARD TYPES

A comprehensive range of mains and audio components is now available from stock, with the highest quality with space, and we can dispatch small quantities of these by return. We urge you to employ a stock item wherever possible, as this will ease the delay in the production of specials.

May we send you our list detailing these components available from stock?

Partridge & Company

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Beautiful Cabinetwork

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NATIONAL H.R.D. receiver, in good condition. -Write Box 5249.

Radio Quality amplifier, good condition; offers -Box 5613.

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6in speaker. £5/10; -offers-Box 5409.

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Philip 15-valve with Garrard universal, condition perfect; offers over £15; -Box 6156.

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2/6.
2v -2ma,
4v -1.4a,
2/6.
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