IN THIS ISSUE: V.H.F. COMMUNICATION SYSTEM
The Problem of Insulating delicate instrument panels from vibration and shock by means of Flexilant Mountings

"FLEXILANT" Mountings: Examples from the SERIES.

The "Flexilant" Mounting of which several varieties are illustrated here is so accurately made that its displacement under load can be calculated to within .010" of requirements. The series is designed to carry loads of from 1 to 45 lbs. per mounting and these may be arranged with bolt axis at 90° to position, or the complete mounting may be inverted. The mountings can be supplied with or without holder and they can be arranged so that two utilize the same bolt.

We should appreciate the opportunity of helping with your vibration problems.

RUBBER BONDERS Ltd.
Engineers in Rubber bonded to metal

FLEXILANT WORKS · WATLING STREET · DUNSTABLE, BEDS.
TELEPHONE: DUNSTABLE 300
TELEGRAMS: FLEXILANT, DUNSTABLE

A Short Review of FLEXILANT Products is available on enquiry.
September, 1946 Wireless World

**PRECISION TESTING INSTRUMENTS**

High accuracy, simplicity, exceptional versatility and proven reliability have won for "AVO" Instruments a world-wide reputation for supremacy wherever rapid precision test work is demanded. There is an "AVO" Instrument for every essential electrical test.

The MODEL 7 50-Range Universal

**AVOMETER**

Electrical Measuring Instrument

A self-contained, precision moving-coil instrument, conforming to B.S. 1st Grade accuracy requirements. Has 50 ranges, providing for measuring A.C. & D.C. volts, A.C. & D.C. amperes, resistance, capacity, audio-frequency power output and decibels. Direct readings. No external shunts or series resistances. Provided with automatic compensation for errors arising from variations in temperature, and is protected by an automatic cut-out against damage through overload.

Sole Proprietors and Manufacturers

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD., Winder House Douglas Street, London, S.W.1. Phone: VICToria 3404/8

Now in full peace-time production, Gardners are still combining the skill of their engineers and operatives with the best of materials to give the Radio and Electronic Industry the finest range of Power Transformers. Now numbering 34, they are all different as regards their secondary outputs and tappings. No difference though in their fine Quality, Dependability, and first-class Workmanship—these remain, as always, their constant factors. There is a Gardners Power Transformer to suit the job you have in hand or the one you are planning.

Write to-day for full data and specifications. If you have a problem regarding Transformers, please consult us—our experience, developed over many years, is at your disposal.

Gardners "SOMERFORD" Power Transformers are available also through our accredited Stockist Wholesalers, a list of whom will gladly be sent on request.

Gardners' Radio Ltd., Somerford, Christchurch, Hants. Tel.: Christchurch 1025
METAL RECTIFIERS for electrical measuring instruments

The addition of a Westinghouse Metal Rectifier enables a D.C. instrument to be adapted to read alternating current quantities and, at the same time, retain all the advantages of the D.C. moving-coil movement.

Rectifiers are available for instruments requiring an input of up to 500 millivolts at currents of from 100 microamperes up to 500 milliamperes and full details are given in descriptive pamphlet No. M.R.3, a copy of which may be obtained from Dept. W.W.

Made in England by

WESTINGHOUSE

BRAKE & SIGNAL CO. LTD.,
82, YORK WAY, KING'S CROSS, LONDON, N.1.

PERTRIX BATTERIES have emerged from the testing ground of war as more reliable, more efficient than ever before. You will soon see them in the smart new post-war pack shown above. It denotes the finest battery for radio use yet made.

HOL SUN BATTERIES LIMITED
137 Victoria Street, London, S.W.1.
MICA Capacitors

THE STANDARD OF TECHNICAL EXCELLENCE, QUALITY AND RELIABILITY

Dubilier Capacitors fully justify the confidence placed in them by leading designers and production engineers.

The Moulded Mica and Metallised Mica Capacitors are small, light and dependable in arduous service and they have excellent electrical characteristics.

The 635 is the smallest Moulded Mica Capacitor manufactured, and the 680 is particularly suitable for Television or other apparatus where higher voltages pertain.

The Protected Metallised Mica Capacitors are manufactured by a specially developed process and they provide inexpensively a high degree of stability.

MAKERS OF THE WORLD'S FINEST CAPACITORS

Dubilier Condenser Co. (1925) Ltd., Ducon Works, Victoria Road, North Acton, W.3

Phone: Acorn 2241
Grams: Hivoltcon, Phone, London
Cables: Hivoltcon, London
Marconi International Code.
BULLERS LOW LOSS CERAMICS

BULLERS LTD., 6, Laurence Pountney Hill, London, E.C.4
Telegafts: “Bullers, Cannon, London”

NTR CATE PARTS

but not too intricate for Bullers

Made in Three Principal Materials

FREQUELEX
An insulating material of Low Dielectric 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.

BULLERS LTD., 6, Laurence Pountney Hill, London, E.C.4
Telegrams: “Bullers, Cannon, London”

THE P.A.10 PORTABLE AMPLIFIER

A portable 10 watts A.C. operated Amplifier, with inputs for one crystal or moving coil microphone and one pickup. Output impedance 2.5, 7.5 and 15 ohms. Ideal for Hotel paging systems, Dance Bands, etc.

BSR

BIRMINGHAM SOUND REPRODUCERS LTD.
CLAREMONT WORKS, OLD HILL, STAFFS. TEL: CRADLEY HEATH 6212-3
LONDON OFFICE: 115 GOWER STREET, W.C.1 TEL EUSTON 7515

with
SIFAM

ELECTRICAL INSTRUMENT CO., LTD.
TORQUAY

THE P.A.10 PORTABLE AMPLIFIER

No Hint of Doubt

with Sifam precision—
The ideal D.C. Radio Service Tester. Longscale 3½” Moving coil instrument mounted on a black bakelite base. The circular design allows terminals to be well spaced, positive contact being obtained without switching. Ten ranges and a resistance scale as follows:—

- 100 mV, 2, 6, 120, 350 Volts D.C.
- 1, 6, 600 mA, 6 Amperes D.C.
- 50,000 Ohms, 2,000 Ohms at mid scale reading.

PRICE:
$6 0 0 TYPE R.T.10.

21 YEARS SPECIALISED EXPERIENCE
CAPACITORS

PAPER
ELECTROLYTIC
MICA
SILVERED MICA
CERAMIC

The Telegraph Condenser Co., Ltd.
NORTH ACTON • LONDON • W. 3
Telephone, ACORN 0061
HY-MEG
for modern impregnation

GIVES STABILITY
IN INSULATION

A copy of the recently printed Brochure "Stability in Insulation" will gladly be sent to those applying on Business Heading or Card and enclosing 2d. to comply with the Control of Paper (No. 48) Order, 1942.

LEWIS BERGER & SONS LTD. (Established 1760) 35 BERKELEY SQUARE, LONDON, W.1
Telephone: MAYfair 9171

CELESTION

LOUDSPEAKERS

Chassis Diameters range from 2½" to 18"
Power Handling Capacities range from .25 Watt to 40 Watt.

Celestion Limited
Kingston-upon-Thames
Telephone: KINGston 5656-7-8

Masteradio
VIBRATORPACKS
PROMPT DELIVERY NOW ASSURED
MASTERADIO LTD • VIBRANT WORKS • WATFORD • HERTS
METALLISED CERAMICS

for

Hermetic Seals and Soldered Assemblies

FREQUENTITE BUSHES

Photographs (above) actual size.
Drawings not to scale.

R. 50636
Code No. GCTBA01
Code nos. are those used in I.S.C.Tech.C.
Specification No. R.C.L./330.11.

PORCELAIN BUSHES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R. 50734</td>
<td>GCTBC01</td>
<td>20.3</td>
<td>7.6</td>
<td>3.8</td>
<td>6.4</td>
<td>4.6</td>
<td>5.5</td>
<td>3.0</td>
</tr>
<tr>
<td>R. 50768</td>
<td>GCTBC02</td>
<td>20.3</td>
<td>12.7</td>
<td>3.8</td>
<td>6.4</td>
<td>4.6</td>
<td>5.5</td>
<td>5.1</td>
</tr>
<tr>
<td>R. 50769</td>
<td>GCTBC03</td>
<td>20.3</td>
<td>15.2</td>
<td>3.8</td>
<td>6.4</td>
<td>4.6</td>
<td>5.5</td>
<td>6.4</td>
</tr>
<tr>
<td>R. 50770</td>
<td>GCTBC04</td>
<td>38.1</td>
<td>10.2</td>
<td>5.1</td>
<td>15.7</td>
<td>6.4</td>
<td>10.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Q. 2092</td>
<td>GCTBC05</td>
<td>55.9</td>
<td>12.7</td>
<td>6.4</td>
<td>25.4</td>
<td>8.9</td>
<td>15.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Q. 1982</td>
<td>GCTBC06</td>
<td>78.7</td>
<td>15.2</td>
<td>6.4</td>
<td>38.1</td>
<td>8.9</td>
<td>25.3</td>
<td>5.1</td>
</tr>
</tbody>
</table>

For full information and prices please write to:

STEATITE & PORCELAIN PRODUCTS LTD.
STOURPORT-ON-SEVERN, WORCS. T'phone: Stourport III. T'grams: Steatain, Stourport.
"Best suited" means an insulating sleeving that meets every Service or general requirement. The DELAFLEX range includes non-fraying Woven Fibre Glass and Tropical Grade ROLLED SILK in a complete range of colours and in sizes from 0.5 mm. to 35 mm. Thus, a recommendation from De La Rue Insulation Limited is unbiased ... you get the sleeving best suited to your needs, not only from the standpoint of efficiency, but of economy as well. Fullest details, samples and prices gladly sent on request.

Delaflex
Insulating Sleeving

DE LA RUE INSULATION LTD
84 REGENT STREET • LONDON • W.1
TELEPHONE : REGENT 2901

ROLLED SILK
METAL SCREENED
VARNISHED COTTON
WOVEN FIBRE GLASS
VARNISHED ART SILK

British N.S.F. Co. Ltd.
9 Stratford Place

MAYFAIR
4234

N.S.F.—OAK SWITCHES
N.S.F. Paper Capacitors, Silvered Mica Capacitors,
Wire-wound Resistors and Volume Controls.
Details on request.

Sinclair
Speakers
London-Glster

Manufacturers of
LOUDSPEAKERS
•
LAMINATIONS
•
SCREENS in
RADIOMETAL
•
PERMALLOY
•
SILICONALLOYS

ELECTRICAL SOUND & TELEVISION PATENTS LTD.
12, Pembroke Street, London, N.1. Terminus 4355
2/4, Manor Way, Boreham Wood, Herts. Elistree 2133

FROM AUG. 1
OUR LONDON
ADDRESS IS
POINTERS FOR DESIGNERS

THE KTW61

A screened tetrode with suppressor plates and with variable-mu characteristics, the OSRAM KTW61 is specially suitable for use as an R.F. or I.F. amplifier in superhet receivers. Its outstanding features include:

- High order of mutual conductance (2.9 mA/Volt) combined with low leakage capacitance (0.0025 μF), which facilitates high stage gain.
- Negligible distortion with the maximum signal likely to be encountered in practice. Conditions of use — as an I.F. amplifier with screen dropping resistance, and in conjunction with OSRAM frequency changer X61M.
- Marked improvement in signal to noise ratio, particularly on the short waves, when used as an R.F. amplifier with fixed screen voltage.

A detailed technical data sheet is available on request.
Over prickly pear
or paddy field or
pasture—across all the
trackless wastes of
the world, you know
where you are with

MARCONI

MARCONI’S WIRELESS TELEGRAPH CO. LTD.
- THE MARCONI INTERNATIONAL MARINE
COMMUNICATION CO. LTD. MARCONI HOUSE,
CHELMSFORD, ESSEX.

Wireless World
September, 1946

Here are a few Specialities

- MINIATURE WIRE
  WOUND RESISTORS

- INSTRUMENT STUD
  SWITCHES

- VARIABLE
  ATTENUATORS

M.R. SUPPLIES Ltd.
offer the following brand new and reliable Radio and Electrical Material. Prompt
despatch. All prices net.

SIGNAL GENERATORS. We confidently recommend the new R.P.L instrument
and have already supplied many of the large firms laboratories. Operation 300/350 v.
A.C. Frequencies—100/250, 250/400, 500/1,000 Kc/s. 1.8/2.3, 4.5/12. 12/30 Mc/s.
Accuracy 1 per cent. 3 volts in 10 ohms. All ranges modulated to depth of 30 per
cent, by internal 400 c. oscillator (off switch provided). Illuminated scale.
400 c. brought out separately. Double screening. £21 11s. net. Ex stock.

MEGOhMETERS. The "We-Megger" by Eveready again in stock. Pressure 500 volts.
Range 0/20 megohms and inf. Supplied with pocket and log books. £1 10s.

ORTHOMETERS PECRYSTAL PICK-UPS, new low price—Baritone, in black.
Lakeline, £7 6s. Also 88, 170 with channel steel arm, 64/. KORTHOMETER Suppressed
Gramophone Needle, permanent, fine reproduction, 12/6. STROBOSCOPES (cord-
less) showing 74, 78 and 80 r.p.m. on 60 c. viewing, £1.

METhAL RECTIFIERS by STC (B.C.C.C.). All for charging up to 12 volts at 1.0 amp.,
1.5/2; 3 amps, 22/6; 6 amps, 39/6; 10 amp., 50/6. These are all full-wave
bridge connected. Reliable TRANSFORMERS, all with tapped primary, 200/250 v.
Sec.—10, 11 and 12 v. at 2 amperes, 20/. Sec.—8 and 14 v. at 2 amperes, 33/6.
Sec.—12 and 17 v. at 6 amperes, 40/6. These can be sold separately.

MILLIAMMETERS by Taylor. High-grade moving coil, 5ths. Flashed nickel. Deflection
0-300 milliamperes (can be demounted for lower reading), 2/6.

VARIABLE RESISTANCES. General wire-wound meters (or rheostats), 10 ohms,
1 amp., with knob, 5/6. MILDING RESISTANCES, fully enclosed, 100 watt range.—
4 ohms 5 amperes, 10 ohms 3 amperes, 50 ohms 1.4 amperes, 100 ohms 1 amp., 200 ohms
60 cent., or 400 ohms 60 cent., any one, 2/7/6. Also 6 ohms 10 amperes (100 watts)
50/6 (deep, 4/6).

INSTRUMENT KNOBS. 3½ in. with 2½ in. skirt, brass bushed with ½ in. bore, with 2 set
screws, 1/3 each, 11/9 dozen.

POWDER KNOBS, brass-bushed, 1½ in., 8d. each, 6/6 dozen.

LOUDSPEAKERS. We only offer the superior types. Vitavox High-fidelity P.M.
models, with high-fused iron magnets, 15mm. glass-encased, 15 ohms coils, the
K12/10 (10 watt), £7, K12/20 (20 watt), £11 (deep, either 3½/6). The new Gramophone
7 watt, 6½ in. P.M. Speaker with either 5 or 10 ohm coil, £2½ (deep, 1½). The ideal
unit for horn-loading. PROJECTOR SPEAKERS, large range in stocks for im-
mediate delivery—Vitavox 10 watt P.M. Unit (18 ohms) with 42mm. all-metal round
Horn, £1 10s. (deep, 7½). With 30ohm all-metal square Horn, £1 17s. 6d.
Units only—Vitavox 10 watt, £6. G.E.C. 12 watt (with line neutral),
£7 10s. Radio and Gramophone 10 watt, £7 5s.

HAND MICROPHONES, ex-Goat, new. Superior carbon type with press-switch,
filter, lead and plug, 8/6.

FOR CALLERS ONLY
Large range of G.E.C., Gramaphone and Vortexion R.C.W. AMPLIFIERS, A.C.
and Mobile (12 v.), with or without radio stage. 10 amperes to 60 watts. Prices £1 12½ to £7 10s. WAVE
METERS, ex-Goat. Class D Mk II, new, great bargain, £6 17s. 6d. Useful
range of ROTARY TRANSFORMERS.

Please include sufficient for despatch where not stated

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

Telephone: Museum 2938
WEBB'S
are pleased to introduce the EDDYSTONE "504" COMMUNICATION RECEIVER

The new British made "504" Receiver embodying refinements and technique resulting from close contact with war-time research.

Unique unit construction gives great mechanical rigidity. Precision type tuning mechanism, free from back-lash, effective scale length of tuning dial is 36 inches per band. For A.C. operation, 40 to 60 cycles, 110 and 200/240 volts.

We are registering orders for delivery August and September. Supplies will be in strict rotation and early booking is desirable.

Write for details of our registration arrangements, also brochure giving full technical data on the "504."

Some salient features:
- Nine valves.
- Five switched bands.
- Two R.F. and two I.F. stages.
- Continuous coverage 30,000 to 600 Kc/s.
- Crystal Filter.
- Noise Limiter.
- Sensitivity better than 2 microvolts.
- B.F.O. "S" meter.

Specimen Receivers are on show at 14, Soho Street, London, W.1, and our Midlands Depot at 41, Carrs Lane, Birmingham, 4.

PRICE: £48:10s. (PLUS PURCHASE TAX, £10:8:6)

DURALUMIN TUBE
For receiving and transmitting aerials.
In 8' 6" lengths covering five and ten metre radiators and reflectors. Outside diameter 8". Per 8' 6" length...... 4s. 6d.

NOTE : CALLERS ONLY FOR THIS TUBE !

STAND OFF INSULATORS
For mounting aerial elements, etc.
Eddystone "Beehive" type 916, height 2½" 1s. 6d.
Webb's "Heavy Duty," height 6" with clip for 8" tube, very strong, long insulation path. 6s. 6d.

AERIAL INSULATORS
Pyrex "Strain" type, 3½" long ................. 9d.
Pyrex Heavy Duty, 6" long ...................... 6s. 3d.
Pyrex "Shackle" or Egg Insulators for aerial or guy wires ...................... 1s. 3d.

AERIAL RELAYS
Stocks now available of new double-pole Aerial Changeover Relay. Approximate size 3"×2½" x 1½" high, low-loss construction. Contacts take 4 amps R.F. Coil operation 4 to 6 volts A.C. ......................... £2.17s. 6d.

CO-AXIAL CABLE
0.54" diameter Polystyrene insulation, copper braided with green P.V.C. outer covering. Impedance 80 ohms. Per yard .................. 1s. 6d.
(Minimum length supplied is 18 yards.)

EDDYSTONE
New Illustrated Eddystone Component Catalogue now available, Post Free for 2½d. stamp.

Write, phone or call—
Our shop hours are 9 a.m. to 5 p.m. (Saturdays, 9 a.m. to 1 p.m.)

WEBBS RADIO
14 SOHO ST., LONDON, W.1. Phone: Gerrard 2089
PORTABLE ELECTRIC FANS

S.E.M. design and manufacture electric fans up to 5 h.p. capacity and have had special experience in fans for searchlight and valve cooling and for ship ventilation.

Typical of the range is the compact and portable fan unit designed for ship ventilation. This "centrifugal" unit, with a fan mounted on the same shaft as the motor, is capable of displacing 500 cu. ft. of air per minute at 6 inches water gauge pressure.

In common with all S.E.M. machines, this fan is manufactured to the highest standards of mechanical detail and passes rigid inspection tests.

SMALL ELECTRIC MOTORS LTD. have specialized for over 30 years in making electrical machinery and switchgear up to 10 kW capacity. They are experienced in the design and manufacture of ventilating fans and blowers, motors, generators, aircraft and motor generators, high-frequency alternators, switchgear, starters and regulators.

A subsidiary of Broadcast Relay Service Ltd.

BECKENHAM • KENT

WEGO CAPACITORS

★ CALCULATED TO ANSWER THE MOST EXACTING DEMANDS
★ FOR ALL RADIO AND ELECTRONIC PURPOSES

WEGO CONDENSER COMPANY LIMITED
EIDFORD AVE • PERIVALE • GREENFORD • MIDDX • Tel. PERIVALE 4277
U.I.C

Silved Mica & Ceramic
CAPACITORS

A wide range of types for all purposes

UNITED INSULATOR CO. LTD., OAKCROFT ROAD, TOLWORTH, SURBITON, SURREY

Telephone: Elmbridge 5241 (6 lines)  
Telegrams: Calanel, Surbiton

Unsurpassed In Ceramics
Advertisements

**GOODMANS**

The illustration shows the comparative sizes of a Goodmans 15 in. and 12 in. Loudspeaker. You already know the performance of the famous 12 in. Now consider the technical data of the new 15 in. model.

**Overall Diam.** 15 in. —
**Overall Depth** 8 in.
**Fundamental Resonance** — 55 c.p.s.
**Voice Coil Diam.** — 2 in.
**Voice Coil Imped.** — 4 ohms at 400 c.p.s.
**Flux Density** — 14,500 gauss.
**Max. Power Capacity** — 25 W. peak A.C.
**Net Weight** — 26 lb. 8 oz.

With an excellent response up to 6,000 c.p.s., and an unusually high power handling capacity, this instrument sets a new standard in Loudspeakers for the Dance Hall, Rink, Cinema and Heavy Duty P.A. installations.

**PRICE** £18.10s. (subject)

**The Connoisseur**

NOW IN PRODUCTION

★ Artistically designed — scientifically developed.
★ Light in weight — small in size.
★ Constant Velocity type, response from 30 c.p.s. to 12,000 c.p.s. without objectionable resonances.
★ Weight of pick-up on to record 30 grams, armature and needle weight .090 grams.
★ When used on high fidelity reproducing equipment the realism is amazing.

MADE BY
A. R. SUGDEN & CO. (ENGINEERS) LTD.
BRIGHOUSE YORKSHIRE

**R.F. ELECTRONIC VOLTmeter**

By RADIO-AID LIMITED
29 MARKET ST., WATFORD, HERTS.

**TYPE B**. Full scale deflection 1 volt R.M.S., four ranges to 250 volts.
Standard Probe impedance 6 Mc/s in parallel with 3 pf thermal drift compensated.

**THE GOODMANS T10/1501/3-5**

Loudspeaker

GOODMANS INDUSTRIES LTD., LANCELOT RD., WEMBLEY, MIDDX.
Telephone: Wembley 4001 (8 lines).

**Price** £42-12-0

Sole London Agents
WEBB'S RADIO, 14, SOHO STREET, W.1.
Our products for the Radio Industry range from the tallest steel radio towers to 0.001 μF capacitors. If you’re not interested in monsters or midgets we make a lot of other things besides, including every type of cable and wire used in radio work. You get the benefit of 60 odd years’ research and manufacturing experience when you specify B.I. Callender’s.

BRITISH INSULATED CALLENDER’S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON W.C.2
The Redifon G.12 T transmitter covers the very wide frequency range of from 102 to 1,200 kcs, divided into four overlapping bands with continuous tuning throughout.

This transmitter is suitable for long-range aircraft beacons and communications, for shipping control and services, and general telegraphic transmissions over distances extending to upwards of 1,000 miles. The power is 2,000 watts on C.W. or 450 watts telephony or M.C.W.

Many of these transmitters have been used on arduous service involving continuous operation at full load, with only one 3-hour break for maintenance each three months. This is typical of their overall reliability.

The extremely compact design of the Redifon G.12 T makes it suitable for mobile use, particularly in areas undergoing reconstruction. The three bays take up a floor space of only 8 feet 8 inches by 2 feet 4 inches and the overall height is 5 feet 5 inches.

This transmitter is available for almost immediate delivery. Further particulars can be supplied on request.

**REDIFFUSION LTD.**
Designers and Manufacturers of Radio Communication and Industrial Electronic Equipment.
Subsidiary of Broadcast Relay Service Limited,
CARLTON HOUSE, REGENT STREET, S.W.1
To meet the demand for various parts of the well-known R.A.F. PORTABLE DINGHY RADIO TRANSMITTER, which cost approximately £39 to manufacture, we are this month offering the Transmitter in the following sections and components:

**CRYSTAL**
500 Kc/s. Accuracy .025%. Mounted in bakelite holder with two pin (6" spaced) fitting
PRICE 10/6

**WOODEN BOXES**
Cost 30/- to manufacture. Ideal for Tool Box or for storage of spare parts. Made of ½" plywood with hinged lid. Divided into two sections 12" and 4" wide. Internal dimensions 16½" x 12½" x 9½" deep.
PRICE 5/6

**TOP PANEL**
Comprising: Valves 6L7 and 6V6—Crystal, 500 kc/s, accuracy .025%—Variable Condenser with Neon Radiation Indicator—Litz Wound Coils (Iron Dust Core)—Transformer—H.F. Choke—Various Condensers and Resistors, etc.
PRICE 22/6

**POWER PACK**
Comprising: Hand Generator with handle (300 volts 60mA H.T. and 6 volts 2 amp. L.T.)—Voltage Regulator—Smoothing Unit—Relays—Electrolytic Condenser, etc. PRICE 22/6

Don't play blind man's buff
Quick identification of cables and components saves labour, time and error. Lasso Identification Tapes provide neat, legible markers that are quickly applied at any point. They also make neat, permanent name tabs for marking furniture, containers, plastics and tools. Lasso Tapes are supplied in 10 yard rolls, printed with your own inscriptions at intervals spaced to suit diameters and other measurements. Inscriptions cannot be erased. Lasso Tapes are self-adhesive, resistant to water, oil, petrol and solvents, and are tested for tensile strength, durability and electrical resistance. An interesting booklet is free on request.

LASSOVIC - LASSOTHENE - LASSOBAND - LASSOFIBRE
LASSOTHYL - LASSOPHANE - LASSOLASTIC

Herts Pharmaceuticals Ltd., Welwyn Garden City, Herts Tel.: Welwyn Garden 3333 (6 lines)
READY...AYE READY!

What a fine fumbling job it is, messing around with dozens of tiny nuts and washers and bolts, picking up the nut, holding the bolt with one hand while the other fiddles round the back to get the nut on the thread. And drops it! You know! Spire solves the problem. Spire U nuts slip into position over the bolt holes—no washers needed with a Spire fixing, of course. So both hands are free to put in the screws and once they're in, they're in for good. Sounds easy and it is easy!

THAT'S Fixed THAT!
Here's a little chap in action Reference No. NU 531. Its uses are legion. Wherever there is blind assembly work, wherever your operatives are fumbling with nuts and washers the NU 531 will save time and cost and a lot of bad temper. Clip it into position and it stays "put" until you are ready to drive home the screw. No washer needed of course.

* A BETTER Way of Fixing
Simmonds Aerocessories Limited • Great West Road • London • A Company of the Simmonds Group
... but Stratosil Sealed VIBRATORS OPERATE EFFICIENTLY UNDER ALL CLIMATIC CONDITIONS

Come rain, come shine, or any other climatic condition, Wearite 'Stratosil Sealed' Vibrators will continue to operate without trouble. Why? Oh! We designed and built them with just that end in view, and after tests, specified the following as essentials...

- All steel construction — even the rivets — uniform expansion under temperature extremes ensured. • Vibrator acoustically and electrically shielded by Metal Can, sponge rubber lined. • Precious metal driving contacts — non-tarnishable — ensure starting under the lightest pressures and voltages. • Contacts ground almost to optical limits. • Stack assembly — mica and steel only used. • Base sealed by the WEARITE Stratosil process. • Always keep going...

STRATOSIL Sealed VIBRATORS
SEND TODAY FOR FURTHER DETAILS, AND REMEMBER, WE ALSO MAKE SOME OF THE BEST TRANSFORMERS, COILS AND SWITCHES.

WRIGHT and WEAIRE LIMITED
HIGH ROAD • TOTTENHAM • LONDON • N.17 • TELEPHONE: TOTTENHAM 3847-9
This mathematical symbol means 'not less than'

This well-known emblem means 'not less than the best'

PHILIPS
LAMPS · RADIO · X-RAY · COMMUNICATIONS EQUIPMENT AND ALLIED ELECTRICAL PRODUCTS

PHILIPS LAMPS LIMITED · CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON · W.C.2
Illicit Transmission

It had to come. Although we do not know, at the time of closing for press, how complete the ban on the sale of ex-Government transmitters will be, it is clear that gear with enormous potentials for doing harm should not be sold indiscriminately to all comers, as it has been during the past few months. True, complete suppression of sale to the public will not put an end to the clandestine transmitter, but it will at least remove an almost irresistible temptation from the path of the irresponsible kind of person who is likely to cause the maximum of interference to legitimate services.

The position at present seems to be that, by agreement between the Government departments concerned, the sale of transmitters, at any rate of certain classes, is to be discontinued, except under conditions which reduce the risk of the sets falling into undesirable hands. No doubt methods will ultimately be devised whereby those qualified to make legitimate use of the sets will be able to obtain them. In the meantime, it seems likely that a certain amount of hardship will be suffered. It is a pity that the inevitable results of indiscriminate sale were not foreseen, and proper steps taken from the first to dispose of the sets to those who could make good use of them, or at least of their components. In particular, we can see no reason why the offer of the Radio Society of Great Britain to purchase sets on behalf of its members, made some considerable time ago, should have been flatly declined.

Guarantees

Mutual goodwill between producer and consumer is surely something to be striven for. If that can be accepted as axiomatic, it is to be regretted that, in framing the new standardized form of broadcast receiver guarantee, the British Radio Equipment Manufacturers’ Association has lost an opportunity to remove a common cause of friction between seller and customer. We refer to the clause which states that the labour costs incurred in replacing a faulty component may, at the manufacturer’s discretion, be charged to the customer.

Not unnaturally, the owner of a receiver feels aggrieved if he is charged an appreciable sum for the replacement of a component that is admittedly defective through faulty workmanship or materials. His ruffled feelings are not soothed by the fact that the replacement component itself has been given to him without cost. He argues, with some force, that the replacement was made necessary by an admitted error of judgment or negligence on the part of the manufacturer; why should he have to pay?

We have little doubt that the offending clause will in most cases be interpreted liberally, but that is hardly enough. The question of maintenance service is likely to assume particular importance during the early period of television development. The revised form of guarantee applies to television sets, and it is highly desirable that the growth of the new art should not be hampered by unsavoury squabblings over repair charges. The whole matter should be put upon a firm and equitable basis.

F.M. versus A.M.

The issue between F.M. and A.M. is one that cannot be determined in the laboratory, but only by widespread field test. Consequently, the results of the B.B.C. frequency modulation trials, described by H. L. Kirke (head of the research department) in the current B.B.C. Quarterly will be read with particular interest. The general conclusion is very much in favour of F.M. as a means of distributing high-quality noise-free broadcasting.
ARMY No. 10 SET
Some Details of the U.H.F. Equipment

SIGNALLING Equipment No. 10 which forms part of the Army Wireless Set No. 10, was described under the title "Pulse Width Modulation" in the June issue of Wireless World.

It was explained how eight audio-frequency channels were made to modulate in width a series of rectangular pulses in the pulser or sending section of the equipment and how the separator recovered the audio channels from the received width-modulated pulses.

The width-modulated pulses produced by the pulser are used to modulate a magnetron U.H.F. sender working at a frequency of about 4,500 Mc/s. The receiver is of the superheterodyne type and the pulses in its output are passed to the separator section of the Signalling Equipment No. 10.

It is the purpose of the present article to conclude the account of the 10 set with a description of the U.H.F. sender, receiver and aerial system.

It is usual in U.H.F. equipment to conduct the energy from one unit to another by means of waveguides and coaxial cables. The principles of waveguide engineering and their uses in connection with coaxial cables have been dealt with in the issues of Wireless World for September and October, 1944. Resonant cavities are used in U.H.F. equipment for tuning purposes in much the same way as the more familiar tuned circuits are employed at lower frequencies.

These cavities are described below in relation to this particular equipment, but it is as well to give some general remarks at this point. The same principles apply to them as to waveguides and it is assumed that reference has been made to the earlier Wireless World articles. A resonant cavity is merely a waveguide of a certain length, usually a multiple or submultiple of a wavelength, closed at each end. Where such a cavity is, say, one wavelength long and energy of the appropriate frequency is fed into it, this energy will build up until quite large amplitudes are obtained. It will then be seen that if a cavity is equipped with a movable piston at one end it fulfils much the same purpose as the more familiar tuned circuit consisting of coils...
and capacitors at lower frequencies. Arrangements for feeding in

pending on the power dissipated in the material of which the
cavity is made and the load to which it is coupled.

The waveguides used in this equipment are of circular cross-section
and propagate H₁ waves. Longitudinal loops of magnetic lines of
force are formed in this case also and the transfer of energy along
the waveguide may be considered as due to the loops of magnetic
lines of force moving down the waveguide.

A frequency of about 4,500 Mc/s is generated by a split-anode
magnetron valve. The use of the magnetron valve in this connec-
tion has been described elsewhere, but it is of interest to note the con-
struction of the electrodes which is shown in the inset of Fig. 1. The
anode segments are arranged in cylindrical forma-
tion, the cathode lying along the axis. The mag-
netic field required to give the neces-
sary spiral motion to the electrons
is supplied by two cylindrical bar
magnets and the magnetron

mounting allows the valve to be
rotated to a certain extent to
bring the axis of the cylindrical
anode parallel with the field. One
of the magnets has a micrometer
adjustment which enables the
strength of the magnetic field to
be varied, to suit the particular
type of valve employed.

Energy is extracted from the
magnetron by arranging that it
lies in a rectangular cavity. This
cavity is tuned to resonance at the
frequency of the oscillator by an
adjustable piston. The central
conductor of a coaxial line crosses
the cavity at a distance approxi-
mately one-quarter wavelength
from the end and this picks up
energy which is conveyed by the
coaxial line to the aerial system.
The impedance of the coaxial line
is matched by an adjustable pis-

The aerial system is mounted on the roof of
the trailer

Fig. 3. Construction of oscillator and mixer used in the receiver is shown here. The
oscillator is a triode and the third harmonic of its output is fed to the crystal mixer.

Fig. 2. Circuit diagram of the
sender including the modulator
valve which is fed with the
pulses produced in the pulser
unit.

Interior view of the
receiver. The tuner is
just visible close to the panel

those used for the waveguides
treated in the earlier articles.
The tuning cavities are of rectangular
cross-section and are designed for
electromagnetic waves of H₁
mode. It will be remembered that
for H₁ waves longitudinal loops of magnetic lines of
force are formed and electric lines of
force stretch from one side of the enclosure to
the other. In a resonant cavity, the loops build up
to form standing waves, the ampli-
tude reached de-
Army No. 10 Set—

A piston in a cavity into which the centre conductor extends on the side of the resonator opposite the point where the coaxial line enters.

The manner in which the magnetron is modulated may be understood from the circuit of the sender shown in Fig. 2. \( V_2 \) represents the oscillator and \( V_1 \) the modulator. With no input from the Signalling Equipment No. 10, \( V_1 \) is so biased that it draws current. The magnetron H.T. supply is taken from a voltage-dropping resistance \( R_1 \) common to both valves and when \( V_1 \) is taking current, the anode potential of \( V_2 \) is too low for that valve to oscillate. The arrival of a negative pulse from the Signalling Equipment No. 10 at the grid of \( V_1 \), however, stops that valve from drawing anode current and the consequent rise in the anode voltage of \( V_2 \), about 300V, is sufficient to start the magnetron oscillating.

The output of the Signalling Equipment No. 10 consists of a series of negative-going pulses and thus the output from the sender consists of corresponding pulses of U.H.F. energy.

At the receiver (Fig. 3), the input from the aerial is fed into a mixer cavity or resonator, from a coaxial cable, the centre conductor projects into the cavity about \( \frac{1}{4} \) wavelength from one end. Energy from a local oscillator is similarly fed into the cavity at the other end. A crystal detector mounted across the cavity, i.e., parallel to the direction of the electric field, rectifies the oscillator and signal frequencies, thus producing a difference frequency (i.e., signal frequency minus oscillator frequency) of about 45 Mc/s which is amplified by an I.F. amplifier. It will be seen that there is nothing fundamentally different between this circuit and that of an ordinary superheterodyne receiver. The signal frequency is tuned by a resonating cavity instead of the more familiar coil and capacitor. It is also interesting to notice that the principle of heterodyning applies also at these frequencies although the arrangements required to carry it out are somewhat different.

The local oscillator uses a miniature-type triode valve oscillating at about 1,485 Mc/s. The third harmonic of this frequency is used to mix with the signal frequency. The arrangement of the oscillator itself is very similar to that of the familiar triode oscillator tuned by a Lecher-wire system, the difference in this case being that the wires are replaced by concentric cylinders. Such an arrangement constitutes a system of concentric lines which are tuned by movable pistons, the pistons being the analogue of the movable bridges used with Lecher-wire tuning. For this reason they are referred to as bridges in Fig. 3. The necessary feedback between the anode-grid lines...
and the grid-cathode lines to cause the circuit to oscillate is provided by internal capacitance in the valve. The coupling between the mixer cavity and the cavity between the anode and grid lines is by means of a concentric feeder, capacitance diode \( V_8 \) acts as detector and is followed by an amplifier \( V_{10} \) and a cathode-follower stage \( V_{19} \), the latter giving a low impedance output required to match the input of the Signalling Equipment No. 10. This outputable waveguide connects the mirror to a waveguide matching section just below the trailer roof and a coaxial cable connects the matching section to the sender or receiver. The waveguide enters the centre of the mirror at the rear

![Diagram](image)

**Fig. 5.** This sketch shows the arrangement of the aerial system. A paraboloid is energized by a waveguide having a reflector plate opposite to its open end.

The centre conductor extending into the mixer and oscillator cavity consists of a series of positive-going pulses. Automatic gain control is provided by the diode \( V_{11} \), which rectifies part of the output of the I.F. amplifier, followed by the D.C. amplifiers \( V_{12} \) and \( V_{13} \). The control is applied direct to the screens of the first three I.F. valves from the anode of \( V_{13} \).

The aerial system which is illustrated diagrammatically in Fig. 5, comprises two parabolic mirrors, one for the receiver and one for the sender. These aerials are mounted on the roof of a trailer, the remainder of the equipment being inside. The connection between each aerial and its sender or receiver is in two stages. A flexi-

---

**OUR COVER**

*This month's cover illustration shows the parabolic reflectors for the Army's No. 10 set, mounted on the roof of the trailer. The half-wave dipoles, located off the centre of the paraboloid, are for monitoring purposes.*

---

**WIRELESS TELEGRAPHISTS' HANDBOOK**

The eighth edition of the "Handbook of Technical Instruction for Wireless Telegraphists," by H. M. Dowsett and L. E. Q. Walker, which first appeared in 1913, was recently published from the offices of Wireless World. In addition to providing a complete theoretical course for the P.M.G. certificate for sea-going wireless operators, the Handbook, which costs £0, gives practical details on the installation and maintenance of marine radio equipment. It contains 606 pp. and includes 618 illustrations and diagrams.
RADAR IN NATURE

Pulse Technique at Supersonic Frequencies

By THOMAS RODDAM

THE original plan of this article was that it should give a general description of an acoustic system analogous to radar, for the benefit of any Wireless World readers who might care to construct a model radar system. Only in such a way can the home constructor work in the radar field, for the power required for radar working is quite prohibitive even if many other practical difficulties did not exist. Unfortunately, the writer has had no opportunity of making such an acoustic model and was still nervous lest he should be asked for more details, when a most interesting paper appeared on the acoustic equipment of bats which suggested a broader treatment.

Immediately, it must be explained that there is no suggestion that readers should become bat-fanciers: such a suggestion would probably cause a deputation of readers' wives, led by Mrs. Free Grid, to storm my attic in Pimlico. Equally, however, there is no suggestion that the younger readers should not take twilight walks along secluded lanes to study the habits of bats.

The interesting thing about bats to the radio engineer is their habit of flying about at full speed in dim lights. In fact, they can fly perfectly safely in total darkness. This apparent recklessness, however, does not lead them into constant collisions with the many obstructions which might harm them: even telegraph wires do not seem to constitute a hazard. To explain this behaviour it was suggested in 1920 by Professor Hartridge that bats were fitted with what would now be called a sonar system. Quite recently it has been shown that this is in fact the case, and that bats are equipped with a very efficient system for blind flying. This equipment is sometimes unserviceable, and a particular form of unserviceability occurs when the bat has a cold in the head, a disorder common in all animals kept in captivity, such as members of the Government Scientific Service. If a bat is deafened by plugging its ears it also loses the use of its blind flying system.

In flight a bat may, according to Hartridge (loc. cit.), produce any of four different kinds of sound:

1. A buzz of about 12,000 c/s;
2. A tone of about 7,000 c/s and lasting for about a quarter of a second. This is probably used as a communication channel to enable messages to be sent to other bats.
3. A supersonic tone usually about 40-50 c/s, but sometimes as low as 30 c/s or as high as 70 c/s. Pulses of this tone, each lasting about 1,000 second, are produced and normally twenty or thirty pulses per second are emitted. At rest the rate falls to 5-10 pulses per second, while when there is an obstacle immediately ahead the rate rises to sixty pulses per second.
4. A click, which is probably a single pulse of the supersonic tone.

The mechanism which produces these various sounds is outside the scope of this article: it is discussed in the paper referred to above. A further discussion of the click appears in a later paper and a letter. Details of the various theories will not be given here, as the evidence does not seem to be sufficient to enable any really final conclusions to be drawn. There is also some conflict of opinion about just how the sound is radiated. Hartridge considers that it is emitted from the nose of the bat, while Griffin is convinced that the mouth is used. It would perhaps be unkind to suggest that there is some difference between Harvard bats and London bats in this matter. Many bats have snouts so shaped that fairly good beaming of the supersonic tone would be obtained, thus giving a useful power gain in the direction of dangerous obstacles. In addition, as the bat uses its ears for reception and direction finding, beaming of the signal reduces the level of the direct sound and thus prevents the echo being masked by a strong transmitted pulse. There is almost certainly some additional protection provided which desensitizes the hearing while the pulse is being emitted. The receiving system is also directive: a large flap extends from the side of the bat's head behind each ear, providing considerably increased sensitivity in a forward direction.

It is interesting to note that the sonar system used by bats is just

---

Oscillogram of supersonic cry of a bat taken by Dr. D. R. Griffin of Harvard University. The horizontal sweep motion is from left to right.

---

1 Nature Vol. 126, p. 490 (1945). (This paper has a list of 14 references which can probably be consulted.)
good enough for the job. In a description of the flight of bats towards a large lighted window, it is stated that on nearing the window the bats went into steep turns, stalled turns or half-rolls. An interesting avoiding technique adopted consisted of folding the starboard wing, which gave an unbalanced and reduced lift, swinging the bat on to its back and allowing the nose to drop. The wing was then opened again and the bat dropped in a vertical dive with its belly towards the window and pulled out about four feet lower down. This manœuvre was carried out within a foot of the window, avoiding action having begun about two feet from the obstruction. Assuming a speed of 25 feet/second and a reaction time of 1/10th second, the decision to turn must have been taken at a range of about four feet.

The pulse length is sufficiently short for a minimum range of about one foot, which corresponds to a total delay time of 2 milliseconds. Any muting during transmission will probably increase the minimum range, but clearly the performance is quite adequate for ordinary flying.

So much for this natural form of “supersonic radar” as it is observed by the zoologists. Let us now consider the “design data.”

The reader will remember that in an ordinary radar system a short train of radio waves is produced. This train of waves travels off into space with a velocity of $3 \times 10^8$ cm/sec, is reflected by the target and the echo is picked up by the receiver. If the time between the transmitted pulse and the received echo is 10 microseconds, the target is clearly at a distance of 1,500 metres. Sound waves in air have a velocity of 34,250 cm/sec at a room temperature of 20°C. (At other temperatures the velocity is $33,170 + 54t$ cm/sec.) The ratio of sound velocity in air to radio velocity in free space is therefore about 1.1:10. As far as timing goes, therefore, a one-inch range with sound waves is roughly equivalent to 16 miles range with radio waves. For making a model radar system using supersonics the standard international map series with a scale of $1:10^5$ can be used to replace the actual area of a radar system.

It is not very convenient to scale all the other dimensions of a radar system in the same way, and it is usual to base supersonic systems on the attenuation characteristic of supersonic waves in air. In Fig. 1 the range for a fall in intensity of 10db is plotted against frequency. It will be seen that with a frequency of 100kc/s the range is four metres. A perfect reflector at this range would, therefore, produce an echo 20db down. At the lower frequency of 50kc/s used by bats the corresponding range is greater, about 12 metres on this 20db criterion.

The actual transmitted field strength is about 10-50 dynes/cm², but there does not seem to be much information on the minimum size of object which can be detected. It seems that useful information could be obtained by jamming experiments, in which the room was filled with noise distributed throughout the 30-70kc/s band. With a noise field exceeding the pulse strength which the bat expects, the bat should find it impossible to detect objects in time to avoid them.

A frequency of 100kc/s corresponds to a wavelength of 3.3 millimetres; with an aperture of the “aerial” of 2 centimetres a beam about 10° wide will be obtained. A model-maker can easily obtain an aperture of this size in one dimension by using a flat quartz plate (X-cut) in longitudinal vibration.

The pulse length is fixed by the carrier frequency. At least ten wavelengths should constitute a pulse train, and in general about 30 should be used. This means that a pulse train of 3 to 10 centimetres, with duration 0.1 to 0.3 milliseconds is desirable. The resolution in range which is obtainable is thus of the order of 5 to 15 centimetres and the band-width required in the receiver is from 3 to 10kc/s. For ease in model making, it may be noted that this band-width is that of a conventional receiver; if a broadcast receiver with a long-wave band is used the carrier frequency can be increased to 150kc/s, and the only modification required will be the provision of a modified detector circuit for pulse working.

The pulse repetition rate is fixed by the maximum range; a pulse must not be transmitted until the echo of the previous pulse from the most distant target has been received. If the range is chosen as 3 metres, a repetition rate of 50 pulses per second can be used. It will be found very convenient to choose either 50 pulses per second, or some other rate simply related to the mains frequency, as this reduces the need for smoothing the supplies to the various circuits; 33 1/3 pulses per second or 66 2/3 pulses per second can be used, for example. As we saw above, bats at rest transmit about 5 to 10 pulses per second and in flight up to 60 pulses per second. Thus at rest the bat is using a long range warning system, presumably to detect approaching enemies up to 15-30 metres away. In flight the bat is interested in much shorter ranges with more frequent measurement in order to avoid obstacles. It is interesting to note how closely the blind flying system of the bat ap-

Fig. 1. Range of supersonic waves in air for a 10db fall in intensity. (Courtesy: Nature)
Radar in Nature—
proaches the system designed purely on the basis of the discussion above. Only the pulse length differs substantially, and this limitation does not affect flying, for the bat does not want to know anything about an obstacle which is too close to be avoided. The minimum range requirements are less stringent than with an A.I. system, in which the object is to come as nearly as possible into collision with the target.

A model radar system using supersonic waves in air was used for demonstration at the 1946 exhibition of the Physical Society. In this demonstration the signal frequency used appeared to be about 12kc/s, corresponding to a wavelength of about 3 cm. With the size of horn used the beam is rather wide. The resolving power in range appeared to be about 30 cm, which would mean pulses containing about ten cycles and lasting for about a millisecond. The peak power used in this demonstration is not known, but there is little difficulty in getting several hundred watts from a pair of push-pull KT8 valves. Powers of this order can most conveniently be used to drive magnetostriiction radiators. It is thought that a much more successful demonstration would be produced by using higher frequencies as then the range limitation due to attenuation would prevent permanent echoes from the walls of the work-room, and the ranges could be laid out on a map to give a fair degree of verisimilitude.

It is equally possible to make a supersonic system working in water. Radar training devices have been produced on this basis, and "Aedic" is another well-known application. The velocity of propagation in water is 1,475 metres/second, so that the radar/Aedic scale ratio is 4 miles/inch. The range quoted for Aedic systems is 2,500 yards so that the pulse repetition rate for general search purposes can only be about one pulse every three seconds. The frequency used is not known, although references to "pinging" and attenuation considerations suggest that it is probably between 5 kc/s and 10 kc/s. This means that the wavelength in water will be about 14-28 centi-

metres, which would permit a range resolution of a few metres. For short range tracking repetition rates of more than one pulse in 3 seconds are probably used, as in this time the relative movements of two ships may be as much as 100 feet. Readers may be interested to know that even "window" had an underwater equivalent. Just as metal foil strips provided artificial radar echoes, so "Pillenwefer" produced artificial Aedic echoes. These devices were balls filled with chemicals which, like the familiar fruit salts, produced streams of bubbles. A stream of bubbles in water provides an impedance discontinuity which reflects the supersonic waves and thus provides an artificial echo.

These notes on the application of supersonic waves to range and distance measurement cannot, unfortunately, be completed by a description of a practical system which has been used for this purpose. They do, however, indicate to the keen experimenter a new field which he can explore without excessive apparatus costs. The signal frequency arrived at on purely theoretical grounds is convenient in that a long-wave receiver can be used with very little modification. The cathode-ray oscillograph will probably already be available. The writer does not know whether an ordinary "tweeter" will give an adequate output at such high frequencies, but if so the only apparatus to be constructed is an unsymmetrical multivibrator keying a self-oscillator. From this stage the addition of a rotating head to link the supersonic beam to a P.P.I. and construction of models of all the main radar systems offers a very interesting field for home study: a field, moreover, which does not involve the possession of a transmitting licence. Extensions to the study of parabolic reflectors using scale models can also be made using the same equipment. One word of warning must be added. Multivibrators can be very unpleasant neighbours if they are lashed up to produce very square pulses. A neat layout, with some screening, and capacitances added to round the pulses will prevent the circuit acting as a general-purpose jammer.

INDUSTRIAL ELECTRONICS

B.T.-H. Exhibition

RECENT developments in industrial electronics was the theme of an exhibition by the British Thomson-Houston Co. held last month at Rugby, and the application of thyratrons to industrial control was a major part of the display. As an example of the control now possible with such valves, a pentode-type thyratron can control currents up to 33 A, the thyratron itself being controlled by a photo-electric cell with no intermediate amplification.

Voltage regulation is one of the most interesting applications of the thyratron. A pair of such valves, with one hard valve, is usually employed and regulations up to 0.25 per cent are obtainable. The alternator output is rectified and the D.C. is amplified by a hard valve, the output of which controls the grid bias of a pair of thyratrons. These are fed with A.C. in push-pull on both anode and grids, but the grid voltage is 90° out of phase with the anode. The striking voltage are controlled by the D.C. bias and the thyratron output thus depends on the bias. It is used for the field supply and hence controls the alternator output. Similar principles are used in speed regulators, the control voltage being frequently derived from a tachometer. Electronic timing circuits, ensuring that the amount of heat applied to the work is under exact control, are employed in the B.T.-H. radio heating equipment.

The Ignitron is a valve which effectively disposes of the idea still held by many that valve currents are small. Some Ignitrons pass peak currents of 10,000 A. They are steel-jacketed, and often water-cooled, with a mercury-pool type cathode and they are used for the control of A.C. power and for the conversion of A.C. to D.C. In this latter application six valves fed from a six-phase supply can provide an output of 500 A.

Magnetostrictors and klystrons form the major development at the other end of the scale—in centimetre-wave engineering. In conjunction with waveguide technique they have made modern radar possible and in the B.T.-H. marine radar equipment the aerial system is simply a slotted waveguide. Radiation takes place from slots across the wall of the guide and a beam angle of 1°-5° is obtained. The display is in the form of a plan position indicator.
ELECTROMAGNETIC FRAME SCANNING

Time-base Amplifier

By W. T. COCKING, M.I.E.E.

in a 3 mH coil, the back e.m.f. on the scan is \( E = \frac{dL}{dt} = 3 \times 10^{-4} \times 0.6 = 0.0018 \text{ volt} \); the drop across the resistance is 0 to 0.6 x 6.4 = 3.84 volts. With a 0.6 H coil and 43 mA, the figures become 1.35 volt and 0 to 53.8 volts, respectively. In both cases the inductive back e.m.f. is negligible in comparison with the drop across the resistance.

If the fly-back were linear the inductive back e.m.f. would be 10 times as great as on the scan. It will not be linear, however, and so will be greater still. Referring to Fig. 1, the conditions on the fly-back are as if the deflector coil, itself of inductance \( L_2 \) and resistance \( R_2 \), were shunted by a resistance \( R_1 \), and the maximum current \( i_0 \) were allowed to die away.

The current at any instant is then \( i = i_0 e^{-t/T} \) where \( T = L_1 / (R_1 + R_2) \). The total voltage across the deflector coil terminals is \( V = i R_1 e^{-t/T} \). This is a maximum when \( t = 0 \), that is, at the start of the fly-back, and is simply \( i_0 R_1 \).

The fly-back is 99 per cent complete when \( t = 0.01 i_0 \) and then \( t/T = 4.5 \). Therefore, \( R_1 = 4.500 L_2 = 4.50 \times 0.6 = 2.70 \text{ ohms} \). This is the minimum value of \( R_1 \) permissible if the fly-back is to be 99 per cent complete in the nominal fly-back period.

For the 3 mH coil, we have \( R_1 = 4.500 \times 0.003 = 6.4 = 7.1 \text{ ohms} \) and for the 0.6 H coil \( R_1 = 4.500 \times 0.6 = 2.70 = 1.450 \text{ ohms} \). These are minimum values of resistance for the required fly-back time, and with them the maximum back e.m.f. for the smaller coil is 4.26 volts and for the larger 62.3 volts.

It will thus be clear that the maximum voltage across even a high-inductance deflector coil is not sufficient to cause serious insulation difficulties. In the case of the line scan, the back e.m.f. reaches 1,000 - 2,000 volts, and a high-inductance coil is ruled out by the impossibility of providing adequate insulation. No such difficulty arises in the frame scan and a choice between the two must be made on other grounds.

The use of low-inductance deflector coils is desirable for two reasons; they reduce interaction between the line and frame deflection circuits and they are easier to wind. However, a transformer is necessary and its construction demands a large quantity of fine gauge wire which is not easy to obtain at the moment.

The usual transformer circuit is shown in Fig. 2 and has the equivalent of Fig. 3 (a). This can be further reduced to Fig. 3 (b) in which \( R_1 \) represents the total shunt damping of valve and transformer-core losses, \( r_p \) is the transformer-primary winding resistance and \( L_p \) the primary-inductance. \( R \) is the sum of the deflector coil resistance \( R_L \) and the secondary winding resistance \( r_s \), multiplied by the square of the transformer ratio \( n \), and \( L = n^2 L_1 + \frac{1}{r_s} (1 - k) \) where \( L = M / \sqrt{L_1 L_2} \) = coupling co-efficient. The circuit capacitances,
so important in the line-scan case, can here be ignored. It is to be noted that $k$ is taken as unity except where its difference from a nearly equal quantity is involved; the approximation $2(1 - k^2)$ instead of $(1 - k^2)/k^3$ is then used.

$$R_s + R_c(1 + \mu)$$

Fig. 3.

Taking a 3-mH deflector coil, if the transformer ratio is arbitrarily made 14:1, the primary current required becomes 43mA and, ignoring the leakage inductance for the moment, $L$ becomes 0.6H. These are the same values as for the high inductance coil without a transformer. Ignoring $r_s$ temporarily, $R = 1,250\Omega$. Our aim is now to form a preliminary estimate of the primary inductance needed.

It is not difficult to show that during the scan the deflector-coil current is proportional to $1 - e^{-(L_s + L)}$ if the valve is linear. If 2 per cent distortion at the end of the scan is permissible, then at this time $R/\phi = 0.02$. As $t$ is 19 msec, we have $L + L_s = 0.059$ in henrys and ohms. With $R = 1,250\Omega$, $L + L_s = 1,185\Omega$.

This is a very large inductance and cannot be obtained in any reasonable size with negligible winding resistances; $r_p$ is unlikely to be less than $1k\Omega$ and $r_m^2$ about the same. The value of $R$ will thus be around 2.25k$\Omega$ instead of 1.25k$\Omega$ and $L_p$ will have to be further increased to 2,130H.

Taking into account the fact that the valve will need 30-40mA mean anode current, which flows through the transformer primary, the primary winding is likely to need some 20,000-40,000 turns with an iron core similar to that of a small mains transformer.

The leakage inductance then becomes very important. Even if many interleaved primary and secondary sections are used it is unlikely that $k$ can be made greater than 0.998. Taking this figure and with $L_p = 2,000\Omega$, the leakage inductance is $2 	imes 2,000(1 - 0.998) = 8H$. The true value of $L$ is thus 8.6H and the leakage inductance pulls more weight than the deflector coil.

Using the formula given earlier, the minimum shunt resistance for an adequate fly-back time is $1.500 \times 8.6 - 2.250 = 36,000 \Omega$. Of this $r_p$ will account for at least 1,000$\Omega$, so that $R_1$ of Fig. 3 (b) would be not less than 35,000$\Omega$.

As the current is 43mA, the peak voltage across the transformer primary is $35,000 \times 0.043 = 1,530$ volts.

The voltage on the transformer, and valve, is thus of the same order as in the case of line-scan and very high insulation is needed. This is particularly difficult in view of the large number of interleaved primary and secondary sections needed to secure tight coupling.

As an example of the fantastic voltages which can be reached, in theory at least, suppose that the coupling is 0.99—a value which is quite likely to be obtained if the primary and secondary are not interleaved. Then the leakage inductance is 40H, so $L = 40.6H$; $R_1 = 4,500 \times 0.046 - 2,250 = 180,000 \Omega$, and the peak voltage is $180,000 \times 0.043 = 7,750$ volts.

Such a voltage is not likely to be reached in practice, because iron losses in the core and the valve A.C. resistance would prevent $R_1$ from being made high enough. The practical effect of inadequate coupling would thus be to slow down the fly-back.

The question now arises as to what can be done to ease matters, for the requirements laid down lead to an impracticable design. The fly-back time can be increased slightly, and this will result in slight curvature of the scan at the top of the picture. In a small degree this is not important, but it must be kept small and then the situation is eased only slightly.

The second thing is to permit increased curvature towards the end of the scan, which will cramp the picture towards the bottom. Quite a bit can be done to correct for this by the natural curvature of the valve characteristic, so that much more distortion can be allowed than would otherwise be permissible.

Before proceeding further with a consideration of transformer coupling, however, it is as well to investigate the alternative of a high-inductance deflector coil with a resistance-capacitance feed. Choke-capacitance feed is ruled out because the choke would have to be of such large an inductance as a transformer. The circuit is shown in Fig. 4, and its equivalent in Fig. 5, in which $R$ represents $R_1$ in parallel with the output resistance of the valve $[-R_s + R_c(1 + \mu)]$.

On the fly-back $C$ has a negligible effect, and the circuit is essentially the same as that of Fig. 1 with $R$ written for $R_1$. We found earlier for this that with $L_L = 0.6H$, $R_L = 1.25k\Omega$ and a current of 43mA, the value of $R$ should not be less than 1.45k$\Omega$ for a fly-back time of 1 msec. This can easily be achieved with a pentode valve.

www.americanradiohistory.com
On the scan the deflection current is proportional to 1 - \( \frac{1}{T} \) where \( T = C(R + R_L) \). For 2 per cent distortion at 19 m sec. \( f/T = 0.02 \); therefore, \( C(R + R_L) = 50\alpha = 0.95 \) in farads and ohms.

If \( R = 2k\Omega \) and \( R_L = 1.25k\Omega \), \( C = 0.95/3.250 = 0.000292F = 292\mu F \). This is inconveniently large, for in a 500-volt rating the component would be both expensive and bulky. The working voltage on the valve will, of course, be well below 500V, but this rating is desirable to allow for the voltage rise when switching on.

By permitting more distortion the capacitance can be reduced just as in the case of transformer coupling. Thus, if 6 per cent distortion is allowed it can be brought down to 100\( \mu F \). It can be further reduced by increasing \( R \), for it is the product \( C(R + R_L) \) which is important, not the individual values.

As \( R \) consists of the coupling resistance \( R_1 \) in shunt with the output resistance of the valve, and as the only limitation to the maximum value of \( R_1 \) is set by the loss of anode voltage in it, it is clearly desirable to make the valve resistance as high as possible. The use of a pentode valve is thus indicated in preference to a triode, which would be permissible on the score of fly-back time. With a pentode and any reasonable value of \( R_1 \), the output resistance of the valve is high enough to be ignored, and to all intents and purposes \( R = R_1 \).

The limit to \( R_1 \) is set by the minimum permissible anode voltage of the valve, and with a positive-going saw-tooth input this occurs at the end of the scan when the anode current is a maximum. Ignoring the inductive back e.m.f., and assuming that the change of voltage across \( C \) is negligibly small during the scan, the change of anode voltage \( \Delta E_a \) on the scan is \( \Delta E_{RL} \), where \( \Delta i \) is the peak-to-peak coil current. In this instance it is 0.043 \times 1,250 = 53.8, or say 54 volts.

The saw-tooth anode current is

\[
\Delta i = \frac{\Delta E}{R_1 + R_L} = \frac{\Delta i}{R_1 + R_L}
\]

so that in effect \( R_1 \) robs the coil of current and the valve must provide a greater output. It is again advantageous to make \( R_1 \) as large as possible compared with \( R_L \).

If we call the mean anode voltage \( E_a \) and the current \( i_a \), the minimum anode potential is \( E_a = \Delta E_a/2 \) and with a pentode this should not be less than about 100 volts in most cases. With some valves it can be a little lower, but this is a reasonably safe figure. Therefore, the mean anode voltage must not be less than \( E_a = 100 + \Delta E_a/2 = 127 \) volts in our example.

Now this voltage is also \( E_{HT} = i_a R_1 \), so that it is necessary to determine \( i_a \). There is a minimum permissible anode current \( i_{amin} = i_a - \Delta i_a/2 \) which is necessary for reasonable linearity. This varies with different valves, but one is not far out in taking it around 15mA.

These factors are expressed in Eqs. (1) to (5) in the Appendix, and lead to Eqs. (6) and (7) for the values of \( R \) and \( i_a \). If we have \( E_{HT} = 350V \), \( E_{amin} = 100V \), \( i_{amin} = 15mA \), \( \Delta i = 43mA \), \( r_L = 1.25k\Omega \), we find \( R_1 = 5.35k\Omega \) and \( i_a = 41.5mA \). Then \( r_L + R_1 = 6.58\Omega \) and \( C = 144\mu F \).

In the foregoing it has been assumed that the valve characteristic is linear. In practice, it will not be unless an uneconomically large valve is used. If the input saw-tooth wave is positive-going on the scan the curvature at the start of the scan is in the right direction to compensate for the curvature introduced by \( C \). Valve curvature towards the end of the scan, however, can be in the opposite direction, and so may accentuate the non-linearity of the scan. This can be avoided by the use of an adequate H.T. voltage, but even then the curvature at this point may not be sufficient to correct the circuit distortion.

From all this it is clear that it is necessary to make use of valve curvature in order to attain an economical time-base. An attempt to design for linearity in each part by itself, while the ideal, is much too expensive for normal purposes. Adequate valve linearity demands a heavy anode current and a large amount of negative feedback. Adequate linearity in the coupling to the deflector coil demands either an impracticable transformer or an uneconomically large capacitance.

By letting the defects of one piece of apparatus offset those of another, a much more economical design is obtainable. Of course it is too much to expect exact compensation, but the distortion can be greatly reduced without difficulty, and a reasonable amount of negative feedback can be employed to correct the residue.

It is of the first importance to note that for such compensation it is essential for the output valve to be fed with a positive-going saw-tooth wave. This is necessary in any case on the line scan for other reasons, but there is no obvious objection to the use of a negative-going input on the frame scan. However, with a negative-going input the valve distortion is in the same direction as the circuit distortion and the two accentuate each other. Only with a positive-going input are the valve and circuit distortions in opposition.

The estimation of the effect of valve and circuit together will be considered in detail in a further article.

**APPENDIX**

*Units (mA, V, k\( \Omega \))*

Let

\[
i = \text{mean anode current}.
\]

\[
\Delta i_a = \text{peak-to-peak saw-tooth anode current}.
\]

\[
\Delta i = \text{peak-to-peak saw-tooth coil current}.
\]

\[
i_{amin} = \text{minimum permissible instantaneous anode current}.
\]

\[
E_a = \text{mean anode voltage}.
\]

\[
\Delta E_a = \text{peak-to-peak saw-tooth anode voltage}.
\]

\[
i_{amin} = \text{minimum permissible instantaneous anode voltage}.
\]

\[
E_{HT} = \text{voltage of H.T. supply}.
\]

Then

\[
\Delta i_a = \frac{\Delta i}{R_1 + R_L} \quad (1)
\]

\[
\Delta E_a = \frac{\Delta i}{R_1} \quad (2)
\]

\[
E_a = \frac{\Delta E_{amin}}{2} + \frac{\Delta E}{2} \quad (3)
\]

\[
E_{HT} = \frac{E_a + i_a R_1}{(R_1 + R_L)} \quad (4)
\]

\[
i_a = \frac{\Delta i}{2} \quad (5)
\]

\[
R_1 = \frac{E_{HT} - i_a}{i_a} \quad (6)
\]

\[
i_a = \frac{\Delta i_a}{2} \quad (7)
\]
SHORT-WAVE FORECASTING
Using Ionosphere Charts for Choosing Frequencies

(Concluded from page 250, August issue)

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

TABLE I
Distance Factors by which F layer 2,500-mile contours or E layer 1,000-mile contours must be multiplied to obtain M.U.F. for shorter distances.

<table>
<thead>
<tr>
<th>Distance</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F, F layer</td>
</tr>
<tr>
<td>0</td>
<td>0.35</td>
</tr>
<tr>
<td>250</td>
<td>0.36</td>
</tr>
<tr>
<td>500</td>
<td>0.42</td>
</tr>
<tr>
<td>750</td>
<td>0.52</td>
</tr>
<tr>
<td>1,000</td>
<td>0.64</td>
</tr>
<tr>
<td>1,250</td>
<td>0.83</td>
</tr>
<tr>
<td>1,500</td>
<td>0.90</td>
</tr>
<tr>
<td>1,750</td>
<td>0.95</td>
</tr>
<tr>
<td>2,000</td>
<td>0.98</td>
</tr>
<tr>
<td>2,500</td>
<td>1.00</td>
</tr>
</tbody>
</table>

CHARTS prepared in the way described last month may be used to find the predicted average M.U.F.—and from this the Optimum Working Frequency, or O.W.F.—for a transmission path of any distance, in any part of the world, for every hour of day for the month for which they are valid.

If the transmission path is exactly 2,500 miles long, then the M.U.F. will be read off directly from the chart at the point at the centre of the path. If the path is less than 2,500 miles long then, as has been explained, the M.U.F. will be less than that indicated on the chart. It is only necessary in this case to read off the M.U.F. at the centre of the path and multiply it by a factor which is the ratio of the M.U.F. for 2,500 miles to that for the given distance. A set of such "Distance Factors" for various distances is given in the second column of Table I.

When the transmission path is more than 2,500 miles long the transmission will be by multiple hops, but the M.U.F. can still be read off directly from the chart. Experience has shown that beyond 2,500 miles the M.U.F. does not at first decrease, as might have been expected owing to the sudden decrease in the length of each hop, and transmission cannot be considered as a simple extension of one-hop transmission to multiple hops. In multi-hop transmission there is considerable scattering at each reflection at ionosphere and earth, resulting in energy traveling by a multiplicity of paths, and, because of this and other effects, it is not possible to consider the conditions at certain separate ionospheric points as if transmission were by a "single ray" of radio energy. It has been found in practice, however, that if ionospheric conditions are considered at two points 1,250 miles (the distance of "half a hop") from each end of the path, good results are obtained. If the frequency used is such as will be reflected at both of these "control points," then the wave will, in general, be propagated by the ionosphere over the whole path.

Finding the Working Frequency.—The full procedure for the determination of the M.U.F.s and other relevant quantities for any transmission path is thus as follows: Using a Mercator map of the same size and co-ordinates as those used for the contour charts the location of the transmitting and receiving points is first marked off, and the great circle path between them is drawn in. If the path is 2,500 miles or less in length, the centre of the path is then marked off, whilst, if it is of greater distance than this, the two control points 1,250 miles from each end of the path are similarly indicated. By reference to the map of Fig. 3 (last month's issue) it is next ascertained in which zone the separate control
points lie. If, as in the case of paths 2,500 miles or less in length, there is only one control point, or if where there are two they both lie in the same zone, it is only necessary to make use of one contour chart, but if the control points lie in different zones, then the contour charts appropriate to both zones must be consulted.

We will deal with multi-hop circuits first. Using the appropriate chart, this is placed over the Mercator map so that the equators on each coincide, and the transparency is slid over the map until its 00 hours meridian coincides with the meridian on the map corresponding to the standard time in which it is desired to work. For instance, if it is desired to work in terms of G.M.T., we start operations with the 00 hours meridian coincident with the 0° longitude meridian on the map. Fig. 4 will help to make this clear. The 2,500-mile M.U.F. at each control point is then read off, and by sliding the transparent contour charts along so that each hour in turn coincides with the Greenwich meridian, this is done for every hour of the day, the M.U.F.s indicated being entered upon a Work Sheet like that shown in Table II, which is for a multi-hop path with control points in two zones.

Having done this it is only necessary to strike out the higher of the two M.U.F.s appearing on the work sheet to be left with a value which is the M.U.F. for the whole path.

It must be remembered that the contour charts are compiled from critical frequency measurements which are the average of those obtained on every day of the month, so that what the contours show is the average predicted 2,500-mile M.U.F. for the month. On some days the M.U.F. is likely to be considerably above this value and on others considerably below it. It is likely like that of the B.B.C. where the aim is to provide regular service on every day, we cannot afford to work on a frequency which is likely to fail for a considerable portion of the total time. We must work somewhat below the average M.U.F., though it is always advisable to work as near it as possible, because of the fact that as we reduce the frequency ionospheric absorption increases, and with a given power radiated the field intensity at the receiv-

**TABLE II: PREDICTED WORKING FREQUENCY WORK SHEET**

<table>
<thead>
<tr>
<th>G.M.T.</th>
<th>00</th>
<th>02</th>
<th>04</th>
<th>06</th>
<th>08</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST CONTROL POINT F, F₂ M.U.F.</td>
<td>14.4</td>
<td>14.0</td>
<td>17.4</td>
<td>20.5</td>
<td>22.5</td>
<td>25.0</td>
<td>25.5</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>15.8</td>
</tr>
<tr>
<td>K =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F, F₂ M.U.F. FOR PATH</td>
<td>14.4</td>
<td>14.0</td>
<td>17.4</td>
<td>20.5</td>
<td>22.5</td>
<td>25.0</td>
<td>25.5</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>15.8</td>
</tr>
<tr>
<td>E 1000 M.U.F.</td>
<td>-15%</td>
<td>12.5</td>
<td>11.9</td>
<td>16.8</td>
<td>17.5</td>
<td>19.0</td>
<td>19.6</td>
<td>19.8</td>
<td>20.0</td>
<td>19.8</td>
<td>17.2</td>
<td>15.5</td>
</tr>
<tr>
<td>M.U.F. FOR PATH</td>
<td>14.4</td>
<td>14.0</td>
<td>17.4</td>
<td>20.5</td>
<td>22.5</td>
<td>25.0</td>
<td>25.5</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>15.8</td>
</tr>
<tr>
<td>K =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.U.F. FOR PATH</td>
<td>14.4</td>
<td>14.0</td>
<td>17.4</td>
<td>20.5</td>
<td>22.5</td>
<td>25.0</td>
<td>25.5</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>15.8</td>
</tr>
<tr>
<td>O.W.F. FOR PATH</td>
<td>-15%</td>
<td>12.5</td>
<td>11.9</td>
<td>16.8</td>
<td>17.5</td>
<td>19.0</td>
<td>19.6</td>
<td>19.8</td>
<td>20.0</td>
<td>19.8</td>
<td>17.2</td>
<td>15.5</td>
</tr>
</tbody>
</table>

*K = DISTANCE FACTOR*

**Fig. 4. Showing the method by which the M.U.F. is read off for every hour of day. The transparency is shown over the Great Circle path to Delhi at 16 hours G.M.T.**
Frequency or even well above the M.U.F. They would, in fact, often obtain best results by working on such frequencies, but that is a different matter from the operation of a regular broadcasting service, where no immediate reports from the receiving end are available.

**Circuit Curves.**—It is now advantageous to plot the data from the Work Sheet in the form of curves, as is done in Fig. 5. We are now in a position to choose our actual working frequencies for every time of day and these will depend upon the allocations made for the particular services in which we are interested; i.e., the highest frequency band, not above the O.W.F. at the various times of day, which we may have available. Fig. 5 shows (in horizontal full lines) the actual working frequencies inserted into the curves in terms of the broadcast bands, while the vertical lines connecting them indicate the times when a frequency shift is necessary. Of course, it does not follow that one would necessarily change frequency at all the times indicated, particularly in a broadcast service, in which continuity of transmission on a single frequency for as long as possible is a desirable feature. Nevertheless, such curves show at a glance the frequencies which should be used at any time of day, and, in general, the transmission schedules will be compiled in conformity with them. Thus, having available, some three months in advance, curves like this for every circuit over which it is desired to transmit, one is able to plan the transmitting schedules with some facility.

**Single Hop Circuits.**—Now let us return to the case of the single-hop circuit; i.e., one of 2,500 miles or less in length, such as we meet in the B.B.C. European services. As has been said, the 2,500-mile M.U.F. is read off at the centre point of the path. This is then multiplied by the Distance Factor from the second column of Table I appropriate to the length of the circuit and the result is the M.U.F. for the path. The O.W.F. is obtained in the same way as for multi-hop paths, and this completes the operation for most circuits and times of day.

There is however, a further complication in certain cases. Because the F₁ and E layers are lower than the F₂, they are capable, at certain times of day when their ionisation is highest and yet lower than that of the F₂, of controlling the transmission at certain distances. What this means is that at these times the M.U.F. for certain distances is determined by the critical frequency of the lower layer and not by that of the F₂, and any frequency which penetrates the E (or F₁) at the particular angles necessary to cover these distances will also penetrate the F₂. Thus the E layer can, during the summer day, act as the controlling layer for distances out to about 1,400 miles, whilst the F₁ layer can do the same thing up to about 2,000 miles.

It will be noticed that on the chart of Fig. 2 there are plotted (in dotted lines) contours of E layer M.U.F. for a distance of 1,000 miles. These are calculated from the measured values of E layer critical frequency obtained from the observatories, these being multiplied by the E M.U.F. factor for 1,000 miles, and contours drawn in a manner similar to that already described for the F M.U.F. contours. It may be noted about the E layer that, unlike the F, it is always more or less symmetrical (in its ionisation) about local noon, and that the highest values of ionisation always exist over the sub-solar point. Thus the contours move north and south as the seasons progress in accordance with the relative movement of earth and sun. It may also be of interest that the E layer is always at the same height and so the M.U.F. factors for any distance remain constant for all times of day and seasons, and that it is only, in any case, of any significance in short-wave communication during daylight.

In order to take account of these effects it is necessary during the daylight hours and for distances up to 2,000 miles, to read off the E layer 1,000-mile M.U.F. as well as the 2,500-mile F₂ M.U.F. When the former is multiplied by the E layer distance factor appropriate to the distance (Table I) the result is the E layer M.U.F. for that distance. This is entered on the Work Sheet, and whenever it exceeds the F layer M.U.F. for the path it is the controlling M.U.F. Fig. 6 shows a curve for a distance of approximately 1,100 miles during June, and the

---

**Fig. 5.** Curves of frequencies for a specific route. Dotted line shows M.U.F. for path, while the full lines refer to O.W.F.; broadcasting bands are shown.
hump in the centre of the day shows the effect of the E. It is seen that because of this effect higher frequencies may be used.

For the distances between 1,400 and 2,000 miles it is the F₁ layer which sometimes controls the M.U.F. and since the F₁ ionisation, although somewhat higher than that of the E, follows that of the E layer in the nature of its variations, it has been found convenient to avoid plotting the F₁ M.U.F. contours on the charts, but rather to obtain the M.U.F. from the contours of E M.U.F. For the distances 1,400-2,000 miles (the only cases where it applies) it is therefore only necessary to multiply the E layer 1,000-mile M.U.F. by the F₁ distance factor (Table I) in order to obtain the F₁ M.U.F. for the path. This is applied in the same way as was described for the E layer; i.e., if the M.U.F. so found for the F₁ is higher than that for the F₂ then the former is the controlling M.U.F., and as such is plotted into the curve.

This, then, is the modern technique in which, by the use of world-wide M.U.F. contour charts, the scientific data is put to use in practical engineering. There are two other features which may be mentioned — though not discussed in detail. The first is that, particularly during the months of May, June, July and August, the M.U.F. for single-hop transmission may sometimes be higher than those found because of the presence of sporadic E. This, however, is not predictable. It appears and disappears at random and during most months of the year is not present often enough to be of significance. During the months just mentioned, however, it is much more prevalent; so much so that it does become a tangible factor in transmission over 1-hop circuits.

The second point is that, although it is a good principle always to work as near to the O.W.F. as possible, it is useful also to know the lowest frequency on which it is possible to obtain communication. Particularly is this so on long multi-hop circuits where this low limiting frequency may exceed the O.W.F. for several hours a day; i.e., the circuit may become unworkable. The low limit frequency, however, unlike the high limit, does not depend on the ionosphere alone, but varies also with the power radiated, the noise level at the receiver, the type of service and other factors. The technique has, however, been so developed that this low limiting frequency may also be calculated with the aid of contour charts, and inserted into the circuit curves, but the principles underlying this operation are too complex to deal with here.

**AMATEURS’ EXAMINATION**

In view of the number of applications for amateur transmitting licences it has been decided by the City and Guilds of London Institute to hold an additional Radio Amateurs’ Examination this year on November 13th from 7-10 p.m. It will be held at a number of centres throughout the country, and intending candidates are asked to apply to their local technical colleges. The Institute’s examination fee is £5, in addition to which a small accommodation charge may be made by the examination centres. The closing date for applications is October 8th.

It is intended that in future the examination will be held annually in May.

Prospective candidates will be interested in the following questions set at the first examination, when 145 of the 182 entrants passed.

1. A 100-ohm resistor and a 300-ohm resistor are joined in parallel and connected to a battery of 1.5 volts and negligible internal resistance.
   (a) What is the total current taken from the battery?
   (b) What power is dissipated in the 100-ohm resistor?

2. What do you understand by the term “resonance”? If an inductance of 100 µH is connected in parallel with a capacitance of 100 µF, what is the resonant frequency of the circuit?


4. Why are quartz crystals frequently used in radio transmitters? Describe a typical crystal-controlled oscillator.

5. Explain why “standing waves” are undesirable in a feeder system connecting a transmitter to an aerial. How would you detect their presence and minimize them?

6. Describe an “artificial aerial.” How can an “artificial aerial” be used to measure the power output of a transmitter?

7. In what ways may a low-power transmitter interfere with radio and television reception? What precautions should be taken to minimize such interference?

8. What are the conditions laid down by the Postmaster-General for the frequency measurement and control of amateur transmissions?
Wireless World

September, 1946

World of Wireless

SERVICING EXAMINATION

ARRANGEMENTS have now been made for the first of the joint servicing examinations to be held since the merger of the examinations previously held by the Radio Trade's Examination Board and the City and Guilds of London Institute. It will be on May 17th. It will be known as the Radio Servicing Certificate Examination, the practical tests for which will be conducted under the auspices of the Radio Trade's Examination Board whilst the written examination will be conducted by the City and Guilds.

Applications to sit for the examination should be made to the Secretary, R.T.E.B., 9, Bedford Square, London, W.C.1.

PORTABLE LICENCES

The Postmaster-General has announced that he will now issue permits for licensed amateurs to operate portable transmitters for an additional fee of 10s.

This permit will allow a transmitter to be operated within a radius of 10 miles of the permanent address of the licence itself or, alternatively, within a similar radius of a given point if different from the operator's address.

As in the past, amateurs will suffix their call sign with "J.P." The maximum permissible power is 25 watts on all present bands, with the exception of 1.8-2.0 Mc/s or, which, to watts is the limit. Applications should be made to the Engineer-in-Chief, Radio Branch, G.P.O., London, F.C.1.

FACSIMILE

There has been a tremendous growth in the interest in facsimile transmission and reception in the U.S.A., especially among newspaper proprietors. Apparatus has been installed in some 100 public buildings in New York and a small four-column facsimile newspaper, called Air Express, is being produced twice a day.

The apparatus, which has been installed by Finch Telecommunication, Inc., is similar to that illustrated on this page. At a recent demonstration a four-page paper, each page measuring 8.5 x 11 in., took eight minutes to produce - that is, at a speed of approximately 44 sq in. a minute. This means that it takes one minute to reproduce 525 words of 8pt type - the size in which this paragraph is set.

The transmissions were radiated by the recently completed F.M. facsimile station, WGHF, New York, operating on 99.7 Mc/s.

Another New York demonstration, arranged by Radio Inventions, Inc., a research organization sponsored by some 20 newspapers and broadcasting stations, showed a facsimile attachment which can be connected to an ordinary F.M. receiver. During the demonstration printed pages measuring 9 x 12 in were reproduced, complete with illustrations, at a rate of 16 an hour.

The F.M. station used for this transmission was WBAM, New York, working on 96.5 Mc/s.

SLOW MORSE PRACTICE

Readers who, from time to time, have asked for details of slow Morse transmissions for practice reception, will be glad to hear that the Radio Society of Great Britain has now organized a regular service of transmissions.

The stations participating in the service and the frequencies (kc/s) on which they operate are: G2CPF (Yorks), 1,892; G2BJY (Staffs); G3KJ (Notts), 1,865; G3LP (Glou), 1,865; G3UM (Herts), 1,900; G6GD (Chester), 1,885; GW3GL (N. Wales), 1,965.

The operating schedule (B.S.T.), which has been arranged by D. Rock, G8PXR, "Sandhurst," Vicarage Road, Ambleside, Stourbridge, Wors., to whom further offers of help from licensed amateurs should be sent, is:

- Sundays, 0900, 1030, 1100, GW3GL.
- Mondays, 0930, G2CPF, G2BJY, G6GD.
- Wednesdays, 0930, G2CPF, G3LP, G6GD, GW3GL.
- Saturdays, 1200, G2BJY, G6GD.

MEASURING INTERFERENCE

We referred in our June issue to the fact that the G.P.O. was adapting a number of Army interception receivers, Type R206, for the measurement of radio interference and that these would be made available to manufacturers of electrical equipment through the British Standards Institution.

The B.S.I. has notified us that a limited number of these modified receivers will be available early next year and will cost about £150 each. Manufacturers who are in a position to undertake the modification will be able to purchase sets at £250.

Applications for sets should be addressed to the Director, B.S.I., 28, Victoria Street, London, S.W.1, quoting reference OC/13.

FULLY AUTOMATIC RADIOPHONES

According to a correspondent, the Bell Telephone Laboratories, U.S.A., have recently patented a V.H.F. radio-telephone communication system in which the operation of dialling calls the distant station and, at the same time, causes the transmitting aerial to orient itself in the desired direction. The system is particularly adapted to inter-communication between a small group of islands or in other circumstances where metallic links would be uneconomic.

DECCA CHAIN

The first chain of Decca Navigator Stations, cited in the South of England, was officially declared operational by the Admiralty and Ministry of Transport on July 18th, following a test period of operation. The Master Station is at Buntingford, Herts, the "Red" slave station at Stokeyholme Cross, near Norwich, and the "Green" slave station at East Hoathley, near Lewes, Sussex. A third slave (Purple) will be at Wormleighton, Warwickshire.

HIGH-POWERED P.A.

Philips have introduced a high-power A.F. amplifier with a maximum output of 1,000 watts; the characteristic is flat within better than 1 db from 50 to 10,000 c/s; total harmonic content at 1,000 c/s is 1 per cent. The "Philowatt," as it is called, is designed for very large P.A. installations or relay networks serving up to 6,000 subscribers. Automatic monitoring allows untended operation of the amplifier. When no audio signal has been present in the output stage for 3 minutes, a test impulse is automatically applied to the input.

www.americanradiohistory.com
this impulse fails to reach the output, an alarm signal is sounded, or, alternatively, a stand-by amplifier may be switched on.

TELECOMMUNICATIONS RESEARCH

THE formation of a new company to promote telecommunications research in this country is announced by British Insulated Callender's Cables and the Automatic Telephone and Electric Co. (A.T.M.), the sponsoring companies.

Laboratories are being established at Taplow Court, near Maidenhead, which will be under the direction of Air Vice-Marshal O. G. Lywood, C.B., C.B.E., managing director. He recently retired from the R.A.F. after 33 years' service in the Signals Branch.

The chairman of the new company is P. V. Hunter, C.B.E., director and engineer-in-chief of B.I-Calenders, Dr. T. Walsmsley, C.B.E., formerly of the G.P.O., is a director and chief engineer. The other members of the Board are: Dr. J. L. Miller, chief engineer (equipment and telecommunications), B.I.-Calenders; A. F. Bennett, director and manager, A.T.M., and A. J. Leyland, director and chief engineer, A.T.M.

PERSONALITIES

Sir John Lennard-Jones, K.B.E., D.Sc., F.R.S., who has been Director General of Scientific Research (Dentence) in the M.C.B. of Canada, is returning to his post at Cambridge University, but will continue as Chief Scientific Adviser to the Ministry.

Sir Clifford Paterson, O.B.E., F.R.S., D.Sc., director of the G.E.C. Research Laboratories, has been elected a vice-president of the Royal Society of Arts.

Air Vice-Marshall R. S. Aitken, C.B., C.B.E., has been appointed to the Board of Radio and Television Trust, Ltd., as a director. He was appointed chief signals officer, R.A.F. Fighter Command, in 1940, and the following year became Air Officer Commanding-in-Chief Signals Radar Group.

S. L. Capen, vice-president and general manager of the Philco Corporation of Canada, has been elected president of the Radio Manufacturers' Association of Canada.

Prof. G. W. O. Howe, D.Sc., Technical Editor of our sister journal Wireless Engineer, is retiring from the James Watt Chair of Electrical Engineering of Glasgow University at the end of the present session. Old students and friends of Prof. Howe are invited to contribute to a presentation to be made to him, contributions for which should be sent to Dr. A. J. Small, Electrical Engineering Department, The University, Glasgow, W.2.

R. G. Clark, who until recently was head of the Research and Development Department of Philips Lamps, which he joined in 1928, has been appointed manager of the Engineering Departments of Ferguson Radio Corp., Ltd., Endfield, Middlesex. Mr. Clark was a member of the B.R.E.M.A. sub-committee responsible for the industry's Plan for European Broadcasting.

J. M. Fleming, who has been appointed chief development engineer of the Micanite and Insulators Co., was secretary of the U.K. Radio Materials Mission to the U.S. in 1944.

H. MacDougall has been appointed secretary of the Electronic Manufacturers' Association, the offices of which will temporarily remain at Vernon House, Sicilian Avenue, Bloomsbury Square, London, W.C.1. In the Association's rules the term electronic apparatus is defined as including "all apparatus depending for its functioning in whole or in part on the emission of a stream of electrons, including apparatus incorporating thermionic valves."

A. Parsons, until recently of the Overseas and Engineering Information Department, B.B.C., has rejoined the Radio Department of the Municipal College, Portsmouth.

J. W. Ridgeway, manager of the Radio Division of Edison Swan Electric Co., has been re-elected for his fifth term of office as chairman of the British Radio Valve Manufacturers' Association (B.V.A.). He has also been appointed vice-chairman of the Radio Industry Council. The new B.V.A. vice-chairman is G. A. Marriott, who preceded Mr. Ridgeway as chairman. He is a director of the Manganese-Osram Valve Company and manager of the Osram Valve Sales Department.

G. R. Scott Farnie, GW5FI, has been appointed to handle the section of E.M.I. which is to cater for the particular needs of the radio amateur.

C. W. Goyder, C.B.E., has relinquished his appointment as chief engineer of All-India Radio and is returning to this country. He went to India in 1936 as the chief engineer (broadcasting) to be appointed by the Government to develop a broadcasting system in British India. This now comprises 22 medium and short-wave transmitters at nine broadcasting centres, with an engineering staff of some 300. Mr. Goyder, who was created a C.B.E. in the New Year Honours, will be remembered by many readers as the amateur who, in 1924, with his station G2SZ at Mill Hill School, was the first amateur to obtain two-way communication between England and New Zealand.

C. W. GOYDER, C.B.E., until recently chief engineer, All-India Radio.

IN BRIEF

Television Interference.—Amateurs operating in the 414 to 1434 Mc/s band have been warned by the R.S.G.B. that interference may be caused to television receivers if due care is not taken to suppress the third harmonic.

No Radio Imports Yet.—As in the case of the token imports permitted from the U.S.A. and Canada, radio apparatus (except H.T. batteries) is not in the list of goods now allowed into this country from Belgium.

Overseas Receiver Wanted.—The superintendent of the leper colony in Africa asks for suggestions as to where a short-wave (10-50 m) broadcast receiver to operate entirely from a 6-volt accumulator can be obtained.

Dry batteries of not more than 6 volts are now exempt from Purchase Tax.

Coming of Age.—We offer our congratulations to the R.S.G.B. Bulletin which, with the publication of the July issue, attained its majority.

B.R.E.M.A. Secretary.—The British Radio Equipment Manufacturers' Association announces the appointment of S. E. Allchurch, O.B.E., as secretary.

Singapore.—Reception reports of transmissions from the Singapore broadcasting stations are welcomed by the Department of Broadcasting, Cathay Building, Singapore, Federated Malay States. Transmissions on 4.78 Mc/s are radiated from 1130-1630 B.S.T. and on 7.24 Mc/s from 0530-0930. A third transmitter works on 9.54 Mc/s.

Radio SEAC, the 100-kW station of the South-East Asia Command, which is now broadcasting in the 19-, 25- and 45-metre bands, welcomes reception reports, which should be sent to Radio
World of Wireless—

Unit, S.E.A.C., 191, Turret Road, Colombo, Ceylon. The latest schedule gives transmission times (G.M.T.) as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000-0245</td>
<td>25.49 m</td>
</tr>
<tr>
<td>0315-1145</td>
<td>10.81 m</td>
</tr>
<tr>
<td>1215-1700</td>
<td>49.42 m</td>
</tr>
</tbody>
</table>

Amateurs' Examination Course.—A course covering the syllabus of the City and Guilds Radio Amateurs' Examinations has been arranged by the Brentford Evening Institute for the 1946-47 session. The fees for the course, which commences on October 23rd, are £1 15s. 6d. for students over 16 years of age, 5s. 6d. for students under 16, 25s. 6d. A prospectus is obtainable from the Chiswick Polytechnic, Bath Road, Bedford Park, London, W.12.

F.M. Goes Ahead in U.S.—According to the Washington, D.C., contemporary, Broadcasting, the number of constructional permits for F.M. stations granted by the F.C.C. totalled 117 at the middle of July. It is also stated that the number of applicants to whom formal permission has been granted to operate F.M. stations, although not yet received permission to erect stations, totals 349. In addition, some 386 applications are pending.

Television Slow-down.—As a result of a request made by the American Television Broadcasters' Association the Federal Communications Commission has deferred for six months—until January 1, 1947—the introduction of the rule requiring television stations to broadcast a minimum of 2 hours on any one day and not less than 28 hours of programme service a week. A further indication that the television slow-down is provided by the withdrawal of some 50 applications for the erection of television transmitters.

I.E.E. Council.—The following members of the I.E.E. Radio Section have been elected to serve on the I.E.E. Council for the ensuing year:—V. Z. de Ferranti, M.C., president; Prof. E. B. Moullin, M.A., F.R.I.P., F.G.Z., chairman; and D. F. C. Williams, O.B.E., an ordinary member.

I.E.E. Radio Section.—The vacancies which will occur on the Radio Section Committee on September 30th have now been filled. Prof. Willis Jackson, D.Sc., D. Phil., recently appointed head of the Electrical Engineering Department of the Imperial College of Science, has been elected chairman; R. T. B. Wynn, assistant controller, B.B.C. Engineering Division, vice-chairman; and Dr. R. F. T. Jarvis, G.P.O. Research Station, B. N. Mallett, O.B.E., B.B.C., Dr. E. C. S. Megaw, M.B.E., Admiralty Signal Establishment, Dr. R. L. Smith-Rose, N.P.L., and G. M. Wright, Marconi's, as ordinary members.

Glasgow Exhibition.—Enquiries regarding the exhibition of engineering components relating to electrical, scientific and marine instruments, to be held in the Kelvin Hall, Glasgow, from November 15th to 27th, should be addressed to M. Sivitch, the honorary secretary, at 19, Ladysmith Avenue, Sheffield, 7.

Southampton's Enterprise.—An attendance of nearly 400 was recorded at the recent series of lectures and demonstrations on telecommunications and electronic navigation at the School of Radiotelegraphy, University College, Southampton.

Licence Figures for the three months ended June 30th show an increase of 279,000. The total is 10,671,000.

INDUSTRIAL NEWS

Television School.—Since the opening of the Television School by Pye, Ltd., last February, some 200 students have been trained. Those wishing to take the ten-day course should apply for particulars to the Service Manager, Fye, Ltd., Cambridge.

Equipment for high-quality reproduction of radio and gramophone is to be the main interest of the H. A. Hartley Co., 132, Hammersmith Road, London, W.6. A new loudspeaker with 9-inch diaphragm and Ticonal magnet is already available at £8 5s., and other items in preparation include radio tuner units, amplifiers and a pick-up.

Rola Speaker repairs will in future be undertaken by a newly formed company—Speaker Services, 50, Malden Road, Cheam, Surrey (tel.: FAIrlands 9351). The managing director, W. T. Maynard, has been working director of British Rola for 15 years.

Philco Patents.—Some 500 patents relating to radio, television and electrical gramophones have been licensed by the Philco Corporation to the Radio Corporation of America. The corresponding patent rights in Great Britain are licensed to Aircme, Ltd., manufacturers of Philco sets, a subsidiary of Radio and Television Trust.

Morgans at War.—Is the title of an excellently produced book telling the story of the Morgan Crucible Company's achievements at its Battersea, London, S.W.11, factory. The corresponding charts show that, among other increases in production, the company's wartime output of resistors was seven times that of its pre-war figure.

Frank Murphy of London, Ltd., incorporated in May, 1914, as a private company for the production of woodware, was converted to a public company on June 6th, and the balance of the authorized capital, approximately £6,000, is now the subject of a public issue. A further public issue of shares will shortly be made to establish a factory to produce receivers which it is planned to retail at between £50 and £100, including fittings.

R.S. Amplifiers have moved to a new factory in Reynolds Road, Acton Lane, London, W.4. Tel.: CHIswick 1011.

CLUBS

Chatham.—Meetings of the Medway Amateur Transmitters' Society are held every Monday at 7.30 at the Co-operative Employees' Welfare Club, 207, Luton Road, Chatham. The Club's transmitter will soon be operating, using the call G2FJA. Sec., S. J. Coonbe, 'Stunvic,' Longhill Road, Chatham.

Coventry.—Members of the Coventry Amateur Radio Society are invited to attend the recent meeting held in the B.B.C. station at Davenry on September 14th. A revival of the pre-war transmitting and receiving contest in connection with the Coventry Amateur Radio Society is planned for October. The new secretary is J. W. Swimington, G2YS, 116, Moor Street, Coventry.

Holloway.—The Grafton Radio Society meets three times a week, on Monday, Thursday and Friday, at 7.30 at the Grafton L.C.C. School, Eburne Road, Holloway, London, N.7. Details of the current syllabus are obtainable from the Secretary, W. H. C. Jennings, 82, Craven Park Road, London, N.15.

Oswestry.—As a result of a meeting held on July 31st the Oswestry and District Radio Society has been formed. Details are obtainable from A. D. Narraway, 'Lamorna,' Pant, Nr. Oswestry, Salop.

Reading.—At a recent meeting of the Reading and District Radio Club, G6CU, formerly of Cocos Island, spoke of his activities in the Pacific. The club, which has been in existence for just over two years, has a membership of 75 and meets at the Palmer Hall, West Street, Reading, at 6.30 on the last Saturday in the month and again fourteen days later. Hon. Secretary, P. J. Nash, 9, Holybrooke Road, Reading.

Romford.—Meetings of the Romford and District Amateur Radio Society will in future be held in the Maynew Road Schools, Romford, each Monday at 8, Secretary, R. C. E. Beardon, G3FT, 3, Glyn Gardens, Whittlestone Lane North, Chadwell Heath, Essex.

South Shields.—Meetings of the South Shields Amateur Radio Club are held every Friday at 7.30 in St. Paul's School Room, Westoe, Secretary, W. Donnell, 12, South Frederick Street, South Shields.

Wolverhampton.—Meetings of the Wolverhampton Amateur Radio Society will in future be held at 7.30 on the first Monday in each month in the community centre, Messrs. Bymall, Merridee Street, Wolverhampton. W. O. Sturme, G8KL, of 3, Broome Road, Wolverhampton, is the secretary.
CONVENTIONS AND VIEWPOINTS
Where Readers and Writers Have to Take Care

By "CATHODE RAY"

I WONDER how many thousands of **Wireless World** readers had to do their bit towards winning the war by trying to stay awake while listening to the hour to this sort of thing—"negative square wave cuts off \( V_{a} \), charging \( C_{20} \) positive and making current flow through \( R_{1001} \) and \( R_{1002} \) in parallel, biasing \( V_{1000} \) positive... etc., etc." Does that bring it back at all? No? Then at least you must often have tried to follow some printed explanation of circuit action. In doing so did you ever feel in your inner heart that when a condenser was said to be charged it was really being discharged? Or that "positive" should have been "negative" or "parallel" should have been "series"? If you have never been confused in ways like this you must either be very clever or (forgive me) very inattentive; and just to make sure, will you please answer the following simple questions:

![Fig. 1](#)

**FIG. 1**

In Fig. 1, are \( R_1 \) and \( R_2 \) in series or in parallel? When \( G \) in Fig. 2 is made positive, does it charge \( C \) or discharge it? If it charges \( C \) does it do so positively or negatively? An arrow alongside the resistor in Fig. 3, to show the direction of the voltage drop, should point downwards—true or false? In the "valve equivalent circuit" (Fig. 4) does the signal current \( i_a \) flow in the same direction as the signal voltage \( \mu V \), or in the opposite direction?

If you have given the right answers to all these I bow to your omniscience. The last question was hotly debated for several months by Prof. G. W. O. Hove, D.Sc., M.I.E.E., K. R. Sturley, Ph.D., B.Sc., A.M.I.E.E., D. A. Bell, M.A., B.Sc., and D. H. Parnum, B.Sc., A.R.C.S., Ph.D., among others, in at least three different technical journals; while the easiest-looking of the lot (Fig. 3) was the subject of controversy in the inconceivably learned pages of **Wireless Engineer**. So perhaps I am not insulting readers by hinting at the possibility of their being confused, even in such elementary matters.

In fact, failure to crack off ready answers to these questions is no ground for shame or despondency. Quite the reverse. Whether or not it is true that there are two sides to every question, there are certainly two sides to these. There are so many sides to the Fig. 4 problem that it might almost be described as a polygon.

For there are quite a number of crossroads in electrical science where Nature does not give an indisputable lead, so the direction has to be settled by convention or general agreement. And where there is no general agreement, how is one to know which is right and which is wrong?

The direction of electric current is a good example. When the need first arose for specifying it, nobody had much of a clue to what an electric current was or how to tell which way it was flowing. So it was agreed to make a guess and say that in the external circuit of a cell the current flowed from copper to zinc. When electrons were discovered, this looked like a bad guess, because it was found that they flowed in the opposite direction to the supposed current. So long as only wire circuits were involved, it didn't matter a great deal. Electrons were only a theory, anyway. But when vacuum valves came into use, electrons could no longer be treated as a collective phenomenon in which direction was a mere matter of convention. They became real and individual. So a lot of people have reversed the original guess and now say current flows from "negative" to "positive" (two more conventional terms). The maximum confusion thereby exists. The revisionists contend that obviously everyone ought to change over, instead of clinging to what is now known to be wrong. To which the conservatives answer that an electric current can flow in the conventional direction, and does so in soft valves and electrolytes.

![Fig. 4](#)

**FIG. 4**

![Fig. 5](#)

**FIG. 5**

So until an international authority succeeds in persuading everyone to do one thing or the other (and international authorities don't seem to be having much luck at this kind of thing just now) confusion can only be avoided if people take the trouble to say which convention they personally are using.

Fig. 3, for all its apparent simplicity, is a little more subtle. It was discussed on page 442 of the September 1945 **Wireless Engineer**, and has nothing to do with the current flow convention, being a question of e.m.f. and potential difference (p.d.). To me the answer seems to be bound up with the Fig. 1 question. Two circuit elements connected as shown there are in series and in parallel. Which is the more appropriate way to regard them depends mainly on what is not shown—the e.m.f. or e.m.fs. If the source of e.m.f. is external, connected between the points \( a \) and \( b \) in Fig. 5, then with respect to this source \( R_1 \) and \( R_2 \) are in parallel. Any currents flowing must be downwards in both or upwards in both, and
Sticking rigidly to this rule when the condenser voltage is periodically reversed by the signal may lead to very cumbersome explanations. Then it may be better to ignore incidental "base-line" potentials. For instance, in Fig. 6 suppose the effect of a recurring signal at the input to the valve is to make A alternately positive and negative with respect to B. A detailed description of this by the first method would involve one in a discharge and a charge in opposite polarity at each stroke of the signal. It is easier to forget the fixed positive potential of B and call each positive movement of A a charge, and vice versa.

The same question crops up in specifying potential changes. A in Fig. 2 is always positive, if it is understood that earth is zero. But one would generally say that making G positive drives A negative. The initial potential of A is understood for the time being to be zero. At least, it is understood by the more experienced, but I am sure it must be terribly muddling to the novice who has only learned the printed rules and not the unspoken traditions. Even the experienced would sometimes like to be told whether "negative" means really negative (with respect to earth) or just less positive. I find it helpful to call a signal "negative-going" rather than "negative" if one wants to indicate its direction rather than its relationship to earth.

There is another aspect of this relative potential business that I am sure learners must often find confusing, just because it may never occur to their instructors to point it out. They are told, for example, that a positive voltage is applied to a in Fig. 7. C is charged by it; so as a is its positive terminal, b must be its negative terminal. But when R is considered, b is not negative; it is positive. Then are both terminals of C positive? Easy enough, you say. But if you are teaching somebody else, do make quite sure he is following the leaps and jumps of your potential "zero".

No, I am not going to answer Fig. 4. If you want some of the answers, you can turn up the following and sort it out for yourselves:


All I will add is to drag in the series-parallel question by mentioning that Fig. 4, showing valve internal resistance and load resistance in series, is only the better-known of two alternative valve equivalent circuits. The other shows r, and r, in parallel with one another and with the e.m.f. Both equivalents work.

Moral: Whether you are the explainer or the explainee, make quite sure that in matters of viewpoint or convention you are both on the same ground at the same time. Polarity, direction, positive and negative, charge and discharge, even series and parallel, are relative things; and if you don't take care about them the ambiguity bug will get you.

Marine Navigation Prize

The Royal Society of Arts is again offering a prize of £50 under the Thomas Gray Memorial Trust for "an invention, publication, diagram, etc., which is considered to be an advancement in the science or practice of navigation proposed or invented between January 1st, 1941, and December 31st, 1946." Further details are obtainable from the Secretary, Royal Society of Arts, John Adam Street, London, W.C. 2. Last year's prize was awarded to W. J. O'Brien for the Decca Navigator.
THE TREND OF MODERN ELECTRONICS

THE PINT VALVE
IN THE
HALF-PINT GLASS

BRIMAR
BVA
VALVES
Bantam Range

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.
There's a moral in the ECHINOCACTUS NAPINUS CHILE

... a moral in so far that if you don't know anything about cacti and start messing about with them you are liable to get stung rather badly.

Now apply the same thought to Transformers; some people want a few Transformers and think the order is not large enough to bother us with (nonsense of course, as you know, but some people do think that) so they knock a few up themselves from odds and ends that are lying about.

Of course, the so called Transformers are just not quite perfect and don't just do the job they should. The same thought applies also to very cheap quality Transformers which some people buy and attempt to use.

The moral is when buying Transformers - go to an expert and get the right article - it may cost you a little more but, in the long run, you are saving money.

PARMEKO of LEICESTER.
Makers of Transformers.
Simple resistance coupling is of little use when the high-frequency response of an amplifier extends into the megacycle region because of the shunting effect of the valve and circuit capacitances. In order to obtain a useful amplification from each stage, therefore, inductance is associated with the circuit in such a way that it tends to compensate the unwanted effects of the capacitance.

Of the many possible circuits the shunt-corrector, of which the circuit is shown in Fig. 1, is one of the most widely used. It has the great merit of combining good performance with simplicity. The procedure for determining the optimum circuit values is given below and followed by some examples.

Assumptions

That the anode A. C. resistance of the valve is very large compared with R, and that the resistance of L is very small compared with its reactance at high frequencies, and small compared with R at low frequencies.

Conditions

The formulae are derived for the condition of the flattest frequency response, curves A, and for critical damping, curves B.

Procedure

Given the drop in response (db) required at a maximum frequency f, and the total circuit capacitance C, to find the other circuit values:

(a) for the flattest frequency response
1. Determine fCR from curve A, Fig. 2.
2. R = (fCR)/fC
3. A = g m R
4. L = 0.414CR^2
5. C1 = 0.352 C

(b) for critical damping
1. Determine fCR from curve B, Fig. 2.
2. R = (fCR)/fC
3. A = g m R
4. L = 0.296 CR^2
5. C1 = 0.125 C

Alternatively, given the response required at a given time t after the onset of a pulse:

(c) for the flattest frequency response
1. Determine t/CR from curve A, Fig. 3.
2. R = (t/C)/(t/CR)
then proceed as in (a) 3, 4 and 5.

(d) for critical damping
1. Determine t/CR from curve B, Fig. 3.
2. R = (t/C)/(t/CR)
then proceed as in (b) 3, 4 and 5.
Design Data—

Symbols

- \( E_o \) = output voltage
- \( e_{in} \) = input voltage
- \( A = E_o/e_{in} \) = amplification
- \( \varepsilon \) = mutual conductance of valve
- \( R \) = coupling resistance
- \( L \) = correction inductance
- \( C \) = total stray capacitance
- \( C_1 \) = capacitance across \( L \)
- \( f \) = maximum frequency required
- \( t \) = time

Units

mA/V; k\( \Omega \); \( \mu \)H; pF; Mc/s, \( \mu \)sec.

Examples

Referring to Fig. 1, C represents the sum of the stray circuit capacitances and is the starting point of design. Its value must be measured or estimated and, in practice, it is rarely less than 25 pF, and may be 40-50 pF. The capacitance \( C_1 \) bears a definite optimum relation to \( C \); in its smaller values the self-capacitance of \( L \) can provide it without an additional component.

The circuit relations are given for the alternative conditions of the flattest frequency response and for critical damping. The former leads to rather higher amplification but for pulse excitation there is some overshoot. The latter is free from overshoot.

As an example of the procedure, suppose that a response of -1 db at 3 Mc/s is required when the total capacitance is 40 pF and that the condition of flattest response is satisfactory. From curve A of Fig. 2 /CR = 232, and hence \( R = 232/(40 \times 3) = 1.93 \Omega \). If the valve has \( \varepsilon = 6 \text{ mAmV}, A = 11.6. \) Then \( L = 0.414 \times 40 \times 3.74 = 62 \mu \)H; and \( C_1 = 0.352 \times 40 = 14 \text{ pF}. \)

It will be noticed that \( R \), and hence \( A \), is inversely proportional to \( C \); so that in the interests of maximum amplification it is important to keep the circuit capacitance as small as possible.

The transient response is indicated by Fig. 3, curve A showing \( E_o/e_{in} \) as a function of \( t/CR \). This curve indicates the way in which the output voltage varies with time for an input step voltage, that is, a voltage which changes instantaneously from one value to the other.

It will be observed that the output oscillates slightly about its final value before settling down. This can be avoided by a different choice of circuit values, but only at the expense of amplification. For television purposes when only a single V.F. stage is usual this small degree of overshoot is usually permissible.

For oscilloscope amplifiers and for multi-stage television amplifiers it is often necessary to avoid overshoot. With critical damping different relations exist between the components and a different set of design equations is given. Curves B in Figs. 2 and 3 then apply.

As an example, taking the same values as before, but working from curve B of Fig. 2, we find \( f/CR = 140, \) so \( R = 140/(3 \times 40) = 1.165 \Omega. \) Then \( A = 7; \) \( L = 0.296 \times 40 \times 1.36 = 16.1 \mu \)H; and \( C_1 = 5 \text{ pF}. \) There is thus a considerable loss of amplification as compared with the condition of flattest frequency response.

To illustrate the pulse performance of this last condition we have \( CR = 40 \times 1.165 = 46.5 \). We want to know how many microseconds after the application of a pulse the output reaches 90 per cent of its final value. Curve B of Fig. 3 gives this information; \( t/CR = 0.9 \) is 0.00145, so that \( t = 0.00145 \times 46.5 = 0.0675 \mu \)sec.

For the example with the flattest frequency response we use curve A and find \( t/CR = 0.0013 \), while CR is 40 \times 1.93 = 77.3, \) so that \( t = 0.0013 \times 77.3 = 0.101 \mu \)sec.

As another example, suppose that overshoot cannot be tolerated and that it is required that the pulse response be 90 per cent complete in 0.1 \( \mu \)sec. Let the stray capacitance be 30 pF and the valve have a mutual conductance of 6 mA/V, what circuit values are needed?

From Fig. 3, curve B, \( t/CR = 0.00145, \) hence \( R = 0.1 \times \frac{40 \times 1.93}{2.3} = 2.3 \Omega; \) \( A = 6 \times 2.3 = 13.8; \) \( L = 0.296 \times 30 \times 5.3 = 47 \mu \)H; \( C_1 = 0.125 \times 30 = 3.75 \text{ pF}. \)

If the condition of flattest response had been permissible, we should have used curve A and obtained \( t/CR = 0.0013, \) giving \( R = \frac{30 \times 0.0013}{0.1} = 2.56 \Omega; \) \( A = 6 \times 2.56 = 15.4; \) \( L = 0.414 \times 30 \times 6.6 = 82 \mu \)H; \( C_1 = 0.352 \times 30 = 10.55 \text{ pF}. \)

NEW BROADCAST RECEIVERS

BANDSPREAD tuning for television sound and the 13, 16, 19, 25, 31, 41 and 49 metre bands is provided in the Ekko Model A28 by a system of permeability tuning which is claimed to obviate microphony on the short waves. Station selector switches for three medium-wave and two long-wave programmes are additional to normal slow-motion drive tuning. The four-valve plus rectifier superhet circuit employs a pentode output valve with negative feedback and there is a "magic eye" tuning indicator. The price is £29 8s (purchase tax £6 6s 6d). In the Ekko Model A23 a similar circuit is employed with five station selection buttons, and television sound as well as short, medium and long wave ranges. The price of this receiver is £21 (purchase tax £4 10s 4d). The makers are E. K. Cole, Ltd., Southend-on-Sea.

The Model A463, produced by Allander Industries, Milngavie, Glasgow, is a superhet (four valves plus rectifier) and is available in two forms: (1) for the home market; (2) for export. The home model uses British valves and has wavebands of 17-90, 185-565 and 820-2,300 metres, while the export model uses international octal, covers 185-565.

Bandspread tuning on seven short-wave bands and the television sound channels is provided in the Ekko Model A28.

31-100 and 12-37.8 metres, and is fitted with tropicalized components. The price of the home market receiver (Model A463/1) is £15 15s, plus tax £3 7s 9d.

Three new domestic receivers are now in production by Masteradio, Ltd., 193, Rickmansworth Road, Watford. The Model D110 is a small table model for A.C./D.C. mains, housed in a moulded plastic cabinet with a choice of three colours. It covers short, medium and long waves and the price is £14 3s 6d, plus tax £3 3s 6d. A similar chassis in a walnut cabinet (Model D110W) costs £15 4s 6d. A larger table model for A.C. mains in an acoustically designed two-colour plastic cabinet (Model D111) is priced at £18 7s 6d, plus tax £3 19s 4d. In each case the basic circuit is a four-valve superhet, plus rectifier.
A selection of answers to questions we are continually being asked by letter and telephone.

Minimum length roft. depending on peculiarities of the site.

Q.13. Would a metal mast adversely affect the picture?
A.13. In practice no, provided it is earthed. The presence of a conductor in this position between the dipole and reflector is taken into account in the design and suitably allowed for. The disadvantage is a mechanical one. A metal pole of the above mentioned dimensions is necessarily heavy, costly and difficult to handle on sloping roofs, etc.

Q.14. Can a television aerial be used for broadcast reception?
A.14. Yes, in districts where there is little or no interference, many people have got into the bad habit of doing without an aerial and have never heard their sets at their best because they have always had to operate with the volume control unnecessarily full. When installing a television receiver a television aerial is almost essential, so when it is being erected an insulated lead should be taken*3 from the metal cross arm to the broadcast receiver. This lead need not be disconnected when receiving television—it exercises a negligible effect.

Q.15. Can a television aerial be used as an anti-interference aerial?
A.15. Yes. A kit*4 comprising transformers and cable is available, provision being made to secure the aerial transformer to the cross bar of the television aerial, the rest of the system being carried out as an ordinary anti-interference installation.

Q.16. Must a dipole and reflector always point directly at the television transmitting station?
A.16. Generally, yes, but an installation department or any people doing a large number of installations know that it is often advantageous to rotate the television aerial slightly one way or the other due to distortion of the polar diagram caused by local conditions at the receiver end. The rotation of the receiver aerial is also often used to improve the “signal to noise” ratio where there is local interference. See next question 1, repeated.

Q.1. (Repeated from Quiz No. 1.) What are the advantages obtained when using a reflector with a dipole?
A.1. (a) It is necessary in areas of weak field strength to increase the signal input to the receiver.
(b) The directional properties can be utilised as a means of minimising interference, particularly so, if the aerial can be installed in such a position that the location of the source of interference is placed behind the reflector in relation to the transmitter.
(c) By rotating the aerial, ghost image can be reduced or eliminated.

Q.17. What type of plug and socket is recommended for use with L.336 balanced feeder?
A.17. The L.303*5 range for skirting board terminations and wall plugs for the receiver. The L.93 range are flat pin plugs complying with BSS.613 and are available for flush mounting and proud mounting and in Brown and Cream (Cream in short supply).

---

** BELLING & LEE LTD CAMBRIDGE ARMS ROAD, EMPIRE, MIIDX

---

Q.11. Are masts supplied with Belling-Lee*1 aerials?
A.11. Normally yes, but at the present time the bulk purchase of suitable wooden masts is almost impossible. That is why we ask customers to supply their own. It is generally possible to obtain a single one locally.

Q.12. What kind of pole is required?
A.12. We specify turned pine 2¹⁄₂in. in diameter by approximately 16½ft. in length. In practice any stout mast will do but the 2¹⁄₂in. diameter is important, as this has to fit pole clamps and a pole cap*6.

1. L.502/L Dipole, reflector and cross arm, chimney lashings (less mast), £5 5 0
   Supplied also without reflector and/or chimney lashings from £2 3 6


4. L.392/100 ... ... £7 10 0
   L.392/120 ... ... £8 6 0
   Including 2 transformers. Suffix No. denotes length of L.1221 Feeder Cable.

5. L.303/F 3-way socket flush mounting ... 3/- each
   L.303/F 3-way flush mounting ... 1/6d each
   L.303/S 3-way socket surface mounting ... 2/9 each
   Cream approx. 25% dearer

TO BE CONTINUED.
Advertisements

Wireless World September, 1946

The engineering resources which produced hundreds of millions of Erie components for war-time needs are now at your service. May we advise you, quote you, or send you samples?

ERIE RESISTOR LTD.
CARLISLE ROAD, THE HYDE,
LONDON, N.W.9.
Telephone: Colindale 8011

FACTORIES: London, England
Toronto, Canada • Erie, Pa., U.S.A.

Musical Radio

The POLYPHONIC RADIOGRAM
A combined quality Instrument without cabinet "dialect," incorporating the phase inverter speaker, and seven valve three band tandem coupled variable selectivity super-het with paraphase triode output.

£67.10.0
Plus Purchase Tax.

Sound Sales Ltd.
WEST STREET, FARNHAM, SURREY.
FARNHAM 6461-2-3.

Agents. LONDON : Messrs. Wallace Heaton, Ltd., 127, New Bond St., W.1
KENT : Messrs. Potter Bros., 49, High Street, Tenterden.
S. WALES : Messrs. Sound Ltd., 46, Charles Street, Cardiff.

SURREY : West End Radio, West Street, Farnham.
LANCS : Liverpool Sound Studios, 83a Bold Street, Liverpool, L.
CHANNEL ISLANDS: Sound Services, 16 Charing Cross, St. Helier, Jersey.

www.americanradiohistory.com
AIDS TO TRAINING

"Synthetic" Methods in the R.A.F.

By

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

DURING the war enormous numbers of people, most of whom possessed no previous knowledge of radio, had to be trained in the operation and maintenance of ever more complex equipment, in the shortest possible time. At the start, blackboard and chalk, and sometimes (but not always) a sample of the equipment to be taught, were the only training apparatus available. Anything else had for the most part to be extemporized from salvage by the instructors themselves, who were already fairly well loaded with teaching. Nevertheless, a mere selection of the aids developed for use in the R.A.F. Group concerned with radio training was sufficient to make up a large and interesting exhibition held recently at Cranwell.

The exhibits represented great changes in methods of teaching. They were of two main categories: those designed to make the teaching more palatable and digestible, such for example as a mechanical model of wave motion; and synthetic devices such as the Harwell Box, into which radio signals and engine noises are fed, in order to simulate the surroundings of wireless operators in flight without having to provide aircraft.

Blackboard and chalk, even in the hands of the most capable lecturer, leave much to be desired. For some of the instruction they are being supplanted by cathode-ray tubes large enough to be seen by a whole class, or alternatively a number of small tubes mounted on the classroom desks and wired in parallel. A good example is the trainer for AI Mark X (American SCR-720). It consists of a boldly drawn circuit diagram the size of a blackboard, a working set of the equipment, and an outsize in oscilloscopes with two 12-in cathode-ray tubes. By means of push-button switches the instructor can connect either of the tubes to any important point in the equipment, and at the same time as the waveform appears on the tube an indicator lamp marks the corresponding point on the circuit diagram. Similar apparatus is used for a number of other circuits.

Illuminated panels are used to demonstrate the functions of an aircraft aerial switch.

This scheme has many advantages. It saves the instructor’s time in drawing diagrams, and is more legible (generally!). It is more convincing to the trainee, who sees an actual oscillogram coming from an actual set. The effects on waveform of operating the controls can be demonstrated. It adds usefulness to familiarity with oscilloscopes. Direct correlation of the gear itself, its circuit diagram, and its oscilloscope pictures, is far more effective than blackboard sketches which have to be related elsewhere to the thing itself.

During the war radio and radar equipments were too numerous and transitory for such refined methods to be used universally, but in peacetime these difficulties should lessen.

Although the policy in R.A.F. instruction is towards study of the equipment itself rather than theoretical blackboard sketches, the external or even the internal appearance of a set seldom goes far towards enabling a trainee to grasp how it works. It is helpful therefore to demonstrate some of the more involved processes by means of aids that are part-model and part-diagram. For instance, the Type J aerial switch in the aircraft radio T1154/R1155 is connected to a diagram in which illuminated panels show the circuit changes as the switch is operated.

Another modern trend is to give the trainee opportunities for repeating demonstrations himself until they are thoroughly absorbed. The push-button devices already mentioned can be used for this. Another self-teaching aid is the Quiz Board, down one side of which are a number of questions, and down the other, in random order, are the answers. Question and answer can be selected by push-buttons; and if the trainee ventures the right answer he is rewarded by a green light. Any other answer results in a red light and (to rub it in) a blast from a horn.

A very important qualification in radio is being able to deduce the nature of a fault quickly from the symptoms. If this can be done without the aid of any instruments, so much the better. Devices for associating the fault with the symptoms include an R1155 receiver in which by means of a selector switch any valve heater could be open-circuited to simulate a faulty valve. Another, for teaching the use of the oscilloscope in tracing radar faults, is similar to the "live" circuit diagrams already described, except that, instead of being provided with push-buttons for selecting waveforms, the key points in the working equipment were brought.
Aids to Training—out through screws to the appropriate points on the circuit diagram. The instructor organizes a fault behind the board; and the trainee, armed with an oscilloscope, has to check the test points and deduce the fault.

The properties of centimetre-wave equipment were demonstrated by assemblies in which the output from a magnetron could be passed into waveguides fitted with all the gadgets known to modern electro-magnetic plumbing. The paths taken and the relative field strengths were indicated by neon lamps and explored in space by means of a vacuum-enclosed dipole and thermo-junction with indicating meter.

Centimetre waves are used not only to demonstrate their own techniques but also for scale-down study of aerial polar diagrams. The output of a klystron can be coupled to any one of a number of model aerial systems, rotating at about 6 r.p.m. Radiation is picked up by a receiver a short distance away, and the amplified output displayed as the length of a radial line on a C.R.T., rotating in synchronism with the model aerial. The polar diagram of the aerial is thus continuously painted on the tube.

A synthetic trainer of true scientific elegance is Type 54, for simulating flight conditions with H2S radar. H2S, it will be remembered, is the centimetric radar with a rotating scanner mounted on the underside of a bomber, showing on a plan position indicator a picture of the terrain beneath within a controllable radius. The scaling-down necessary to enable echo pictures to be obtained from an indoor model of the country is effected by replacing radio waves travelling at 300,000,000 metres per second by supersonic sound waves travelling in water at about 1,500 metres per second. One mile can therefore be represented by about 8 millimetres in the model, which consists of a sheet of glass forming the bottom of a tank of water a few feet square. The glass is left smooth to represent water and sandblasted to represent land, with towns built of grains of corundum.

The scanner of the H2S set is replaced by a quartz crystal mounted over the glass model at a distance representing to scale the height of the bomber. By means of its mounting the crystal can be moved about to simulate the flight of the imaginary aircraft; if necessary, under the control of a Link Trainer. These movements are traced on a glass map forming the lid of the tank.

The crystal is rotated at the scanning speed and pulsed at the normal pulse frequency, setting up a beam of sound waves in the water at 14.5 Mc/s, which is the H2S intermediate frequency. Echoes impinging on the crystal generate piezo-electric voltages which are passed straight to the I.F. amplifier, from which point the normal H2S equipment is used; and the P.P.I. traces simulate effectively those that would appear in a flight over real country. The trainee radar operator is able to practice bombing runs, and as a check on the accuracy of his work the position on which the bomb would have fallen is indicated on the map.

STABILIZED POWER UNITS

A series of voltage-stabilized supply units is being produced by S. Szymanski and O. Dzierzynski, 95, Strodes Crescent, Staines, Middlesex. The units are electronically controlled and are notable for the large number of independent supplies available from each instrument. As an example, the Model 35/46 gives three adjustable and stabilized H.T. supplies: 250-700 V, 200-50 mA; 120-350 V, 200-80 mA; 40-120 V, 70-25 mA—all stabilized to within 2 per cent. In addition there are A.C. auxiliary circuit supplies of 2, 4, and 6 V, 2 amps; 1, 4 and 5 V, 3 amps and 300 V centre tapper, 80 mA. Two grid bias supplies of 0.45 V D.C. with common positive and negligible ripple content and a 3,000 V D.C. 5 mA supply for C.R. tubes complete the picture.

The three stabilized voltages have and – insulated from the chassis and can be connected in series.

POLYTHENE AT V.H.F.

An interesting letter by J. G. Powles and W. G. Oakes appears in Nature for June 22nd, 1946, regarding the behaviour of polythene at high frequencies. As might be expected, the power factor decreases with frequency for the lower radio frequencies, rising from 0.9 x 10^-4 at 100 kc/s to about 2.6 x 10^-4 at 1,000 Mc/s for 30 cm wavelength. At higher frequencies, however, the rise is not continued; there is a flat maximum around 1,500 Mc/s and thereafter the power factor falls. At 10,000 Mc/s (3 cm) it is down to some 2.2 x 10^-4 and the curve falls quite rapidly at higher frequencies.

The reason for this rather unexpected state of affairs does not seem to be fully understood.
AMERICAN SERVICE VALVE EQUIVALENTS

CORRESPONDING CIVIL TYPES

WE published in the August, 1945, issue a list of British Service valve equivalents, and since then many readers have written asking if we can identify various American types. No claim to completeness is made for the following list, but we have found that it answers all the enquiries we have so far received and we think that it will be useful as it stands.

The short list of "JAN" serials at the end of the main list gives the few types in which the "JAN" number differs from the normal civil number.

To avoid confusion with R.A.F. types, some of which also bear "VT" numbers, two appendices are given. Appendix A indicates those valves which are not immediately distinguishable by their British or American bases, and Appendix B gives types which have different "VT" numbers in the British and American Services.

Suffixes A, B, C, D to a "VT" serial generally distinguish between M, G, GT or GT/G, though not necessarily respectively.

APPENDIX A

<table>
<thead>
<tr>
<th>Service Number</th>
<th>Civil Type</th>
<th>Service Number</th>
<th>Civil Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT184</td>
<td>VR80/30</td>
<td>VT229</td>
<td>6517GT</td>
</tr>
<tr>
<td>VT185</td>
<td>3D6/1299</td>
<td>VT233</td>
<td>65N7GT</td>
</tr>
<tr>
<td>VT188</td>
<td>ZE8</td>
<td>VT231</td>
<td>6557GT</td>
</tr>
<tr>
<td>VT180</td>
<td>7FT</td>
<td>VT234</td>
<td>65E7</td>
</tr>
<tr>
<td>VT190</td>
<td>71H</td>
<td>VT235</td>
<td>HY114B</td>
</tr>
<tr>
<td>VT191</td>
<td>316A</td>
<td>VT236</td>
<td>836</td>
</tr>
<tr>
<td>VT192</td>
<td>7A4</td>
<td>VT237</td>
<td>256</td>
</tr>
<tr>
<td>VT193</td>
<td>7C7</td>
<td>VT238</td>
<td>255</td>
</tr>
<tr>
<td>VT194</td>
<td>217</td>
<td>VT241</td>
<td>7E114</td>
</tr>
<tr>
<td>VT197A</td>
<td>5Y5GT</td>
<td>VT243</td>
<td>7C8</td>
</tr>
<tr>
<td>VT198A</td>
<td>6G6G</td>
<td>VT243</td>
<td>1203A</td>
</tr>
<tr>
<td>VT199</td>
<td>6SS7</td>
<td>VT244</td>
<td>514GT</td>
</tr>
<tr>
<td>VT200</td>
<td>VR105/30</td>
<td>VT245</td>
<td>2650</td>
</tr>
<tr>
<td>VT201</td>
<td>251L</td>
<td>VT243</td>
<td>2505</td>
</tr>
<tr>
<td>VT202</td>
<td>002</td>
<td>VT247</td>
<td>16AG</td>
</tr>
<tr>
<td>VT203</td>
<td>003</td>
<td>VT250</td>
<td>16F50</td>
</tr>
<tr>
<td>VT205</td>
<td>6ST7</td>
<td>VT255</td>
<td>7GA/9121</td>
</tr>
<tr>
<td>VT206A</td>
<td>5V4G</td>
<td>VT259</td>
<td>829</td>
</tr>
<tr>
<td>VT207</td>
<td>12A11HT</td>
<td>VT260</td>
<td>765/350</td>
</tr>
<tr>
<td>VT209</td>
<td>12SG7</td>
<td>VT264</td>
<td>304</td>
</tr>
<tr>
<td>VT210</td>
<td>15Y4</td>
<td>VT265</td>
<td>806F57</td>
</tr>
<tr>
<td>VT211</td>
<td>6SG7</td>
<td>VT283</td>
<td>125C57</td>
</tr>
<tr>
<td>VT212</td>
<td>96S</td>
<td>VT269</td>
<td>717A</td>
</tr>
<tr>
<td>VT213A</td>
<td>6L5G</td>
<td>VT283</td>
<td>832A</td>
</tr>
<tr>
<td>VT214</td>
<td>115H</td>
<td>VT283</td>
<td>832A</td>
</tr>
<tr>
<td>VT215</td>
<td>65E5</td>
<td>VT283</td>
<td>832A</td>
</tr>
<tr>
<td>VT216</td>
<td>816</td>
<td>VT289</td>
<td>12517T</td>
</tr>
<tr>
<td>VT217</td>
<td>12SG7</td>
<td>VT299</td>
<td>125L717</td>
</tr>
</tbody>
</table>
| VT222          | 3Q5GT/G   | VT303          | 38124     | 45 Special
| VT223          | 1HT6      | VT303          | 38124     | 45 Special
| VT224          | 2C34/1H5  | VT303          | 38124     | 45 Special
| VT225          | 3O7A      | VT303          | 38124     | 45 Special
| VT226          | 3E9/1H5   | VT303          | 38124     | 45 Special

APPENDIX B

<table>
<thead>
<tr>
<th>Civil Type</th>
<th>Service Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A.</td>
<td>British</td>
</tr>
<tr>
<td>VT52</td>
<td>45</td>
</tr>
<tr>
<td>VT73</td>
<td>75</td>
</tr>
<tr>
<td>VT53</td>
<td></td>
</tr>
<tr>
<td>VT55</td>
<td></td>
</tr>
<tr>
<td>VT56</td>
<td></td>
</tr>
<tr>
<td>VT87</td>
<td></td>
</tr>
<tr>
<td>VT67</td>
<td></td>
</tr>
<tr>
<td>VT82</td>
<td></td>
</tr>
<tr>
<td>VT83</td>
<td>665</td>
</tr>
<tr>
<td>VT84</td>
<td>6621</td>
</tr>
<tr>
<td>VT85</td>
<td>1610</td>
</tr>
<tr>
<td>VT86</td>
<td>754</td>
</tr>
<tr>
<td>VT87</td>
<td>67</td>
</tr>
<tr>
<td>VT88</td>
<td>6753</td>
</tr>
<tr>
<td>VT89</td>
<td>125C7</td>
</tr>
<tr>
<td>VT90</td>
<td>125Y7</td>
</tr>
<tr>
<td>VT91</td>
<td>1253</td>
</tr>
<tr>
<td>VT92</td>
<td>125S7</td>
</tr>
<tr>
<td>VT93</td>
<td>125T7</td>
</tr>
<tr>
<td>VT94</td>
<td>125U7</td>
</tr>
<tr>
<td>VT95</td>
<td>125V7</td>
</tr>
<tr>
<td>VT96</td>
<td>125X7</td>
</tr>
<tr>
<td>VT97</td>
<td>125Y7</td>
</tr>
<tr>
<td>VT98</td>
<td>125Z7</td>
</tr>
<tr>
<td>VT99</td>
<td>125A7</td>
</tr>
<tr>
<td>VT100</td>
<td>125B7</td>
</tr>
<tr>
<td>VT101</td>
<td>125C7</td>
</tr>
<tr>
<td>VT102</td>
<td>125D7</td>
</tr>
<tr>
<td>VT103</td>
<td>125E7</td>
</tr>
</tbody>
</table>

PREMIER RADIO Co.

MORRIS & CO. (RADIO) LTD.

All Post Orders to
'Phone: Amherst 4723

Callers to
'Phone: Central 2833

Our New List will be ready the 10th September. Price 2/4d., post paid.

RADIOGRAM CABINETS. Dignified appearance and good workmanship: Size 34in. high, 19in. deep, 36in. wide. Send for illustration. Cabinet only. £2.6. With Electric Motor and Pick-up, £3/2/6d.- With Record Changer, £6/2/6d.-


ROTARY TRANSFORMERS. Size only 7in. by 4in. diameter. With 6v. input; output 200 v. 50 m.a. With 12v. input; output 400 v. 60 m.a. Price 20/-. ROTARY TRANSFORMERS. With 12v. input; output 600 v. 250 m.a. With 6v. input; output 200 v. 250 m.a. Price £3. D.C. to A.C. ROTARY CONVERTERS. Input 24 v. Output 230 v. 200 watts. Or with 12v. input, output 100 v. 80 watts. £7.

PLAYING DESKS.—Consist of an Electrical Gramophone Motor with automatic stop, and speed regulator and a quality magnetic Pick-up mounted on a strong metal frame. Price complete, £6/17/6; without Pick-up, £5/10/.

MIDGET RADIOMIC KITS.—Complete with drilled chassis, valves and loudspeaker, only cabinet required, medium and long wave T.R.F. Size 10in. x 6in. x 6in. 4 valves, inc. rect., tone control, AC/DC operation, 200/250 v. Circuit and constructional details supplied. Price, including tax, £6/17/6. Cabinet, if required, 25/- extra.

FIRST GRADE OIL FILLED PAPER CONDENSERS, with miniature stand-off insulators and fixing clips, 2 mfd. 1,000 v.w., 2/6 or 20/- per dozen; 2 mfd. 600 v.w., 1½ each or 10/- per dozen; 1 mfd. 600 v.w., 1½ each, 8/- per ctn. Super Quality Oil Filled Tubulars. Insulation as good as Mica. 1 mfd. 500 v.w., £2.50; 5 mfd. 750 v.w., 5 mfd. 350 v.w. Each type, 9d. each, or 7/6 per dozen.

SERVICEMAN'S KIT.—Consists of 50 resistances, 50 condensers. All useful values, 20/- only.

B.P.L. SIGNAL GENERATOR, 100 Kc/s to 30 m/c/s in six bands, 1 per cent. calibration, 1 volt into 10 ohms. 30 per cent. modulation by 600 cycle osc., mains driven, £21.
RADIO AUSTRALIS

Wireless in the Commonwealth: Openings for British Goods

From a Correspondent

Australian radio is slowly but surely taking its post-war shape. First efforts of manufacturers to catch up with a receiver demand starved over the war years have as yet not been completely successful. Various bottlenecks in production such as the shortage of parts, i.e., loudspeakers, variable condensers and electrolytic condensers, added to industrial hold-ups, have tended to slow things up. Nevertheless, a good range of broadcast, dual wave and kit sets is gradually becoming available.

It may not be generally known that Australian manufacturers have been able, behind a very high tariff wall, to found a very large business, and at this date an imported receiver is a rarity. Australian broadcast receivers are first-class articles. Largely of American design and mostly with an American valve kit, they give first-class results.

Customs duties leave a very small field for the British manufacturer. There is, however, scope for some lines of S.W. components. The writer had occasion recently to approach the "sole" agents in Australia for two well-known brands of English S.W. components which sold well in the pre-war days. One firm had no stock at all, the other almost none.

Broadcasting.—No concrete plans have as yet been formulated for the future of F.M., television or facsimile. The present A.M. service is a combination of national (Government-owned) and commercial stations. Powers range to 10 kW in the case of national stations and 2 kW in the case of commercial stations. The commercial stations are entirely dependent on income from advertising.

There is a good deal of dissatisfaction among the commercial stations on the questions of power and frequency; on these they claim parity with the national service. There are still some 900 ungranted applications for commercial station licences. When a licence is issued a chorus of protest arises from the have-nots, and the usual vigorous protests were made when a licence was recently granted to the Queensland Labour Party. The administration of all radio is firmly in the hands of the Postmaster General, who in effect makes the regulations and interprets them too. Certain quarters are now asking that the whole of radio administration be taken from Ministerial control and placed in the hands of a Federal Communications Commission.

At the present time the Federal Parliament is being advised on broadcasting matters by a standing committee of both sides of the House who take evidence at the request of Parliament. They have issued ten reports which deal with such matters as station licences, sex broadcasts and salaries for staff of the Australian Broadcasting Commission who are responsible for the national programmes. This committee has recently taken evidence on the desirability of setting up F.M. and television services, but no report has been issued to date. Broadcasting circles are hardly satisfied with the slow-moving methods of this committee, claiming that technical progress is being impeded.

Amateurs.—The re-licensing of amateurs has been going on steadily since January, some 1,500 licences having been issued. The new amateur requirements have been set out in a new set of regulations issued by the P.M.G.'s Department in a booklet called "Handbook for the Guidance of Experimental Wireless Stations." Principal changes from the pre-war licences is the grading of operators' licences "A" and "B," and the provision of two classes of stations, "A" class with a final plate input of 1,000 watts, and "B" class with a similar input of 50 watts. Frequencies available until recently have been 28-29, 50-54, 166-170 and 1,345-1,425 Mc/s, but the bands 14-14.3 and 7.4-7.5 Mc/s have just been allotted.

Aviation.—Radio facilities, greatly expanded during the war, have now been established on a firm footing. A complete string of Aeradio stations has been established, with D.F., navigational and communication facilities on the main airways. These are likely to be further expanded and improved as the Government has established its own Airlines Commission and is shortly to enter the Interstate Airways business in competition with private airlines.

Communications.—It is proposed that legislation will shortly be brought before Parliament to enable the Government to take over the communications facilities of Amalgamated Wireless, Ltd. This step is said to be in accordance with Empire policy. This action will be somewhat peculiar, in that the Government already controls 51 per cent of the £1,000,000 capital. The Government is still negotiating with the management on the matter of compensation. Amalgamated Wireless will presumably concentrate on its industrial activities, which are already large.

M.S.U.

Another contribution from Australia, in the form of a letter from a reader, is printed below.

British Test Equipment

It was with considerable interest that I read your article in the February number on the Physical Society's Exhibition. This, together with numerous letters which have appeared in your pages from time to time concerning British radio equipment for the overseas market, has prompted me to make this approach to you.

As a physicist in the Australian Munitions Supply Laboratories, having the supervision of the General Physics Laboratory, including an expanding electronics group,
I am required to select the equipment necessary for the work. I regret that very rarely have I been able to recommend the purchase of British test instruments: but the majority of the orders being placed in the U.S.A. The manufacturers of American test equipment evidently consider it worth while to make known their products to the world. By turning to a readily available trade index one can usually find lists of manufacturers of a given type of instrument, and from so large a choice it is rare if a suitable standard instrument cannot be chosen. They advertise their instruments in the trade and professional publications with a wealth of technical data, thus enabling the reader to determine their suitability for his particular requirement. As an example of this one need only peruse the pages of *Electronics*, or the *Proceedings of the Institute of Radio Engineers*, to be able to choose instruments for almost any requirement in the field of electronics. Further, one need only send a request for data to most of the manufacturers in U.S.A. to receive very expeditiously volumes of valuable performance data, characteristics and all necessary purchasing information.

If one wishes to buy British the story is a very different one. It is a matter of some difficulty to find the names of even two or three manufacturers of a required instrument. Often no British instrument can be located. No British publication carries advertisements from any way comparable with those in *Electronics* either in range of products or technical information supplied. When the name of a possible manufacturer has been obtained, a request for information has generally produced the minimum data necessary to comply with the request. Thus on the score of publicity alone the chance of an order going to Great Britain is small.

Then, of course, there is the great drawback of non-standardization of components and valves, particularly valves. There is an obvious objection to holding in stock a spare set of valves for each test instrument. This is unnecessary with the majority of American test instruments, for when a valve becomes faulty a standard one is drawn from the ordinary valve stock. This objection also applies to the use of British types of valve in constructional work. The idea of designing equipment to use British valves is rarely worth considering.

We did have hopes in Australia that Great Britain would attempt to attract orders from the Dominions in the immediate post-war period. We realize that Great Britain is working under difficulties incomparably greater than those encountered by the American manufacturers. We would prefer to buy British equipment. Unfortunately, it would appear that even if Britain desires a market here, the race for orders is already lost. In our own case plans for the next year have already been made and we still don't know what Britain can offer us in the way of equipment, even less are we aware that British instruments are comparable with the American competitors.

In conclusion, may I state that I have recently requested information from the four British manufacturers whose address I have been able to obtain concerning the performance and availability of their products. I await the replies with interest.

A. W. PYBUS, M.Sc.
Ascot Vale, Victoria,
Australia.

BOOKS RECEIVED

Radio-Communications.—By W. T. Perkins and R. W. Barton. The authors have dispensed with question and answer technique in producing this book which is intended for those intending to take the City and Guilds of London Institute examination in radiocommunications. The thirteen chapters deal, inter alia, with components, valves, receivers, A.M. and F.M. transmitters, test equipment, aerials, shipboard radio, landlines, measuring instruments and interference. The final chapter outlines some 22 experiments and the book concludes with a section giving tables and data. 312+vi pp., with 184 diagrams. George Newnes, Ltd., Tower House, Southampton Street, London, W.C. Price 12s. 6d.

Soul of Lodestone.—By Alfred Still. The author traces the story of magnetism through the ages from Greek mythology to the present time. The book includes an extensive bibliography and numerous quotations from authoritative works on the subject. 234+x pp. Murray Hill Books, Inc., 232, Madison Avenue, New York, 16, U.S.A. Price $2.50.

Varnished Cloths for Electrical Insulation.—By H. W. Chatfield, Ph.D., B.Sc.(Hons.), and J. H. Wreden. The results of the authors’ investigations into the use of various fabrics and methods of impregnation in providing high-class insulating cloths are given in this book. The authors have brought together in one volume the results of the researches carried out by the manufacturers of textiles, varnishes and electrical equipment. 255+xiv pp., with some 75 illustrations and diagrams. J. & A. Churchill, Ltd., 104, Gloucester Place, London, W.1. Price 21s.

Tannoy are introducing many new features in their post-war range of products, and highly specialised equipment is now available. Illustrated is the latest pattern Tannoy Ribbon Velocity Microphone. Write for full details of the extensive range of Tannoy Sound Equipment.
random radiations

By "Diallist"

Shock Tactics

All who went through the radar course at Watchet during the war (as hundreds of Wireless World readers probably did) will remember "Nobby"—the say nothing of a fault little dog. Percy, who went through life with the ineradicable conviction that table legs and lamp-posts were one and the same thing. Nobby was in charge of the lab, where he spent his time in guiding students in their practical investigations of the forbidding array of complex circuits that go to make up a radar set. If the circuit on which you were engaged wasn’t working properly, you sought Nobby’s fatherly aid. No matter how high the voltages involved, it was his point of honour with Nobby never to switch off before going in up to the elbows amongst the maze of wires. Of course, he must have been more or less shock-proof, you say. Far from it; he got just what was coming to him in the way of shocks and his reaction in the shape of skyward leaps and naughty words were much the same as yours and mine. His fingers were covered with burns due to encounters with unexpected “hot spots”; but switching off he regarded as something pusillanimous, something definitely not done by the best people. Once when he was rather shakily recovering after “buying” 500 volts on my particular bit of apparatus I ventured to remonstrate with him, telling him that he really ought to make a point of switching off. “Wastes too much time,” he said! I’d like to meet this hero again—provided he didn’t bring Percy.

Positive and Negative

Really it’s about time that in schools and other places where they teach they scrapped the old erroneous idea of a “positive current” and adopted in its stead the conception of a current as a flow of electrons. I cannot see any point in retaining a view which is utterly wrong, especially as it makes things far more difficult for the student when he comes to electro-magnetism and its applications to electronics. One objection often advanced to the change-over from wrong to right is that so many of the ancient rules and aids to memory would have to be dropped or changed. Many of them could actually be scrapped and a very good thing too! No need to bother about idiotic imaginary men swimming in currents, or to wonder whether its the right or the left hand whose thumb, forefinger and second finger must be arranged in odd ways if you remember the one fundamental rule that the magnetic field round a conductor carrying a stream of electrons towards you has a clockwise direction. Matters such as the polarity of electro-magnets and the direction of induced currents then present little difficulty. The Army gave a good lead during the war. We found it infinitely easier and quicker to teach the elements of electricity if we started off right away with the conception of an electron current. There could be no better time than the present for making the change everywhere; school textbooks are largely out of print and there is a golden opportunity of correcting the ancient error in the new ones that will presently be appearing.

Pilot Lamps

One of the very weak spots of present-day receivers is the pilot lamp, or perhaps I should say the pilot lamps, for many sets contain two or more of them used as dial illuminators. The life of these lamps is apt to be so short that they are a continual worry to service-men—and to set designers. After studying an oscillogram kindly sent to me some time ago by a reader I’m surprised that any lamp with a metal filament ever survives the switching-on process more than a few times. As you know, the resistance of a cold metal filament is very low. This oscillogram shows current leaping to ten times its working figure immediately after being switched on and taking an appreciable fraction of a second to drop to normal. What we seem to need for pilot lamps is some kind of protective device, to be connected in series with them, containing an element which has a high resistance when cold and becomes a better and better conductor as it warms up.

Up-the-pole-arization

A kind correspondent has sent me a cutting from a lay paper containing an article in which the reader is promised knowledge without tears of everything that matters about F.M. In excitement the anticipation of finding a crystal-clear exposition of a subject so hedged about with difficulties for the wet-nose listener I plunged into the article. Are you by any chance a little shaky about the basic difference between A.M. and F.M.? Well, here is what it has to tell you. The simplest explanation, says the writer, is that, whereas A.M. sends out waves which go up and down, F.M. sends out waves which go from side to side! I deduce, my dear Watson, that the gifted writer had been in conversation with someone who knew his onions and that someone had passed on the respective merits of A.M. and F.M. to those of horizontal and vertical polarization. It
could, though, be argued that A.M. as we know it is an "up and down" business, since all broadcast transmissions are vertically polarized, whilst F.M. in this country is a "side to side" affair in that the B.B.C.'s experimental transmissions using this system are horizontally polarized.

BOOK REVIEW

THIS revised edition of a book that first appeared in 1937 still serves a useful purpose by providing information, in concise form and at a moderate price, on a selection of the best methods of measuring inductance (self and mutual), capacitance, A.C. resistance, voltage, current, and frequency. The author has succeeded in covering theory and principles adequately while being thoroughly practical. The first chapter recapitulates as much A.C. theory as is necessary to a clear understanding of bridge and resonance methods, and there is also a chapter on conditions of accuracy in bridge methods. The remaining five chapters deal with specific methods. In these theories are applied in comparing their respective merits, and practical points are illustrated by examples. The order of accuracy is everywhere indicated. Methods for mutual inductance, so often neglected even in large texts, are included in considerable variety, and at greater length even than methods for capacitance. The quantities involved and the mode of operation and checking out results are clearly and concisely set out. In this an important contribution is made by the diagrams, which, although not of the highest standard of draughtsmanship, deserve praise for their clarity.

As the book is one of a series intended to supply readers with "a compact statement of the modern position" in their subjects, however, it is a pity that revision was not carried further, as at this date there is a slightly archaic flavour, especially in the chapter devoted to R.F. measurements, comprising one-third of the volume. For example, the statement that "at high frequencies bridge methods are in general no longer suitable" can hardly be squared with the modern position, in which bridges are commercially available to at least 60 Mc/s. The wavemeter circuit diagram (Fig. 55) with terminals for a coupling coil in series with the calibrated oscillatory circuit, and a variable condenser across phones and H.T., among other strange features, suggests the early 1920s. The present generation, too, is so used to thinking of coils as synonymous with inductors that the expression "inductive coils" may seem tautological; and the use of the word "coil" for a non-reactive component may confuse some.

With this one qualification, the book can be highly recommended, especially to students who want something clear and more concise than the large textbooks.

M. G. S.

SHORT-WAVE
Conditions
Expectations for September

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

DURING July the average maximum usable frequencies for this latitude were almost the same as during June, both day and night. The midnight M.U.F. was, in fact, little lower than that for noon, and frequencies as high as 17 Mc/s could have been regularly used till long after midnight on most routes. As was expected, the daytime M.U.F. was relatively low, and communication on exceptionally high frequencies by way of the regular layers was thereon very infrequent, especially to countries in the Northern Hemisphere. This situation should soon change considerably, as is indicated in the forecast given below.

Sporadic E was, however, very prevalent during the month and a considerable amount of communication on very high frequencies by way of this medium was possible out to medium distances, as had been forecast in this column.

Several ionosphere storms occurred and some were of a more severe nature and caused more interference to communication than is often the case in July. The worst one appeared to be associated with an exceptionally large sunspot which crossed the sun's central meridian on July 26th. The most disturbed periods were 3rd-4th (slight), 15th-18th, and 20th (more on 19th) and 25th-28th (very severe 26th and 27th). Incidentally a "very great" magnetic

TO OVERSEAS TRADERS
Wholesale and retail enquiries are invited.
Orders can be executed for B.A.O., C.M.F., and S.E.A.C. customers.

307, HIGH HOLBORN,
LONDON W.C.2, Phone-Holborn 4631

4-MILDON LTV
SUPERHETEROODYNE
3-WAVEBAND
COIL UNIT
16-47, 200-540, 800-2,000 m.

Midget iron-cored, high Q, very selective. Lite-wound coils mounted in 18 u.w. aluminium screen with all necessary holders and terminals. Completely wired up to switch with colour-coded connections, ready to fit into a box. Aerial tested. 39/6

AMPLIFIER CHASSIS

4-VALUES (Inc. Receiver), 4-WATTS
Assembled on 30 x 25 cm. aluminium chassis fitted with separate Tone Control. Volume Control with contact switch, sockets for microphone, earphone, and extension speaker. Hum free, good quality reproductions. A.C. only. Inputs 500/500 v. Input overall. 8 x 6J1 Tuna. Ready for plug, Price, including valves and Siemens, P.M. speaker, 10 Gns.

4-VALUES, 6-WATTS
With P.A. output. Specifications as above, 12 Gns.

Theoretical and practical Blue Prints of the above available separately. 35/- for set.

TO AMATEUR RADIO ENTHUSIASTS

We can supply Blue Prints and complete lists of parts joining, to build any type of receiver from a simple Crystal Set to an Advanced Frequency Modulation Receiver.

Details will be sent upon receipt of your particular requirements.

OUR POLICY—
QUALITY is given priority in our effort to produce radio receivers better than most. Careful design, English craftsmanship, first-class components and rigid inspection combine to give you something really good.

MIDGET 2-GANG CONDENSERS
00035 mfd. Ceramic insulating, 12.6

MIDGET IRON-CORED PERMANENTLY TUNED COILS
460 Kz. Wavemeters cover the following standard ranges: 16-6, 200-540, 800-2,000 m., A. F., H.F. Gs. 3- each coil.

SMALL IRON-CORED PERMANENTLY TUNED I.F.
TRANSFORMERS
Bridged 460 Kz., 15/6.

VARIABLE CONDENSERS.
20 pf. ceramic plate budget single—can be changed. 4/6; 0.0015 ceramic plate 2-pag. small, 12.6; 0.0005 ceramic insulating, 2-pag. small, 12.6; 0.0015 standard, 2-pag. B.W. 12.6. Reception condensers, 0.003 micromicronic. 3-

TRIMMERS.
3/0 ceramic base air spaced, mwt. 2.46 at 200/250, present switching cond. 2.46; 7.0C air spaced straight line, 4.05 ft., 2.46 ceramic postage stamp type, 30/80, 1.0; 50/120, 1.0; 100/250, 1.0.

MAYS TRANSFORMERS.
250-300 4 v. 4 v. 4 v. 2, 5, 8 x 50 micro, 100 micro, 150 micro, 200 micro, 300 micro; 500 micro, 600 micro, 800 micro, 1,000 micro. 200 micro, 250 micro, 300 micro, 400 micro, 500 micro, 600 micro, 750 micro, 1,000 micro, 250 micro, 300 micro, 500 micro, 750 micro, 1,000 micro. 500-1,000 ohms. 100 kohms, interleaved with mounting post, 42/-.

TO OVERSEAS TRADERS
Wholesale and retail enquiries are invited.

Orders can be executed for B.A.O., C.M.F., and S.E.A.C. customers.
Short-wave Conditions—storm also occurred on the 27th, and on this day the interruption to communications was on a world-wide scale.

Several "Dellinger" fadeouts, also apparently associated with the large sunspot, occurred during daylight hours on 21st, 23rd, 24th and 25th.

Forecast.—In September the seasonal effect in the Northern Hemisphere is such as to produce an increase in F-layer daytime ionization, and, as there is also at the present time the rapid increase in sunspot activity to enhance this effect, a very considerable increase in the daytime working frequencies to most parts of the world is expected to occur during September of this year. The night-time frequencies for long-distance transmission will, however, decrease somewhat as compared with August.

Amateur transmitters working the 28 Mc/s band may expect very many more opportunities for DX contacts, especially with distant countries in the Northern Hemisphere, than they have had of late, provided that they work the band at the right time of day.

Sporadic E is expected to be more likely in the frequency of its occurrence during the month, and medium-distance transmission on high frequencies by way of this medium should be much less frequent than of late, though it may occasionally occur. It is not expected that the normal E-layer will often control transmission for any distance in these latitudes during September.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during September for four long-distance circuits running in different directions from this country. In addition a figure in brackets is given, which indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency Range (Mc/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montreal</td>
<td>0000 11 Mc/s (18 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0900 11 Mc/s (18 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1000 11 Mc/s (22 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1200 21 Mc/s (31 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1400 21 Mc/s (34 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1600 21 Mc/s (30 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1600 17 Mc/s (26 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>2100 17 Mc/s (23 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>2300 11 Mc/s (19 Mc/s)</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>0000 11 Mc/s (17 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0400 11 Mc/s (15 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0500 15 Mc/s (23 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1000 21 Mc/s (30 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1100 26 Mc/s (34 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1300 26 Mc/s (30 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1400 21 Mc/s (33 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>2100 13 Mc/s (21 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>2300 11 Mc/s (19 Mc/s)</td>
</tr>
<tr>
<td>Chungking</td>
<td>0000 9 Mc/s (15 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0300 11 Mc/s (17 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0500 15 Mc/s (24 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>0800 21 Mc/s (29 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1100 26 Mc/s (30 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1300 15 Mc/s (21 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>1800 11 Mc/s (17 Mc/s)</td>
</tr>
<tr>
<td></td>
<td>2000 9 Mc/s (15 Mc/s)</td>
</tr>
</tbody>
</table>

POCKET RADIO

With the general release of "sub-miniature" valves, developed by the Raytheon Manufacturing Company for the proximity fuse, the Belmont Radio Corporation of Chicago has produced this pocket receiver. It is a five-valve superhet, the case for which measures 3/8 in wide, 5/32 in thick and 6 3/4 in high and weighs only 10 oz with batteries. Some idea of the compactness of the construction will be gained from the photograph of the interior.

The five valves, each of which measures 1 1/8 in long and is oval in cross section—9.4 x 3 1/16 in—weigh about half an ounce. The H.T. voltage required for these miniature valves is only 22 1/2.

A miniature earpiece is used with the Belmont Pocket Receiver which has been photographed.

With a fountain pen for the purpose of comparison. The annotated view of the chassis shows the disposition of the main components.
LETTERS TO THE EDITOR

Internal-fitting Earphones + Pulse Modulation + Impregnated Winding

Hearing-Aid 'Phones

With reference to the letter from A. P. R. Mackie in your July issue, may I point out that the earpiece described by me in Wireless World of June is intended to work as an air conductor, and it has been shown that it has a smaller bone conductor component than an ordinary Post Office telephone receiver. It does not compete in efficiency with the latest miniature crystal earpieces, but while these are inclined to have an upper frequency response, the shell earpiec, as I have called it, can very easily have its response tailored, and if required it will give a very level response over a wide range, or it can even be made to accentuate the bass by varying the masses and springs (rubber pads) and the damping. The mathematics are very complicated, but theory confirms practice in this matter. In fact, far more amplitude can be delivered by the shell than is allowed by the mechanical restrictions to be found in the small diaphragm associated with a miniature electromagnetic receiver.

I think I am not laying myself open to contradiction if I state that the shell earpiece is considerably more efficient than any bone conductor that has been produced; also that it has all the practical advantages of a bone conductor receiver without the necessity of a head band; but I agree with Mr. Mackie that a number of sizes of receivers will have to be in stock against only a number of anatomical fittings, but this is a point where the manufacturers will have to make provision and good service should obviate the difficulty.

C. M. R. BALBI.

Durban, Natal.

“Miller” Integrator ?

I have noted with interest M. G. Scroggie’s suggestion, in your June issue, that the Miller Integrator should be renamed “Blumlein.”

The problem of correctly attributing many of the wartime electronic developments is clearly going to present many difficulties, although few of the circuits are of such broad significance as the so-called “Miller” integrator.

I agree with Mr. Scroggie that the present name is inappropriate but, although not wishing to detract in any way from the many achievements of the late A. D. Blumlein, would enquire how Mr. Scroggie’s suggestion can be reconciled with British Patent 575,250, recently issued to Messrs. A. C. Cossor and J. W. Whitley (with whom, incidentally, I am in no way connected).

R. J. F. HOWARD.

Walton, Staffs.

Pulse Terminology

In your issue of April, 1946, “Cathode Ray,” in an article entitled “Pulse Modulation,” gives useful information on various aspects of a transmission system which has very great possibilities. However I think that the choice of certain descriptive terms is not exactly happy. May I suggest the following definitions?

(1) When the time of occurrence of one or both edges of the pulses of one class in a train of pulses of the same class (the pulses having constant amplitude) vary in accordance with a modulating intelligence, the pulse train is said to be “Time Modulated.” The general term “Time Modulation” should be applied to all such transmissions.

(2) When a train of pulses of one class (the pulses having constant amplitude and duration, and in the unmodulated condition one of the pulses periodically occurring during successive equal time periods) is time modulated in accordance with a modulating intelligence within limits such that one pulse of said class always occurs during each of the successive equal time periods, the pulse train is said to be “Phase Time Modulated.”

(3) When a train of pulses of 30 cps to 15,000 cps, within ±1/4 db, under 1% distortion at 40 watts and 1% at 15 watts, including noise and distortion of pre-amplifier and microphone transformer, Electronic mixing for microphone and gramophone of either high or low impedance, with top and bass controls. Output for 15-240 ohms, with generous voice coil feedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, as illustrated, with built-in 15 ohms mu-metal shielded microphone transformer, tropical finish. Price 29s. gns.

C.P. 20A 15 Watt Amplifier for 12-volt battery and 230-v. mains operation. This improved version of the old C.P.20 has switch change-over from a.c. to d.c. and 4-7.5 watts output transformer, and only consumes 3½ amperes from 12-volt battery. Fitted mu-metal shielded microphone transformer for 15-ohm microphone, and provision for crystal and moving iron pick-up with tone control for bass and top and outputs for 7.5 and 15 ohms. Complete in steel case, with valves. £22·10·0.

A.C.20 Amplifier.—This well-known model has been retained and has a response 20—15,000 cps, mixing arranged for crystal pick-up and microphone, large output transformer for 4-7.5 and 15 ohms to deliver 15 watts at less than 5 per cent. total harmonic distortion to the speakers. Price £15 15·0 (Case for above model, £3 0·0).

A.C.20 Amplifier.—This is a development of the A.C.20 amplifier with special attention to low noise level, good response (20—18,000 cps) and low harmonic distortion (1 per cent, at 10 watts). Suitable for any type of pick-up with switch for record compensation, double negative feedback circuit to minimise distortion generated by speaker. Has fitted plug to supply 6.3 v. 2 amp. L.T. and 300 v. 30 5 a. a. L.T. to a milliammeter and voltmeter. Price £18 0·0 (Case for above model, £3 0·0).

Record Reproducer.—This is a development of the A.C.20 amplifier with special attention to low noise level, good response (20—18,000 cps) and low harmonic distortion (1 per cent, at 10 watts). Suitable for any type of pick-up with switch for record compensation, double negative feedback circuit to minimise distortion generated by speaker. Has fitted plug to supply 6.3 v. 2 amp. L.T. and 300 v. 30 5 a. a. L.T. to a milliammeter and voltmeter. Price £18 0·0 (Case for above model, £3 0·0).

We very much regret that owing to increased costs we are reluctantly compelled to advance the above prices by 10% on orders placed as from July, 1st.

Dealers and Export Agents should write for special terms to:

VORTEXION LTD.

257-261, THE BROADWAY,

WIMBLEDON, LONDON, S.W.19

Telephones : Liberty 2814 and 6424/3.

Telegrams : "VORTEXION, WIMBLE, LONDON."
Letters to the Editor—

one class (the pulses having constant amplitude and duration, and in the unmodulated condition, \( n \) of said pulses, where \( n \) is a number equal to or greater than unity, periodically occur during successive equal time periods) is time modulated in accordance with a modulating intelligence in such a manner that, over a succession of the successive equal time periods, the number of pulses of said class occurring during one or more of said time periods varies within the limits \( n \) plus and or minus \( n/r \), where \( r \) is preferably greater than unity; the pulse train is said to be "Frequency Time Modulated."

(4) When the durations of the pulses of one class (in a train of pulses of the same class, the pulses having constant amplitude) vary in accordance with a modulating intelligence, the pulse train is said to be "Duration Time Modulated." The terms "Width" or "Height" are to be deprecated in this connection. The word "Duration" has been used in this sense for a number of years by earlier workers.1

These three systems of time modulation can each be characteristic of the phase, frequency or amplitude of the modulating intelligence. Thus Duration Time Modulation can be characteristic of the phase of a signal, the phase in turn being characteristic of the amplitude.

"Cathode Ray" is in error in saying that Frequency Time Modulation has not been used. In actual fact this is the most widely used system,2 being in daily use for photo-radio transmission over world-wide circuits. At the receiving station a train of time modulated pulses of constant amplitude and duration has a time modulation which is characteristic of the variable frequency of a signal, this variable frequency being characteristic of the contrast of the picture being transmitted.

Two practical examples of time modulation may be of interest. When riding in a train running alongside a row of equally spaced fence posts, the apparent spacing of the posts can be modulated by turning the head quickly in the direction of travel, giving the effect of closer spacing, while turning the head quickly in the opposite direction gives the effect of wider spacing.

Again, when travelling in a train, and when passing a station name board at such a speed that it cannot be read in the normal manner, sometimes it is possible to read the name if the head is turned quickly in the opposite direction to that in which the train is travelling.

"Cathode Ray" is wrong in saying that a road sweeper would have missed his vocation if he indulged in some form of frequency modulation in his disposal of refuse.

I remember that in the days of unsurfaced roads, in a small country town, it used to be the practice to sweep the mud into small heaps of fairly constant size but spaced according to the amount of mud, this varying on different parts of the road. After a suitable interval for draining away surplus water, a horse-drawn cart travelled at walking pace alongside the mud heaps, two men walked alongside and without stopping the horse shovelled up the small heaps of mud into the passing cart. The shovelling energy, over equal periods of time, varied in accordance with the frequency of the heaps.


W. A. BEATTY.

The author of "Pulse Modulation replies as follows:

I AM grateful to W. A. Beatty for the information that pulse frequency modulation is widely used. With regard to the terms for different kinds of pulse modulation, he proposes to add one—"Time Modulation"—to cover the three types that I called "Pulse Phase Modulation," "Pulse Frequency Modulation" and "Pulse Length Modulation." If such a term is wanted, I hardly think anyone will quarrel with the choice of the word "time" for the purpose. I can't quite see, however, why it is necessary to drag in the same word in all three sub-types too; surely "phase," "frequency" and "duration," in this connection, imply time? The word "pulse," which I used instead, really is necessary, to distinguish them from C.W. systems. W. A. Beatty's substitution of "time" for "pulse" seems to me to change very much for the worse. But I entirely approve "duration" instead of "length," and perhaps weakly used the latter because "Pulse Duration Modulation" seemed rather a mouthful. These things always become abbreviated to letters, however, and "P.D.M." is not only technically more precise but less liable to be confused with a well-known French railway company than "P.L.M."

I would have liked Mr. Beatty, or anyone else to comment on my one original suggestion—"wave pulses." There is a crying need for such a term, because as far as I know there just isn't one at all at present to refer to groups of R.F. waves. They are commonly called "pulses," which is obviously wrong and very liable to confuse.

I didn't intend to suggest that the frequency-modulating road sweeper wouldn't be excellent at the job, but that he ought to be in a more intellectual one!

Readers who may practice time modulation in railway compartments should, I suggest, take care that their gestures are not misinterpreted. "CATHODE RAY."

"Tropicalizing"

The treatment applied to radio components to render them suitable for tropical use is a problem faced by many of your readers during the war, and is of importance in Britain's export drive. In components such as transformers and chokes, it is essentially the problem of preventing the corrosion of metal parts and guarding against mould growth in windings, etc. This latter is frequently dealt with by processes of vacuum impregnation with suitable varnishes, the essential purpose of which is to prevent the ingress of moisture. It is recognized that such a method is not always successful, and I think that some of my observations during my work in the high vacuum field may throw some light on the mechanism of such failures.

Reference to my letter in

---


Nature, dated 5th Jan., 1946, supporting the experimental work of Dr. Reekie, (Nature, 156, 367 (1945)), shows that very fine channels of the order of 10-5 mm, and under, will admit water in preference to air, owing to the high pressure due to the surface tension of water. Thus it might be that imperfections in the impregnating process would admit either water or air, or both. It seems significant that the better the impregnating process, the more likely it is to leave the finer leaks which admit water only. This moisture is not likely to be expelled by the heat generated in the coil during service.

The answer, therefore, seems to be either to seal the component hermetically, or to adopt an open construction. For tropical use the former is the only solution; while for temperate, climates the latter might be cheaper and better, as any moisture entering the coil would automatically evaporate owing to the warmth generated during service.

At the very high pressures developed by surface tension and osmosis the question of vacuum becomes meaningless when dealing with the risk of very small channels of the order indicated. It might be worth while inviting the observations of your readers, who may perhaps be able to throw even more light on this subject.

Reading. O. P. SCARFF.

MANUFACTURERS' LITERATURE

Bulletin No. 47, issued by Aero Research, Duxford, Cambridge, describes the part played by Ardux cement in the construction of the Mark IV land mine detector. It also gives some particulars of Ardux 120 for bonding metals and other non-porous materials to wood, laminated sheet, etc.

Data sheets for "Midgetron" valves (for hearing aids and portable receivers) have been received from Park Royal Scientific Instruments, 52 Minerva Road, London, N.W.10.

Specifications of a constant-voltage high-tension supply unit (Model 101-A) and a high-voltage test set (Model 301-A) are given in illustrated leaflets issued by All Power Transformers, 8a, Gladstone Road, Wimbledon, S.W.19.

Technical details of the "Lectrona" permanent magnet loudspeaker and output transformers are given in a leaflet issued by Edstone, Ltd., 41, Spencer Street, London, S.W.1. The 8-inch diaiphram is provided with a dustproof centring device.

Bulgin Components in

**Britain's Greatest Air-Liner**

The Avro Tudor II is making aviation history. Huge in size, with a wingspan of 120 feet and a length of 105 feet, the Tudor II is the commercial air liner of the future, bringing the capitals of the world within easy reach of Britain. Precision-built to the last detail, this flying giant incorporates every modern accessory, including components by BULGIN. Switches and signal lamps by these famous makers play their part as they did in the mighty bombers of the R.A.F. That battle record and the skill and research of twenty-five years are behind every component that bears the BULGIN name.

- Bulgin Toggle Switches available in over 200 standard types from light to heavy duty.
- Bulgin Signal Lamps in 36 types from miniature to wide vision-angle panel mountings for button-neons or M.E.S. bulbs.

**BULGIN**

A Name Famous in Radio for over 1,000 Components

A. F. BULGIN & CO. LTD. - BYE PASS ROAD - BARKING - ESSEX

Telephone: Rippleway 3474 (5 lines)
C A V I T Y  R E S O N A T O R S

A B I - M E T A L L I C plate or strip, which lies under the action of heat, is arranged to alter the shape, and therefore the tuning, of a hollow resonator. The device may be used to offset any frequency drift, due to ambient changes of temperature, or to the heat generated under working conditions.

The tuning of a resonator mounted inside a sealed electron-discharge tube, for velocity modulation, can be adjusted within limits by deliberately applying heat from an external battery to the bi-metallic control element.

The M-O Valve Co., Ltd.; N. L. Harris; and J. W. Ryde. Application date, April 22nd, 1940. No. 574934.

R E L A T E S to equipment for assisting a fighter pilot to detect and close on an enemy craft, at night, or under conditions of bad visibility.

Exploring pulses are radiated, and the echo signals are presented against the time base of a cathode-ray tube to indicate the distance of the enemy craft, in known manner.

The incoming echoes are picked up by four separate aerials, which are respectively sensitive to directions above and below, and to the right and left of the axis of the pursuit plane. For part of the duration of each echo pulse, the combined input from all four aerials is applied additively to produce a distance-indication along the time base of the C.R. tube. During the reminder of each echo pulse, the directive effect of each aerial is brought slightly below the pursuit machine.

B, C and D show subsequent indications as the fighter banks to the right, and closes on its target. In diagram (b), the trace M represents a flight of three enemy machines, about three miles away. One lies straight ahead, and a little below, whilst the other two are above, one to the right, and one to the left. The indication N shows a friendly escort, nearly a mile away, flying on a level with, and to the left of the pursuit plane.

Standard Telephones and Cables, Ltd.; assignees of E. Labin; Convention date (U.S.A.), March 13th, 1941. No. 574676.

G R A M O P H O N E  R E P R O D U C T I O N

W H E N recording sound, it is usual to contract or reduce the amplitude of loud passages, and to increase that of quiet passages, the correct balance being restored in reproduction by applying a suitable expansion control to the gramophone amplifier.

Although one setting of the expansion control is usually sufficient to play the whole of any given record, different records may require different settings. In this respect, however, all records fall within one or other of a few distinct groups.

Target indications in airborne radar

According to the invention, a small paper ring is passed over the centre of each record, the ring being divided into black-and-white radial zones, which vary in number according to the particular group into which the record falls. The ring is viewed by a photo-electric unit, which, as the record rotates, generates a current with a typical A.C. component. This is passed through a frequency discriminating circuit, and automatically applies the appropriate degree of expansion control to the amplifier.


G E N E R A T I N G  M I C R O W A V E S

A n electron stream is passed twice through a hollow resonator R, diagram (a), first at P and then at P', in the direction of the arrows. Any lack of uniformity in the stream as it enters will be sufficient to impel the resonator, thus velocity-modulating or "bunching" the outgoing stream, which then provides inductive feedback as it re-enters at P.

The intensity of the internal electric field varies sinusoidally from zero at both the closed ends to a maximum at the centre of the resonator, so that the degree of feedback is determined by the position of the low-potential entry at P relatively to the high-potential entry at P'. The output is drawn off by a small loop (not shown) inside the resonator.

By bending the resonator into a ring, as shown in diagram (b), with the two closed ends abutting at C, the same effect is secured without having to divert the electron stream. Alternatively, the resonator may have the shape of the letter J, so that the stream can pass straight through electrodes at the upper end of the short limb, and at the lower end of the long limb.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.
The latest circuits demand the best valves — Marconi of course!

MARCONI VALVES
The REAL Thing

THE MARCONIPHONE COMPANY LIMITED. HAYES, MIDDLESEX
OUR NEW BARGAIN LIST

This New List gives details of many selected New Lines which we have just purchased from Government departments. All are perfect and clean components and apparatus (we refuse to buy rejects, scrap or dump material). Our purchases include the following:

SMOOTHING CHOKES. YAXLEY TYPE SWITCHES, 2-pole, 6 positions. AUDIO TRANSFORMERS Mu Metal cores. ROTARY CONVERTERS 12v. output 300v. 70 ma.; also some 400v. 60 ma. SELENIUM L.T. RECTIFIERS, several types. MICROPHONES, 4 types, including Hand Microphones. DIALS, H.R.O. type. MORSE KEYS, etc., etc.

If you are interested in any of the above, or would like a copy of our New Bargain List "W," please send us a stamped addressed envelope.

HERE ARE TWO MORE EXCELLENT BARGAINS

CANADIAN TRANSCEIVER No. 58
An 8-valve Superhet and Transmitter complete with power supply, 3 aerials, 2 pairs of headphones, 2 crystal differential microphones, and full instructions. A WONDERFUL BARGAIN. 13 Gns.

R.A.F. 1154 TRANSMITTERS
Complete with valves, but require a power pack. Covers the 'Ham' bands. These transmitters are secondhand but are in good condition. Excellent value. OUR PRICE is 6 Gns.

READY SHORTLY. A New Range of 'RAYMART' Super Transmitting and Neutralising Condensers.

Don't forget to send us a stamped addressed envelope for our New Bargain List "W."

RADIOMART
48 HOLLOWAY HEAD, BIRMINGHAM, 1
NEW RECEIVERS AND AMPLIFIERS

A 88s and other types of communication receivers, enquiries invited.—Alert Radio Co., 27, Temple Fortune Mansions, N.W.11.

E 14 T.R.S. coils, first-class. [5755]

P 14 Speedwell 4552 £3 15s, 4555 £5 15s.—G. J. Ramsbottom, Ramsbottom, Lancs. [5712]

W 14 Exceptionally suitable motor generator, £15.—F. J. Bailey, 15, Flaxton Road, Bradford, 258, 3m., N.1 [5710]

W 14 Low watt amplifiers, push-pull output, separate power pack, £5.—E. C. Woodrow, 18, Podimore, near Taunton. [5719]

NEW RECEIVERS AND AMPLIFIERS

R 88a and other types of communication receivers, enquiries invited.—Alert Radio Co., 27, Temple Fortune Mansions, N.W.11.

E 14 T.R.S. coils, first-class. [5755]

P 14 Speedwell 4552 £3 15s, 4555 £5 15s.—G. J. Ramsbottom, Ramsbottom, Lancs. [5712]

W 14 Exceptionally suitable motor generator, £15.—F. J. Bailey, 15, Flaxton Road, Bradford, 258, 3m., N.1 [5710]

W 14 Low watt amplifiers, push-pull output, separate power pack, £5.—E. C. Woodrow, 18, Podimore, near Taunton. [5719]

NEW RECEIVERS AND AMPLIFIERS

R 88a and other types of communication receivers, enquiries invited.—Alert Radio Co., 27, Temple Fortune Mansions, N.W.11.

E 14 T.R.S. coils, first-class. [5755]

P 14 Speedwell 4552 £3 15s, 4555 £5 15s.—G. J. Ramsbottom, Ramsbottom, Lancs. [5712]

W 14 Exceptionally suitable motor generator, £15.—F. J. Bailey, 15, Flaxton Road, Bradford, 258, 3m., N.1 [5710]

W 14 Low watt amplifiers, push-pull output, separate power pack, £5.—E. C. Woodrow, 18, Podimore, near Taunton. [5719]
You can become a first-class radio engineer

T. & C. RADIO COLLEGE
North Road, Parkstone, Dorset

Post in unsealed envelope, td. stamp. Please send me free details of your Home-Study Mathematics and Radio courses.

NAME
ADDRESS

LASKY'S RADIO
EVERYTHING FOR THE HOME SET CONSTRUCTOR, AMATEUR RADIO EXPERIMENTER, TRANSMITTER AND RESEARCHER.

Can be operated like a pencil.

For Precision Instrument Work

With only 45 watts a Bit Temperature of over 300°C is obtained.

for all Voltages from 6—250 volts

THE
ACRU ELECTRIC TOOL MFG. Co., Ltd.,
123, HYDE ROAD, ARDWICK,
Phone: ARDwicK 428 • MANCHESTER, 12
ELECTRAPHONES

HEADPHONES—Telephones, etc.

HEADPHONES. Single low resistance phone for circuit testing or house phone, $5.00; high resistance, $2.50. New case and cap, best British make, with headband and ear cushions, $12.50.

High resistance double headphones, as new, with headband, $4.50; S.G.B. light weight, sensitive to crystal, 22/6, delivery from stock.

HAND COMBINATION TELEPHONE, Phone and Mike; ebonite body with switch for speech on bell circuit, 6c. 4-way cord, as new, 15c.—as illustrated.

SWITCHES. Drawar panel switches 8-plate new flush fitting, 5c. each. 8-way ex-A.R. switch box, 3/6.

G.P.O. Lab. switches D.P. reversing, for telephone, 6c. each. R.I. 7-stud multi-socket on ebonite panel, test box base 4in. x 4in., 76c. Linked 5 amp. 6-way 4-prong, 25c.

RELAYS. Below are some of the types we have available; send us your enquiries, we have large stocks all in new condition, immediate delivery. New Siemens Relays, 500 + 1,000 ohms, 20 cents, 10c.; 2 makes I S.P.C.O., 12/6; 3 makes I break, 50c.; 4 makes I make, 80c.; 2 makes I break 1 make, 1 break I S.P.C.O, slugged, 12/6; 10,000 ohms S.P.C.O., 21c.—Send for Special Leasel. Relay Contactors, for use with Siemens Relays, High-speed Relays in heavy brass case, 83/6—Type telephone No. 6. 2-coil polarised, S.P.C.O., 6-cells, 12/6; 3 cells, 4c., on-off, 2 volts 40 ma. 5c. Relay movements, 1,000 ohms, less blade and contact, 2c. Moving-coil relays by Vلاقات, 3/6 each.

METER MOVEMENTS. Moving-coil large movement, 71/2 mum. full scale, 1st grade type, with pointer, few only at 21c. each.

Hand MAGNETO GENERATORS. Output approx. 70, 20, 25 ma. A.C. permanent steel magnet, wound armature, driven by gear in housing, suitable for A.C. experiments, bell circuits, shocking coils, etc., 10/- each, post 1s. 1/2p. Spare field on delivery.

DYNAMOS. D.C. car type circular body for charging 6 volt 10 amps., £4.12, 12 volt 10 amps., £1.10, 6 volt 30 volts 5amps., £7/10, 80 volts 12 amps., £10.

AUTOPULSE PUMPS, 12 volt Percol Pumps, in new condition, 35c.—

RADIO COMPONENTS. F.C. Poly Phos. Fans 110 and 220 volts, 10/-; 12v. and guard, 45c., Oscillator type, 21c. blade and guard, 53c., A.C. 10w. Table Fans, 65c. Fans Motors only, 110 and 220 volt, bulkhead size, 35c.—

BELLS. Large Tangent ironclad bells, 6in. gong 120/250 volts, A.C., new condition, 42c., Circular A.C. Bells, 5/8w., 35 drill, diabolo base, 21in. diameter, metal gong, 60c., House bells, baseleke base, with 2jng. 90c. Bell Transformers 230/4-5-8 volts, 7/6.

BUZZERS. Test buzzers, double contact blades for distance testing and timing for vibration, rough construction, 8/6. Morse practice buzzers, operated by key, in metal case, 7/6, or bellcase, 3/6. Tiny Bell Buzzers, for R.F. and wave meter buzzers, platinum contacts, 15c.—

G.P.O. Connections, for telephone solder tags, telephone type moulded mounting 60-way, 3c. each.

WIRELESS COMPONENTS. AC/DC mains magnets, 2-pole 220 volts, 7/6 each. The wonder Midget Magnet, diaph. steel, disc, weight only 5 oz., 5in. dia. .With heavy metal case, 10/- each. Large selection of horsehoft Magnets in stock. Send for leaflet "W."

EDDYSTONE Model 504 communications receiver. Bronsal deliveries now commence and named.

ALL Transm. and B.V.A. values; list prices.

LINE Cord, 4 amp, 600 ft. per foot, 2.75 yd, 3.5 yd, 9/13 yd.

GOODMAN'S 12/130/15 15/130 M.P. quality speakers, £11; 17/150/15 £15 15/130 M.P. super quality speakers to handle, £25, weight 200 lb, £18/10.

1945 MAVIS 5V superhet chassis with 8/1 M.E. speaker, all ready to switch on; 15/10, 20/10 at £20, 800/3000, 500/3000, high-class; £16/10, c.r. paid post pay train.

VERY MOOND 2 waveband coil packs, completely wired and tested, for 465 k.n., 50/6, matched pairs, iron-core L.F. trans., 14/6.

TUNING controls: Index; 2 gang, £0.8, 50/°, mid. with 2 speed rubidium drive and rubber mounted, £1.


EDDYSTONE short-wave components.

TUNING unit, model A4, R.F. stage, 16/50, 300/550, 500/2000, completely assembled and aligned. 12/1, plug-in clip to a Vertex 50-watt amplifier; sell 22/3, stamp for new 350/°.

COILS, high gain t.r.f. combined med. and long wave, 20/14 long, a really first-class job; 9/6, 10/6, 17/6, 22/6, 22/6, 35/6.

Radio \& H. Radio offer all kinds of electro-

Radio Corner

(Proposed, T. R. Williams)

38 Gray's Inn Rd., London, W.C.1 (Terminus 1931)

MAIL ORDER. Delivery by return. THE BANNER CHARGER - 2 oz., 1 cup, ideal for Motors, a really first-class job. Input 240 v A.C. Output 5.5, 9 v D.C., at £3. Designed for the contractor who likes to keep his batteries in tip-
top condition.


Engineers and Electricians Handbook. Price 1/-.


American Radio Valves Types as under at controlled prices. 4525GT, 5735C, 15ASGT, 15ASG M, 12SLG, 15SAGT, 6STG, 125STG, 125STG, 5SG, at £1 5/- each. 15SGT, 725GT, 125STG, 15SGT, 55G, at £1 1/3 each. 125STG, 6STG, 5SGT, 6SGT, 42G, 43G, at £1 12/10 each. 6AGT, 6AGB, 6KG, at £1 14/ each. Postage paid. Other types as they become available for distribution.

American Radio Service Manuals

Volume I. Spartan Emerson.

II. Crosley Belmont. Part I.

III. Crosley Belmont. Part II.

V. Emerson. Part II.

VII. Stewart Warren, FADA.

At 12/6 per Volume, or complete set of six manuals £12s. 6d. These Manuals cover the complete range of American Radio Receivers as given and are invaluable and contain all the technical data necessary.

Terms. Cash with Order only. We regret that we are unable to send goods C.O.D.

Electrolytics

Tube-size 4 1/4 x 7/8

Block-size 4 1/2 x 11/2

The DALY range covers all requirements.

Note—All Condensers bear the date made.

Daly (Condensers) Ltd.

Condenser Specialists for over 20 years.

West Lodge Works, The Green, Ealing, W.S.

Telephone—Ealing 4841

Acoustical

Manufacturing Co. Ltd., Huntingdon. Tel. 3611

For the Radio Service

MAN, DEALER

AND OWNER

The man who enrolls for an I.C.S. Radio Course learns radio thoroughly, completely, practically. When he earns his diploma, he will KNOW radio. We are not content merely to teach the principles of radio; we want to show our students how to apply that training in practical, everyday, radio service work. We train them to be successful!

Special terms for members of H.M. Forces and discharged disabled members of H.M. Armed Forces.

International Correspondence Schools


Please explain fully about your instruction in the subject of Radio.

Complete Radio Engineering Radio Service Engineering

Electrical Radiotelegraphy

The following Radio examinations:

British Institution of Radio Engineers

P.M.C. Certificate for Wireless Operators

Gill and Oldfield's Correspondence Schools

Wireless Operator & Wireless Mechanic, R.A.F.

Name.

Age.

Address.
LONDON CENTRAL RADIO STORES

ELECTRIC DRILLS
SKILSaw 3 in. special duty Drill, model 141, low speed, ball bearing, 4/- complete.

For 60 to 80 cycles. Speed 200 r.p.m. .... $16.10

CHICAGO PNEUMATIC TOOL CO. 1" Drills
Model 4, size 68s, A.O.D. (C.D.) 200/230 v. 4.50 amperes. Speed 200 r.p.m. .... $21.10

SANDING WALLS
E - A - Admixture 3-cord Type 1/2.
Coloured stones, trowelled, green and sandstone only. Each stone sealed for screw use as cork. Tower brackets.

Powerful brush. Strong metal case. Highly plated 2 in. and 4 in. types. 

SAFETY CAP LAMP
Bakelite mounted case. Diameter 3 in., fitted with double filament 2 1/2 v. 1 amp. and 50 amp. gas-filled bulb with 2-way side head and side handle. Contains 100 millamp. accumulator in metal case, with welding-hand and gas-fuel warning. Linseed oil solution 

Price $3.30...

FOR FULL TECHNICAL DATA
See Editorial Article July Issue

Ex.-R.A.F. Type R1155

COMMUNICATION RECEIVERS

Opportunistically low. These receivers are made to the stringent specification of the Air Ministry and are fitted with a large-scale dial calibrated for 2500 to 20,000 wave-lengths complete with 10 valves, including magic eye. Fitted in a strong metal cabinet. There requires only a power pack to be ready for immediate operation .... $15

EX-ARMY No. 58 Mk. 1

Self-contained 8-v. Short-wave TRANSMITTER

- 5-valve Superhet Receiver, 3 v. Transmitter.

- Frequency range - 640 to 9000 metres (50 to 32.5 metres).

- Working range - 6 miles with 125 watt. red aerial.

- Panel Test Meter for check on batteries and various parts of circuit.

- Chassis is encased in case by rubber stock mounts.

- Three aerials in cabinet (125 v. rod, 8 ft. Litz, 200 ft. wire, 200 ft. wire).

BARGAIN OFFER (less Vibrator) $7

By using the latest type of British Vibrator Fines, 2 Accumulators, 3 Differential type - noise-canceling Mikes, 2 Headphones, 4,000,000 Ohms. Operating Talismans, and Power Supply .... $15

VIBRATOR POWER UNIT $15

6-v. V.I.P. Receivers. 100-122 metres. Type 11. Complete with valves .... $4.50

TRANSMITTER for above .... $3.10

2-v. R.F. AMPLIFIERS V.I.P. .... $3/10

EX-ARMY BATTERY 1 VALVE MINI DETECTOR

REPLACER PACKS, size 4 1/4 in., 4 in. Detectors. Use the latest type French Boulanger Valve. Ideal for use in ex-Army and Land Army equipment. Components include 92 gauze condensers, resistors, 3 Ceramic Valve Holders, Microphone Transformer, Volume Control, and 5 inch jack... 

15-

You are invited to call and see the totality of R.A.F. gear we have for sale. It will pay you well.

N.B. We do not issue lists and cannot deal with condition goods on the basis we offer.

Closed Thurs. 1 p.m. Open all day Sat. 23, Lisle STREET LONDON W.C.2

G. A. RYALL, 65 Nightingale Lane, London, S.W.12. Mail order only, at present. C.O.D. under £1 please. Postage extra. U.S.A. goods - 8.00% if 5 sets or over, 15% if 10 or more per consignment.

FOR WANTED, see Last Page.

WANTED, Vacuum tube and transformer, state price. - D. Westwood, c/o Nappier, Dunblane.

WANTED, a number of sets of S.8F. transformers or any other transformers, for use in conjunction with small A.C. output equipment. - D. Blackford, Yard House, Calne, Wilt.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.

21/3.
The illustration shows a new design of particular interest to the radio man. Power transformers and audio units are available in twenty varied specifications.

Write for leaflet "CT/7.

AMPLIFIERS
A.18 Gramo. only, 10 watt .... £10 7 0
A.23 with HG mike stage, 20 watt .... £16 4 6
A.36 De luxe, 35 watt .... £23 16 0
All factory assembled with cases.

1st. stamp should accompany requests for literature.

RADIO INSTRUMENT CO.
Radio Products
294, BROADWAY,
BEXLEYHEATH, KENT
Bexleyheath 3021

W. T. HENLEY's TELEGRAPH WORKS CO. LTD
Raheny Cross, Dept. 53, Raheny Garden, London, E.C.1

TRANSFORMERS & COILS TO SPECIFICATION.
MANUFACTURED OR REWOUND

STANLEY CATTLED LTD
9-11, East Street, TORQUAY, Devon

Phone: Torquay 2162.

REPAIRS & SERVICE. Coils, Vacuum Current Transformers.

A. D. S. Co., Ltd
2613-5, Lichfield Road,
ASTON, BIRMINGHAM, 5

The Scratch Filter for the COIL PICKUP
Costs £2/2/-.
Purchased Tax 9/4d.

WILKINS & WRIGHT, LTD.,
Utility Works, Holyhead Road, Birmingham, 21

Transformers & Coils

A. D. S. Co. Ltd.
2613-5, Lichfield Road,
ASTON, BIRMINGHAM, 5

Connections housed at end of handle - away from the heat.
See that FLUXITE is always by you—in the house—garage—workshop — wherever speedy soldering is needed. Used for over 30 years in Government works and by leading engineers and manufacturers. Of all Ironmongers—in tins, 8d., 1/4 & 2/8.

Ask to see the FLUXITE POCKET BLOW LAMP, price 2/6.

TO CYCLISTS! Your wheels will NOT keep round and true unless their spokes are tied with fine wire at the crossings and SOLDERED. This makes a much stronger wheel. It's simple—with FLUXITE—but IMPORTANT.

The FLUXITE GUN puts FLUXITE where you want it by a simple pressure. Price 1/6, or filled, 2/6.

Write for Book on the ART OF SOFT SOLDERING, and for Leaflets on CASE HARDENING STEEL and TEMPERING TOOLS with FLUXITE. Price 1d. each.

FLUXITE LTD. (Dept. W.W.), Bermondsey Street, S.E.1
SEND YOUR ‘WANTS’ TO VALLANCE’S
TEST EQUIPMENT. DELIVERY FROM STOCK.
A.V.G. Model 40. £17 10s. 6d. • Taylor 80A, 90,000 ohm watt.
A.C./D.C. Taylor 90A, 40 ranges. A.C./D.C. 1,000 ohm watt.
Universal, Avo Minor, 5 ranges. £2 10s. • Taylor 10A, 1,000 ohm watt. A.C. and D.C. 40 ranges. £15 15s.
F.I.C. Universal. Model 35, 5,000 ohm watt, with low range ohms.
£14 6s. 6d. • Taylor 690A, E.C.I. portable, 21 ranges, 0.0001 mfd-50 mfd, power factor 5%, 60 ohms to 2 meg., band gap 800-50,000, 30 watts, 300 volts. £1 16s. 6d. • House, C. and R. Bridge, 110A, capacity measurements up to 120 mfd.
120 ohm resistance, 1 watt. 100 gauss, 50 mch. • Taylor No. 141, 12 m site, 0.001 ohm 500 ohms, 10 Mc.
R.P.I. Signal Generators.—Frequency ranges, 100-250, 250-650, 650-1,600 k.c.; 1.4-6.5, 15.9-19, 15-30 mch; accuracy of calibration, 1% internal modulation, 2% external modulation. £50. 12 cycles: 600 multiplier and attenuator, £22. £20 200 watts or 100-113 cycles, power transformer. £55.
Transmitting Valves.—E.RS. Twin Triode 300D; 10 watts audio dissipation, 0.6 v. 0.9 A amp. £1 2s. 6d. • 807, Beam Power Tetode, 750 v. 30 watt audio dissipation, 0.6 v. 0.9 A amp. £1 2s. 6d. • 607, Hepper (nearly Vesper) 10,000 v. inverse peak 1,000 mfd, half wave 2.5 A. £1 7s. 6d. • DA41, direct equivalent to American T40D, 7.5 v. 2.5 A amp, 120 m watts audio dissipation. £2 15s. • E.G. (model) Beam Power Tetode, 700 v. 33 watt audio dissipation, 0.6 v. 0.9 A amp. £2 15s. £55. Delivery, approximately 1 week, against orders placed.

Immediate attention to all orders and enquiries. Goods sent C.O.D. or against C.O.D. whatever best suits your case. Air mail will be charged at extra. Terms: cash. Goods are insured. Payment in full on receipt of goods: balance (if any) to be paid within 14 days. Immediate delivery on old models being sent away. We suggest engagement of definite items where listed.

VALLANCE'S
144 BRIDGE, LEEDS, 1.

A.C.S. RADIO
OF COMMUNICATION RECEIVERS. AMATEUR
TRANSMITTING GEAR, ALL TELEVISION AND
RADIO EQUIPMENT AND COMPONENTS.

Preliminary LIST NOW READY, but with new models constantly being added, we suggest enquiry of definite items if not listed.

44, WIDMORE ROAD, BROMLEY, KENT

“VICRO-ARC” Engraving Pen
For rapid engraving any size lettering.
Post Operates from 4.6v.

Free Battery or A.C. Transformer: with a 6-amp. cts.

HOLBOROW, 46, Boroughbridge, Yorks.

W. BRYAN SAVAGE CO.

Expert assistance in all conceivable kind of work. We suggest enqyry of definite items if not listed.

Effect of the solution of:

• Transformers, Chokes
• Amplifiers
• Power Units
and Specialised Equipment

EMBODYING

ELECTRONIC CONTROL

WESTMORELAND RD., N.W.9
COLINDALE 7131

SENIOR draughtsman required for company engaged in light current electrical measuring equipment. Box 1469 [5787]
F.A.T. large electrical firm in London area requires draughtsman. Box 1769 [5837]
J.A.M. Draughtsman, fully experienced, good rates. E.S. & T.P. Ltd., 3a Manor Way, Boreham Wood, Herts. £15 15s. 6d.
R. Engineer wanted for light sound production. May travel. Similar experience desirable. Box 1507 [5697]
D. has a vacancy in their receiving design laboratory for a qualified engineer, capable of responsible work on television de

R.U. ENGINEER wanted for loud speaker production, must have experience. Similar experience desirable. Box 635 6s.

D. has a vacancy in their transmitting equipment for a qualified engineer, capable of responsible work on television de

CANDIDATES must possess theoretical qualifications and have had at least 3 years experience on television practice. Ignore without telephone. Box 725 5s.
S. with ability to take charge of engineering section. Application should be made by letter only. 31 D. 215s. 6d. Addressed: The Secretary, Mitcham Works, Mitcham, Surrey.
U. urgently required. Service Engineer. Box 137 7s. 3d.
J. Valves, rectifiers. £1 10s. 6d. • Proprietary to well-known London firm. £1 3s. 9d. • Proprietary to well-known London firm. £1 3s. 9d.

R. Engineer required to take charge of new service department, commercial experience essential. Box 1748 5s. 6d.

M.A. eng. for work on high frequency interference. £2 2s. 6d. • Proprietary to well-known firm. £1 9s. 11d. • Proprietary to well-known firm. £1 9s. 11d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.

M.E. essential. Box 747 £1 10s. 6d.
**ARMSTRONG**

**Model EXP53**

ALL-WAVE 7-STAGE RADIOGRAM CHASSIS


Price. 

with speaker £13 plus tax

**Model EXP83**

ALL-WAVE 8-VALVE SUPERHET CHASSIS


Price 14 gns. plus tax

**Model EXP43**

ALL-WAVE SUPERHET FEEDER UNIT

incorporating wireless band expansion. Manual I.F. gain control, etc.

Price 11 gns. plus tax

**Model EXP63**

ALL-WAVE 6-VALVE SUPERHET CHASSIS

incorporating wireless band expansion. Gram. switching. R.C. fed output. For 100-250 v. A.C. or D.C. mains.

Price 12 gns. plus tax

**Model AMP14**

HIGH GRADE AMPLIFIER

in well-finished metal instrument case. Two inputs, bass, treble, and silver coupling. Crop 4 watts push-pull output preceded by 4 triodes.

Price 15 gns.

Demonstration Sets are now available for interested callers to compare stated technical specifications are now ready.

**ARMSTRONG WIRELESS & TELEVISION CO. LTD.**

WARTERS ROAD, HOLLOWAY, LONDON, N.7

Phone : NORth 3213

**Advertisements**

**AVOMINOR TEST Meters**

A.C./D.C. Universal. £12 0 0

D.C. £4 4 0

**CYLDON ELECTRIC DOOR CHIMES**

Beautifully made. Far more pleasant than buzzer or bell. For homes and shops. Double chimes, back door only single. Universal model for battery, or mains with bell transformer. (in London, C.V.1)

**STUART Centralfugal Electric PUMPS**

for machine tool cooling, garden fountains and all pumping purposes. Three sizes, and for different applications.

ANY OTHER BOVES SUPPLIED ON EASY TERMS

The LONDON RADIO SUPPLY Co. (Est. 1925)

BALCOMBE, SUSEX
Radio service engineer, male or female: opportunity for first-class craftsman or crafts-woman to join progressive established private concern with good prospects for permanency, superannuation, etc., must be efficient, methodical, quick and reliable, only those capable of fault-finding in modern home radio need apply; opportunity to train in pub lic address installation and maintenance if so desired; write, giving full particulars, age, experience required; late paid for interview.—Holden Bros., Ltd., High St., Salford.

TELEVISION and radio engineers required in the near future, experience essential in one or more of the following—search and design fields—Wide band receivers, scanning and C.R.O. tube circuits, frequency modulation, television systems, etc.; applicants must have had actual design experience, a degree of rigour, and knowledge of the tropics, excellent knowledge of initiative and initiative is essential; salary £150 to £200; five week’s—R.F. Equipment, Langley Park, Nr. Slough, Bucks. 1580S.

EX-RADAR mech. (S.J.), 5 years’ experience in service and F.A. work; previous experience—Box 1909.

E.S.C.T. R.E.M.E., tele-comm. mechanic (6 yrs), released July, 10 years’ experience in radio, seeks good position—Box 1669.

E.S.C.T. Signalman, public school, univer. age, 6 yrs, technical officer, pre-war radio work, seeks position of responsibility—Box 1518.

C.Q.M.S. (foreman of Signals), 26, single, G. & G qualifications, on release, seeks position with facilities for further study and experience.—Box 1745.


REPRESENTATIVE desires post, radio, electrical sales or technical; covered Midlands, S.W. Lancashire, Cheshire, etc.; first class technical knowledge; car owner—Box 1471.

ENGINEER, 31, A.M. Brit. I.R.E., C.G.I., 15 yrs’ telecommunication and television, 6 yrs’ private experience; desires position—Box 1093.

E.R.E.M.E. S/ Sgt., 4 yrs experience radio since 1926, C. & G. II., G. service; 15 months’ work in tropics, excellent knowledge construction and repair all types test equipment, British, U.S. and civil services, a.m. and u.a. amplifiers; desires responsible post, technical or representa tive, calling for good education, personality, initiative and knowledge.—Box 1093.

RADIO engineer, 31, Government radio lab, and industrial experience, desires responsible position, technical or representative. calling for good education, personality, initiative and knowledge.—Box 1093.

PATENT AGENTS

A. E. HILL, 11 Chamberland Lane, London, W.C.2.—(5486)

AGENCIES

COMPANY with established dealing organisation in Spain and Portugal is desirous of representing substantial British manufacturer of radios and accessories.—Box 1487.

RADIO manufacturers specialising in high quality radio chassis, amplifiers, and transformers, cordially invite applications for agencies from bona fide radio dealers; export enquiries are specially welcome.—Box 7983.

AGENCIES WANTED

AGENCIES required for goods likely to be of interest to wireless manufacturers, vacuum cleaner manufacturers and the general electrical trades. Your product is of good quality we are in a position to introduce it to all leading electrical manufacturing concerns in the country.—Write full particulars in first place to: Box 1118.

TUITION

Radar—Radar—Radar

THE British National Radio School, first in the field in this country (see W.W. [2 April], now offers a three months’ practical course in radio physics and general laboratory practice. Correspondence courses for C. & G. I.R.E. and I.E.E. Examinations. Our ‘Foundation Paper’ will enable the ambitious student to tackle the ‘Competitive Radio Officer’ may be had on application to The Secretary, B.N.R.S. 66, Addington Rd., Croxted.

RADIO SPARES

RADIOS TRANSFORMERS Primaries 200-350 volts 350-500 volts

TITF C. 100 ma, 4 v. 5 a 34 v. 5 a

TITF D. 100 ma, 4 v. 5 a, 34 v. 5 a

TITF E. 120 ma, 4 v. 5 a, 34 v. 5 a

TITF F. 120 ma, 4 v. 5 a, 34 v. 5 a

TITF H. 50 ma, 360 ma, 34 v. 5 a

Recliners

TITF A. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF B. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF C. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF D. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF E. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF F. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF H. 50 ma, 360 ma, 36 v. 5 a

Recliners

TITF A. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF B. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF C. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF D. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF E. 100 ma, 36 v. 5 a, 34 v. 5 a

TITF F. 100 ma, 36 v. 5 a, 34 v. 5 a

SPECIFICATION

20 Watt A.C. Amplifier, with built-in speaker, Superhet Receiver covering 2000 Metres, Special to be recommended for Schools, Hospitals, etc. Further details and price quotation on request.

R. N. FITTON, LTD.

56 OSBORNE ST.
Glasgow

HOBBOSSARD

INDUSTRIAL RADIO AMPLIFIER

INDUSTRIAL RADIO AMPLIFIER

INDUSTRIAL RADIO AMPLIFIER
WARD ROTARY CONVERTERS

For Radio, Neon Signs, Television, Fluorescent Lighting, X-ray, Cinema Equipment and innumerable other applications.

We also manufacture - Petrol Electric Generators; Plants, H.T. Generators, D.C. Motors, Frequency Changers, etc., up to 25 K.V.A.

CHAS. F. WARD
37. WHITE POST LANE, HACKNEY WIOK, E.9.
Phone: Amhurst 1393

LONDEX for RELAYS

for A.C. and D.C.
2 VA Coil consumption from 2 to 600 volts and tested to 2000 volts, Aerial Changeover Relays, Mercury Relays, Measuring Relays and Time Delay Relays.

Multiple contact
Relay LF
Ask for leaflet
205/WW

LONDSEX LTD
MANUFACTURERS OF RELAYS
707 AMERICAN ROAD - LONDON S.E.20

COVENTRY RADIO

COMPONENT SPECIALISTS SINCE 1925

Now Ready! 21st Birthday

LIST OF COMPONENTS
Price 3d. Post paid.
Prompt Service, Complete Satisfaction.

COVENTRY RADIO
191, DUNSTABLE RD., LUTON, BEDS.
A World-wide Reputation!

IN 1908 Mr. S. G. Brown invented the rightly famous S. G. BROWN Type “A” Headphone. This type is still acclaimed as the finest and most sensitive headphone procurable.

Radio Amateurs desiring maximum reception results over all wavebands, coupled with quality reproduction and highest possible efficiency, should ask their dealers for a pair of S. G. Brown Type “A” Headphones.

TYPE “A”
Adjustable Reed Movement
Price 57/6

For a less expensive pair of headphones, which will also give excellent results, ask for the S. G. Brown Type “F” Featherweight. Price 23/-. 

S.G.Brown, Ltd.
VICTORIA ROAD, NORTH ACTON, LONDON, W.3

Phone: ACOrn 5021

Wharfedale
NEW GOLDEN
10 inch LOUDSPEAKER
During the last six years hundreds of Wharfedale Golden Units have been supplied, and are still being supplied, to the B.B.C. and G.P.O. It was selected by reason of its level response. The new model is fitted with precision die-cast chassis, improved spider, and Alcomax II Magnet increasing the flux density from 10,000 to 12,500. The price is only increased by 5/-.

Mode and Guaranteed by
WHARFEDALE WIRELESS WORKS
NEW ADDRESS
BRADFORD ROAD, IDLE, BRADFORD.
Phone: Idle 461.
Grams: “Wharfdel, Idle, Bradford.”

WALTER CONDENSERS
ARE MADE FOR
LIFE
WALTER INSTRUMENTS, LTD.

GARTH RD., LOWER MORDEN, SURREY
DERWENT 4421. Grams: WALINST, MORDEN, SURREY

5 mmf/ft
NEW LOW LEVELS in capacity and attenuation of CO-AX Cables mean new possibilities in electronic equipment design both for the war effort and for the post-war electronic age.

BASICALLY BETTER
AIR-SPACED
CO-AX LOW LOSS CABLES
TRANSRADIO LTD. 16 THE HIGHWAY, BEACONSFIELD, BUCKS.
STABILITY
and accuracy

The familiar buildings of the Royal Observatory house a proud and stable tradition of British scientific accuracy... "Greenwich Time" is never questioned.

Where stability, accuracy of capacitance are essential requirements, Hunts Silvered Mica Capacitors can be relied upon. They also possess the advantages of initial low cost and also economical application, the lightweight construction allowing them to be used without fixing holes or special mountings.

A range from 10 to 10,000 pF is available in a variety of types and sizes—full details upon request.
The cost of solder for a joint is so little and a sound joint means so much. Whether you make 10,000 sets or repair 1—be safe—use the finest cored solder in the world. Ersin Multicore—the only 3 core solder. Our job is to send you details—please ask for them.

MULTICORE SOLDERS LTD., MELLIER HOUSE, ALBEMARLE STREET, LONDON, W.1