Wireless World
RADIO AND ELECTRONICS

JULY 1949
2/-
Vol. LV. No. 7

IN THIS ISSUE: TUNABLE TELEVISION RECEIVERS

World Radio History
The **NAME** helps you sell

The **B I C C**

*All Wave*

**ANTI-INTERFERENCE AERIAL**

**BICC** are world famous for their electrical and radio products. The Anti-Interference Aerial maintains this reputation.

**What it does**

It has been specially designed to alleviate interference caused by radiation from electrically-operated transport, vehicle ignition systems, electrical appliances using commutator motors, lighting systems, etc. A high signal level is obtained and this ensures better listening on all broadcast wave-lengths, giving maximum choice of programmes against a quiet background.

**What it is**

A 60-ft. polythene-protected dipole complete with insulators and matching transformer, 80-ft. coaxial screened downlead with polythene plug moulded to each end, and a receiver transformer. All the necessary components for the Aerial are included in the complete kit.

*Write for Publication No. 221 giving further information.*

Obtainable only from recognised dealers. **£6.18.0**

**BRITISH INSULATED CALLENDER'S CABLES LIMITED**

**NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2**
A comprehensive instrument built into one compact and convenient case, which will test any standard receiving or small power transmitting valve on any of its normal characteristics under conditions corresponding to any desired set of D.C. electrode voltages. A patented method enables A.C. voltages of suitable magnitude to be used throughout the Tester, thus eliminating the costly regulation problems associated with D.C. testing methods.

A specially developed polarised relay protects the instrument against misuse or incorrect adjustment. This relay also affords a high measure of protection to the valve under test. Successive settings of the Main Selector Switch enable the following to be determined:

Complete Valve Characteristics including $I_a/V_g$, $I_a/V_a$, $I_s/V_g$, $I_s/V_a$, Amplification Factor, Anode A.C. Resistance, 4 ranges of Mutual Conductance covering mA/V figures up to 25 mA/V at bias values up to -100V., together with "Good/Bad" comparison test on coloured scale against rated figures.

"Gas" test for indicating presence and magnitude of grid current, inter-electrode insulation hot and cold directly indicated in megolons, separate cathode-to-heater insulation with valve hot. Tests Rectifying and Signal Diode Valves under reservoir load conditions, and covers all the heater voltages up to 126 volts.

The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
WINDER HOUSE, DOUGLAS STREET, LONDON, S.W.1. Phone: VICTORIA 3404-9
"It is on detail and care in design of small points that the modern set stands or falls"

"Radio Times," Sept. 24, 1948

Attention to details of manufacture and assembly; revolutionary design and the provision of highly accurate specially designed jigs, ensure that in each R. & A. Reproducer the cone, voice coil centre and outer pole are inevitably and automatically aligned upon the axis of the speaker. This is why R. & A. Reproducers are free from mechanical defects. Continuous inspection at all stages is a further insurance that no defect can be present in the complete speaker.
CRYSTAL DEVICES
by Cosmocord

CRYSTAL PICK-UPS AND CARTRIDGES

G.P. 10 is high fidelity model with permanent sapphire stylus. Output 1.7 volts at 1,000 r/s; range 70–800 c/s.

G.P. 11 is high fidelity model with sapphire stylus. Output 1 volt at 1,000 r/s; range 10–10,000 c/s.

G.P. 12 Microcellular cartridge for microgrooves or standard 78 rpm records.

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For acoustic measurements, industrial noise measurement, disc recording technique, and P.A. systems.

Type MIC 16 (illustrated)
High fidelity model with flat response from 10 to 10,000 c/s.

Type MIC 22
General purpose model with substantially flat response from 40 to 8,000 c/s.

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Type R.H. 1
High-quality cutting head for professional use.

Type R.H. 2
Good performance and modest price make it ideal for amateur recordist.

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For hospital or personal use, giving quality equivalent to normal loudspeaker without disturbing others.

For hospital or personal use; non-trasonic, light in weight, and with "ideal" performance. Supplied only to hearing aid manufacturers.

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STAND No. 7 & DEMONSTRATION ROOM No. D10, where you can hear sound reproduction at its best—the ACOS way!
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Marconi's first wireless messages did more than enable nation to speak to nation. They drew closer the world's boundaries, quickened the tempo of existence and turned distant acquaintances into next-door neighbours. Broadcasting has helped still further to increase our knowledge of our neighbours; wireless navigational aids and radar have brought greater safety and faster travel between Continents. And so Marconi's will continue to pioneer. Their engineers are busy today on developments which will make the world a closer community tomorrow.

Marconi
the greatest name in wireless

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD.,
MARCONI HOUSE, CHELMSFORD, ESSEX.
DAILY DEMONSTRATIONS
of the “BARKER 148A” mounted in the
“RD” BASS REFLEX CABINET in con-
junction with the “RD” JUNIOR or
“WILLIAMSON” AMPLIFIERS.
Full details forwarded on request.
ROGERS DEVELOPMENTS CO.,
106 Heath Street, Hampstead, N.W.3

AN ATTEMPT TO REALISE AN IDEAL
In the High Quality World, let us commend
Patience, Perseverence, and Good Temper above all; but also Skill and Intelligence.
The ultimate performance of a speaker unit—
especially if it is a very good one—depends as much on the intelligence of the user as on the skill of the designer.
If you are a true quality enthusiast, perseveringly
pursuing an Ideal, then we know we can help you.
To readers in the North West, we demonstrate
the 148A and discuss its best possible use.
J. H. BRIERLEY (Gramophones and Recordings) LTD.,
46 Tithebarn Street, Liverpool, 2

In December 1947 we were complimented by the Wireless World on
some features of the Barker 148. These were: the excellent balance at
comparatively low levels; the homogeneity of high frequency response;
low frequency response sensibly uniform down to 40 c/s with no major
bass resonance.

Of the new 148A, with its better magnet and new cone treatment, owners
and critics have remarked: the attack and transient response give the
impression of contrast expansion; so wide a range of frequencies with
apparent evenness of output produces an aural naturalness which has to be
heard to be appreciated; it is the best baffle loaded speaker we have
ever heard.

We ourselves believe it to be the most NATURAL, satisfyingly truthful
and pleasant to live with sound reprodcer made anywhere.

The unique constructional features, patented in many countries and
exclusive to BARKER, contribute
to this performance. First is the
DUAL DRIVE shown on the left,
and second the cone LOGA-
RITHMIC CORRUGATIONS.
These produce a very smooth
highly damped acoustic generator
of exceptionally wide frequency
range and remarkable clarity. They
are described fully in a new leaflet
obtainable at the specialists who
join us in this announcement, or
from your usual dealer, or from our
monogram address
BCM/AADU, LONDON, W.C.1
The 148A is being sent to many
countries overseas.
FXPORT ENQUIRIES INVITED

MOST NATURAL SOUND REPRODUCER

ALWAYS THINK OF
GOODSELL LTD.
FOR STANDARD
AND SPECIAL
HIGH FIDELITY
AMPLIFIERS

WEBB’S RADIO invite you to hear the
“Barker 148A” in our demonstration room,
from radio or the Brierley pick-up. You
will doubtless endorse our opinion that this
is an outstanding loud-speaker.

(Webb’s hire-purchase facilities
available on all equipment.)

Stockists for: BARKER,
MORDAUNT, VOIGT, LEAK,
CHARLES, BRIERLEY, AND
ALL “HI-FI” EQUIPMENT.
WEBB’S RADIO
14 Soho Street
London, W.1
## SMALL OSCILLOSCOPE AND WOBBULATOR

Specially designed for Service Engineers

<table>
<thead>
<tr>
<th>Oscilloscope Type 1/B</th>
<th>Wobbulator Type 1/B</th>
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<tbody>
<tr>
<td><strong>Time-base</strong>: 10—350,000 c/s.</td>
<td><strong>Separate Power Supply</strong>: 200-250V. 50 c/s.</td>
</tr>
<tr>
<td><strong>X.Plates</strong>: Direct or Amplified.</td>
<td><strong>Output Voltage</strong>: 4V. R.M.S.</td>
</tr>
<tr>
<td><strong>Y.Plates</strong>: Direct or Amplified.</td>
<td><strong>Nominal Frequency</strong>: 1.2 Mc/s.</td>
</tr>
<tr>
<td><strong>Miniature Valves and 1½” diameter C.R.T.</strong></td>
<td><strong>Frequency Deviation</strong>: 0 to ±40 Kc's.</td>
</tr>
<tr>
<td><strong>Dimensions</strong>: Height 7½” Width 5½” Depth 11”</td>
<td><strong>Dimensions</strong>: Height 2½” Width 5½” Depth 11”</td>
</tr>
</tbody>
</table>

The two units clip together and are priced at **ONLY £20**

ERSKINE LABORATORIES LTD—SCALBY, SCARBOROUGH, YORXS.

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Keeping assembly cost DOWN (and at the same time keeping assemblies safely together) can be a major production headache. Spire Speed Nuts answer that requirement. And many others as well. Acting on its own double-spring locking device, each Spire nut is speedier to put on, holds tighter when it’s home. Awkward fixings and blind assemblies are tackled with equal ease by Spire. Sometimes threaded members can be eliminated altogether. Will you write for more information on Spire Speed Nuts—the fastest thing in fastenings?

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Enquiries to — Simmonds Aerocessories Ltd., Byron House 7-8-9 St. James's St., London, S.W.1.

Head Office and Works: Treforest, Glamorgan
The RC49 . . . a new, reliable Automatic Record Changer featuring PERFORMANCE, LIGHTNESS and LOW COST

Collaro's new Model RC49 more than fills a long felt need . . . . it brings you a reasonable priced record changer incorporating all the refinements hitherto associated only with expensive instruments . . . . plus many new features not to be found in any other record changer.

The RC49 loads, unloads, selects, plays repeats or rejects 10" or 12" records mixed in any order, by the operation of one single control knob.

The powerful induction-type MOTOR is suitable for 100/130 and 200/250 volts A.C., and incorporates the new "Rim Drive." Beautifully simple and completely reliable, the RC49 will give years of trouble-free service.

Write to-day for trade terms and interesting free leaflet which fully describes the Collaro Automatic Record Changer.

MAKERS OF FINE QUALITY GRAMOPHONE COMPONENTS, INCLUDING: COLLARO GRAMOPHONE UNITS, INDUCTION MOTORS, DE LUXE MICROGRAM PORTABLE ELECTRIC GRAMOPHONES.
AN EXAMPLE from the Furzehill range of fine instruments is this high-grade oscilloscope for industrial, radio and television applications. Both axes have identical d.c. coupled high sensitivity amplifiers with symmetrical inputs and a level frequency characteristic from zero to 3 M/Cs. Particularly valuable features are the instantaneous action of the shift controls, expansion of the time base scan from $\frac{1}{4}$ to 5 screen diameters, negligible phase shift in the amplifiers and automatic amplitude-limited synchronisation.

For full details of this, and other instruments in the Furzehill range, write for our new illustrated catalogue.

AN EXAMPLE from the Furzehill range of fine instruments is this high-grade oscilloscope for industrial, radio and television applications. Both axes have identical d.c. coupled high sensitivity amplifiers with symmetrical inputs and a level frequency characteristic from zero to 3 M/Cs. Particularly valuable features are the instantaneous action of the shift controls, expansion of the time base scan from $\frac{1}{4}$ to 5 screen diameters, negligible phase shift in the amplifiers and automatic amplitude-limited synchronisation.

For full details of this, and other instruments in the Furzehill range, write for our new illustrated catalogue.

FURZEHILL LABORATORIES LIMITED
BOREHAM WOOD - HERTS. Tel. ELStree 1137
6F17

MINIATURE PULSE
AND R.F. BEAM TETRODE

The Mazda 6F17 is an indirectly heated miniature pulse and R.F. Beam Tetrode having an anode dissipation of 3.5 watts.

RATING

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Voltage (volts)</td>
<td>V_h</td>
</tr>
<tr>
<td>Heater Current (amps)</td>
<td>I_h</td>
</tr>
<tr>
<td>Maximum Anode Voltage (volts)</td>
<td>V_a(max)</td>
</tr>
<tr>
<td>Maximum Screen Voltage (volts)</td>
<td>V_s(max)</td>
</tr>
<tr>
<td>Mutual Conductance (mA/V)</td>
<td>g_m</td>
</tr>
<tr>
<td>Maximum Anode Dissipation (watts)</td>
<td>p_a</td>
</tr>
<tr>
<td>Maximum Screen Dissipation (watts)</td>
<td>p_s</td>
</tr>
</tbody>
</table>

Further details given on application to the Radio Division.
GOODSELL

15 WATT HI-FIDELITY AMPLIFIERS

are unsurpassed in performance

AS DESCRIBED BY T. D. N. WILLIAMSON IN "Wireless World," MAY, 1947

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Easy Terms from LONDON RADIO SUPPLY CO. Balcombe, Sussex

MODEL ILLUSTRATED
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Price £30.10.0

WILL GO INTO A MATCH-BOX
and every single one is DEAD ACCURATE in size

That's how Thompson's work. Whether you require large or small turnings in wood, Thompson's will make them exactly to your specification.

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AUTOMATIC COIL WINDING MACHINES
AND HAND WINDING MACHINES

Machines supplied complete with stand motor and Two-speed Friction Clutch

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J. P. Fielding Co. (Canada), 131 Ontario Street, St. Catherine's, Ontario.
Hefye & Frogg, Oslo, Norway, Storgaten, 15.

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Phone—5386
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fidelity of response speaks for itself to the discriminating ear. Precision manufacture is no less eloquent to the trained engineer. These qualities make TRUVOX speakers famous.

The SS10A 12-inch Heavy Duty Speaker, illustrated, offering a frequency response from 55 to 11,000 c.p.s. and handling 10 watts is a typical example of TRUVOX workmanship.

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FREQUENCY
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EQUIPMENT

Type TME I

Years ago, the frequency measuring equipments made by Marconi’s were for their own use — because nowhere else could sufficiently accurate instruments be obtained. The present equipment therefore, Type TME I, boasts a long and distinguished pedigree and, like its predecessors, is precision-built to an exacting specification. Anywhere in the world it can be rapidly installed and its rated stability of 1 part in 10⁶ maintained indefinitely. In price too, it commends itself as the ideal laboratory standard. Please ask for further details. Type TME I Frequency Measuring Equipment is available for early delivery.

Marconi Instruments Ltd
ST. ALBANS, HERTS. Telephone: St. Albans 6161/5

Wireless World July, 1949

THE HEIGHT OF EFFICIENCY IN LONDON OR BIRMINGHAM

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From Single Dipole to the Triple Reflector model illust rated, every WOLSEY Tele. Aerial is the most efficient of its type. Many years specialisation is behind them!

THE FIRST AND MOST SUCCESSFUL TRIPLE REFLECTOR ARRAY

giving increased gain for fringe areas and greatly reduced interference in town areas.


One of our fully equipped Vans available for the installation of all our eight types of Aerials in London and Birmingham.

SEND FOR BROCHURES

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Established 1934

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Ex-demonstration and experimental equipment, shop soiled and redundant stock to be sold at "give away" prices. A few examples are as follows:

**RDI High Fidelity Amplifier.** Ex. dem. model. (List £32 10s. 0d.) £12 10 0

**15-watt P.A. Amplifier.** Input for M.I.C., or P.U. In grey linof steel cabinet. £10 10 0

**Wide range Audio Oscillator.** Working but needs slight attention. £4 10 0

Baker 12in. Energised Loudspeaker. £2 10 0

(The above to callers only)

A list giving other single items, and details of the many components available will be forwarded on request.

NEW HIGH FIDELITY LOUDSPEAKERS AND CABINETS.

**Goodmans “Axiom 22,” high flux version of the “Axiom 12.”** £12 13 0

**Goodmans R22/1206, high flux bass loudspeaker.** Resonance 55 cps. £11 0 0

**Bass Reflex Cabinet for the “R22” and “Axiom 22.”** Very solidly constructed and finished in figured Walnut. Carriage 10s. £16 16 0

**“RD Junior” corner reflex cabinet for the Wharfedale WIO.CS.** Compact and attractive design giving good bass response down to 35 cps. Carriage 10s. £12 10 0

Wharfedale WIO.CS Loudspeaker £7 0 0

A full description and photograph of the “RD Junior” cabinet will be forwarded on request.

ROGERS DEVELOPMENTS CO.
106, Heath Street, Hampstead, London, N.W.3
EXTRACT FROM REPORT OF ANGLO-AMERICAN COUNCIL ON PRODUCTIVITY

"... Productivity bears an important relationship to the amount of energy available per employee. In the United States this figure is approximately twice that in the United Kingdom..."

ASKED to comment, our Managing Director (the sly old thing) said (in what he fondly imagined to be the courtly accents of old Virginy): Ah sho will suh! What that grand ole Council says right now, those same vurry words is what ah’ve bin a-tellin’ and a-tellin’ you-all evnh since old Methoosalem. That po’ ole British Workin’ Man he jes’ sweats and strains body all achin’ and racked with pains; lifts dat screwdriver, totes dat brace... Uh! Uh! Uh! Lawdy, lawdy, you-all sho must give that po’ fella mo’ hoss-power. Yassuh! Hoss-power. Nothin’ else but.

Call up dem little horses

DESOUTTER

Your designs

LET US BRING THEM TO

LIFE!

Made in Three Principal Materials

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

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

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

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Bullers
Bullers Low Loss Ceramics

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Telephone: Mansion House 9971 (3 lines) Telegrams: "Bullers, Cannon, London"

the finest in electronic valves

ADA

TRADE MARK REG.

carry this emblem

Supplied to ADA by R.C.A., ADA electron valves are designed to satisfy completely the requirements of radio receivers, service, amateur and laboratory equipment. Sturdily constructed and thoroughly tested, every ADA valve is guaranteed to give long, trouble-free use.

The ADA trademark is your assurance of dependable performance and durability.

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CALIBRATED WIDE RANGE cathode ray oscillograph with simple controls and large screen, combined with the measuring facilities of a valve voltmeter.

THE NAGARD
UNIT CONSTRUCTION in one case provides alternative time bases or amplifiers and improvements at minimum cost. Adequate power supply for all requirements in separate easily portable case.

TYPE 103
STANDARD UNITS include: D.C. AMPLIFIER of high sensitivity — less than 1 mV. per cm. with linear response 0-2.5 Mcz. TIME BASE with calibrated velocity from 10 c/s to 1 Mcz, automatic synchronisation and free from effects of mains variations.

OSCILLOGRAPH & OSCILLOMETER
INPUT SIGNAL VOLTAGES measurable by directly calibrated Y shift control, independently of amplifier gain.

THE ONLY PORTABLE instrument combining all the above for the purposes of enabling you to SEE WHAT YOU MEASURE — MEASURE WHAT YOU SEE AT HIGH OR LOW FREQUENCIES AND D.C.

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Phone: Brixton 3550. Grams : Intertel, Claproad, London
ACHIEVEMENT!

Standard condenser technique now reduced to midget dimensions

HIGH INSULATION RESISTANCE

LOW POWER FACTOR.

Solid aluminium foil

Two layers of paper dielectric

Neoprene sealed

In aluminium tube

WHEN size is the limiting factor, T.C.C. can supply the answer. Here, in the new Metalmite, is a real paper and foil condenser magically reduced to Lilliputian dimensions. Specially built to withstand wide temperature variations between -40°C to +100°C and conditions of high humidity. Its sturdy, rugged construction makes it ideal for use in portable transmitters and receivers — also for deaf aid equipment. In capacities from 0.002 mfd. 500 volts D.C. to 0.01 mfd. 200 volts D.C. — full details on request.

THE TELEGRAPH CONDENSER CO. LTD
RADIO DIVISION: NORTH ACTON, LONDON, W.3 • TELEPHONE: ACORN 0061
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GREATEST BARGAIN
ever offered in Government Surplus

TR9 TRANSMITTER/RECEIVER
LESS VALVES
complete in transit case as illustrated.
12'6d. CARRIAGE FREE

These equipments were in working order before being stored in the open, but their general condition has now deteriorated.

BRIERLEY PICKUPS

Ribbon, type JB'P'R'2
Microarmature, type JB'P'A'1

Recent comparative tests have shown that with the best modern recordings some improvement in performance is obtained by the use of a "special" point shape.
In practice, we naturally endeavour to obtain a shape as near as possible to the cutting stylus whilst retaining the essential characteristics of a reproducing point.
We can supply to order, Ribbon and Microarmature pickups with points having a lateral radius of "0.025" approx.; a longitudinal radius of "0.005" approx.; and a near vertical leading "edge".

J. H. BRIERLEY GRAMOPHONES & RECORDINGS LTD.
46, TITHEBARN STREET, LIVERPOOL, 2.

CONSISTENTLY Accurate

PULLIN INDUSTRIAL MEASUREMENT

A Linear Scale Bridge-type Ohmmeter, with press key, designed for routine production testing of all resistive components.
For battery or A.C. mains operation. (A.C. mains operated instruments are compensated for voltage variations up to — 15%.)
Designed and constructed to withstand severe industrial use. Available as single or multi-range.

MEASURING INSTRUMENTS (PULLIN) LTD
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Telephone: ACOrn 4651 3 & 4995
**Dubilier "Drilitic" Capacitors**

Dubilier "Drilitic" Capacitors have all the essential features.

For the time being these capacitors are only available to manufacturers of radio and electronic equipment.

By the application of special manufacturing techniques we are producing "Drilitic" Capacitors to a high level of engineering efficiency. The equivalent series resistance and leakage current have been reduced, breakdown voltage and life expectancy have been increased and both the audio and radio frequency impedances, together with the temperature characteristics have been improved. In addition to these finer electrical characteristics "Drilitic" Capacitors are extremely small in physical size. To obtain the maximum advantage from the small size, Ear Mounting "Drilitic" Capacitors are now available to provide a more rapid and efficient means of fixing. They are obtainable in single and multiple capacitor forms and in a wide range of capacitances and voltages. High ripple current "Drilitic" Capacitors for television and electronic apparatus, and high temperature "Drilitic" Capacitors for equipment with high ambient temperature or for tropical operation are also available.

We shall be pleased to forward full details of these latest engineering developments together with the eleven points of special interest, upon application.

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High Voltage Testing of insulated components has hitherto meant, in many instances, complete destruction of units below standard. Furthermore, such tests have involved appreciably long periods of time.

This Airmec non-destructive high voltage insulation tester will give immediate indication of weakness in insulation before breakdown voltage is reached. It will indicate the maximum safe voltage at which insulation can be worked and will show whether or not ionisation is present within the insulation. The instrument is self-contained, portable, low in cost, and safe to operate. It may be used by unskilled personnel and is many times faster in use than other test equipment. Voltages up to 5kV are available.

For testing radio and electrical components, motor and transformer windings, insulated wire and cables, and determining deterioration of insulation after storage.

AIRMEC LABORATORIES LIMITED
HIGH WYCOMBE • BUCKINGHAMSHIRE • ENGLAND
Telephone: High Wycombe 2060 • Cables: Commlabs
Manufacturers of all types of Industrial Electronic Equipment and Test Gear

High Fidelity Reproduction.

The S. G. Brown Type "K" Moving Coil headphones, with the following outstanding characteristics, supply that High Fidelity Reproduction demanded for DX work, monitoring and laboratory purposes, etc.

CHARACTERISTICS.
D.C. RESISTANCE, 47 Ohms.
IMPEDANCE 52 Ohms at 1,000 c.p.s.
SENSITIVITY, 1.2 x 10^-15 Watts at 1kc. = 0.002 Dyne/cm^2

PRICE £5.5.0 PER PAIR

For details of other S. G. Brown Headphones (prices from 30/- to 77/6) write for illustrated Brochure "W.W."

BROWN—E.R.D. 13 inch Portable Disc Recorder
An Important S. G. Brown product

BROWN-E.R.D.
DISC RECORDER
Incorporating the latest advances in Sound-on-Disc Recording
Write for interesting brochures presenting full technical details of this latest development in Sound-on-Disc recording. Also 17 inch models for the Professional user.

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Established in Electro Acoustics and high precision Engineering for over 40 years. Manufacturers of the world-famous "BROWN" Gyro Compass.
Telephone: Watford 7241
THE TELEVISION KIT

YOU CAN BUILD FOR £17.17.0

This Receiver consists of 4 units:

The Sound Receiver, Vision Receiver, Time Base and Power Pack. As is usual in all Premier Kits, every single item down to the last bolt and nut is supplied. All chassis are punched and layout diagrams and theoretical circuits are included.

The cost of the Kits of Parts is as follows:

- Vision Receiver with valves £3 13.6
- Sound Receiver with valves £2 14.6
- Time Base with valves £2 7.6
- Power Supply Unit with valves £6 3.0

In addition you will need:

- VCR97 Cathode Ray Tube £1 15.0
- Set of Tube Fittings and Socket 7.0
- 6in. PM Moving Coil Speaker 16.6

The Instruction Book costs 2.6, but is credited if a Kit for the complete Televisor is purchased.

Any of these Kits may be purchased separately; in fact any single part can be supplied. A complete priced list of all parts will be found in the Instruction Book.

A GLANCE AT THE PRICES WILL SHOW THAT THIS IS THE GREATEST VALUE OFFER PREMIER HAVE EVER MADE

WORKING MODELS CAN BE SEEN DURING TRANSMITTING HOURS
AT OUR FLEET STREET AND EDGWARE ROAD BRANCHES.
FOR CALLERS ONLY.

This battery operated U.S. Army Test Equipment was made by Bendix. Essential to all aircraft operators using V.H.F., R.T., equipments. Designed for tuning and testing the American SCR522 Equipment and for the British 1143, 1464, etc. Supplied with Field Strength Meter in strong transit case.

**SIGNAL GENERATOR, Type I-130-A**

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Wireless World  July, 1949
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S.E.C. Cathode Ray Tubes
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**Wireless World**

**July, 1949**

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World Radio History
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- Integrated Light Output: 4,000 lumen-seconds
- Light Quality: Closely resembling daylight

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**PRICES**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Tube</th>
<th>£ s. d.</th>
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<tbody>
<tr>
<td>A.7</td>
<td>6</td>
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<tr>
<td>A.1, A.2, A.4, A.5, A.8 9&quot;</td>
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<td>B.1, C.1... 10&quot; &amp; 12&quot;</td>
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<td>15&quot;</td>
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<td>A.3 (Universal) 9&quot;</td>
<td>6 16 6</td>
<td></td>
</tr>
<tr>
<td>B.2 (Universal) 10&quot;</td>
<td>7 7 0</td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Type No.</th>
<th>Secondaries</th>
<th>Price</th>
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<tbody>
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<td>A6</td>
<td>350-0-350v</td>
<td>75 m/a</td>
</tr>
<tr>
<td>A4</td>
<td>450-0-425v</td>
<td>200 m/a</td>
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<td>B6</td>
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<td>350-0-350v</td>
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<td>5000v</td>
<td>5 m/a</td>
</tr>
</tbody>
</table>

*For "Electronic Eng." Televisor.

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Valves and their applications

The DL93 as a Power Amplifier at V.H.F.

In the rapidly expanding field of low power V.H.F. communications for Business Radio and similar purposes, the designer often has difficulty in obtaining satisfactory transmitting valves for his equipment, since the choice of valves suitable for many such applications is severely limited in this country. In particular there still exist few directly-heated miniature types capable of an efficient performance when used as power amplifiers in battery-operated V.H.F. 'walkie-talkie' transceivers.

At the lower V.H.F. frequencies the designer's requirements for an efficient directly-heated power amplifier are met by the DL93. This valve is a miniature pentode on a B7G pressed glass base, and has a low filament consumption. A table of maximum ratings is shown in Table 1.

In the 60-80 Mc/s Business Radio band the valve has a very satisfactory performance. When operated as a conventional Class C amplifier at 80 Mc/s, and driven by another DL93, the valve has a power output of approximately 1.5 watts and an anode efficiency approaching 55%. Figure 1 shows a suitable circuit for use at this frequency.

The circuit contains no unconventional features, and is simple to adjust. Moreover the layout of the components is not critical, although all leads should be kept short. An efficient screen between the grid and anode circuits should be provided. The grid anode capacitance of the DL93 is low and consequently neutralisation is not essential; a neutralised circuit is somewhat easier to adjust, however, and in this case the neutrodyne (Hazeltine) circuit is recommended.

In semi-portable equipment the existing Business Radio regulations allow the DL93 to be operated at its maximum ratings. In "walkie-talkie" transceivers a maximum of 1 watt input to the final stage is permissible, and an anode potential of 90 volts is therefore adequate. Two 45-volt hearing aid layer batteries may be used to provide the H.T. supply.

Since quartz crystals with a natural resonant frequency as high as 80 Mc/s are not yet generally available, frequency stabilisation entails the use of a master oscillator of comparatively low frequency (15 Mc/s for example) followed by a multiplier chain. Since it is of major importance to minimise the power consumption of the multiplier stages, hearing aid subminiatures such as the DL72 may be used with advantage. The final power amplifier may then be operated from another DL93 as driver. Alternatively, if a reduced power output can be tolerated, the amplifier stage may profitably be driven directly by the final multiplier.

The variation in performance of the DL93 with frequency may be summarised as follows. At frequencies below 100 Mc/s the efficiency and output remain virtually constant, the required drive decreasing with the frequency. It is noteworthy that at frequencies of the order of 5 Mc/s the drive required for full output is unusually low (1.2mA approximately). Thus at these lower frequencies the valve is capable of its optimum performance when driven by a DL72 buffer stage. Above 100 Mc/s the performance deteriorates; the valve will nevertheless give a satisfactory performance in the 144-146 Mc/s amateur band.

The efficiency of the DL93 when used in the 156-184 Mc/s Business Radio band is of the order of 15% to 25%. Details of Mullard miniatures and subminiatures suitable for operation in this and in the 460-470 Mc/s bands will be published in later articles.

TABLE 1

<table>
<thead>
<tr>
<th>SERIES</th>
<th>PARALLEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vf : 2.8</td>
<td>1.4 V (D.C.)</td>
</tr>
<tr>
<td>If : 0.1</td>
<td>0.2 A</td>
</tr>
<tr>
<td>Va max.</td>
<td>150 V</td>
</tr>
<tr>
<td>Vg; max.</td>
<td>135 V</td>
</tr>
<tr>
<td>Vgi max.</td>
<td>-30 V</td>
</tr>
<tr>
<td>Ia max.</td>
<td>20 mA</td>
</tr>
<tr>
<td>Ig; max.</td>
<td>0.25 mA</td>
</tr>
<tr>
<td>Ik max.</td>
<td>25 mA</td>
</tr>
<tr>
<td>pa max.</td>
<td>2.0 W</td>
</tr>
<tr>
<td>pg2 max.</td>
<td>0.9 W</td>
</tr>
</tbody>
</table>

The above limiting values are for intermittent operation as an R.F. power amplifier.

Reprints of this report from the Mullard Laboratories, together with additional circuit notes, can be obtained free of charge from the address below.

MULLARD ELECTRONIC PRODUCTS LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

MVW96
INTERNATIONAL TELEVISION ARGUMENT

Writings on the possibilities of rivalry between American, British and Dutch firms in international markets for television equipment, our U.S. contemporary, Electronics (May, 1949, issue), says, editorially:

"The crux of the matter is the standards to be adopted. Should they follow American or British practice? Evidently, the adoption of one or the other might give a preferred position in the market. So far as studio and transmitting equipment is concerned, it is not difficult to meet the customers' desires regarding standards without major increase in cost. But receivers are different; if foreign standards depart too widely from those used by the manufacturer in his domestic product, the cost of exported sets may rise substantially, possibly enough to price them out of the market."

That is a fair statement of the position. Any competent designer and manufacturer, whether American or European, can provide foreign customers with transmitting equipment for working to any reasonable standards that they may fancy. With receivers, on the other hand, standards are commercially much more important and we enter the realms of Big Business. The country whose standards are adopted by others will have a ready-made export market for its domestic production.

It is less easy to agree with the substance, and still less with the implications, of the paragraph that follows. It reads:

"We feel strongly that whatever standards are adopted in foreign lands, they should not restrict the utility of the service. Further, at the risk of starting an international argument, we venture to remark that two important aspects of the British standards are restrictive. One is the use of a 2.5-Mc/s video band, as compared with the 4.0-Mc/s standard in the U.S.A. The choice of a narrow bandwidth must inevitably restrict the detail of the images provided to foreign customers. The second is the 25-per-second picture transmission rate, adopted in Britain to conform with the 50-c/s power supply frequency. This limits the brightness of flicker-free images to a value substantially lower than that possible with the 30-per-second American rate."

It is implied here that the ratio of bandwidths is a measure of relative picture quality between the British and American systems. Of course, it is fundamental—even platitudinous—that the information content of any form of radio communication is determined by bandwidth. May we say, then, if the American 4-Mc/s bandwidth is good, the French 10-Mc/s system must be potentially better and a hypothetical 20-Mc/s better still? And where are we to stop? It is hardly practical engineering to argue along these lines, so long as the availability of communication channels is limited and economy must be considered.

In any case, the comparison made by Electronics is factually incorrect. First, the British system employs 2.75 Mc/s—not 2.5 as stated. Secondly, the ratio of bandwidths can only be taken as an indication of relative picture quality if the frame frequency is the same. If the Americans used a 25-frame rate, they would need only a 3.3-Mc/s bandwidth for their present picture quality. The relative quality of British and American pictures is in the ratio 3.3 : 2.75 and not 4 : 2.5 as implied by Electronics.

As to the alleged reduction of flicker resulting from the 30-per-second American picture rate, are we seriously asked to believe that it was chosen for that reason? Surely, with the American 60-c/s supply frequency there was no other practicable choice. The use of a frame frequency differing from the mains frequency calls for much more extensive smoothing of receiver h.t. supplies and so increases receiver cost.

With the notable exception of the American continent the world's electrical supply systems are predominantly 50 c/s; for this reason the lower picture rate will generally be preferred. Any advantage in freedom from flicker offered by the higher rate is largely academic.
TELEVISION STATION SELECTION

A Look to the Future

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

Up to the present British television receivers have been designed for the reception of one station only—the vision and sound channels of Alexandra Palace. When the Birmingham station opens there will be two stations in operation and, according to the present plan, there will eventually be five.

Since all stations are intended to transmit the same programme each receiver will need to receive only one of the stations except perhaps, in certain fringe areas midway between two of them. Even here one station will, in general, afford a better signal than the other and so it is necessary only for the receiver to be able to receive this better one.

Even under the new plan, therefore, it will not be necessary for any individual receiver to be suitable for more than a single station. However, there are certain obvious difficulties in manufacturing only single-station receivers; if this course is continued, each maker will eventually have to produce five different models. This alone will increase production costs and, in addition, he will have to regulate the relative quantities made very nicely.

Then viewers do occasionally move their homes, and those changing from the service area of one station to that of another will not expect their receivers to become obsolete.

It is, therefore, likely that the receiver of the future will have to be suitable for any of the five stations. There are many possible ways of doing this and it is interesting to consider their relative merits.

In the first place it is clearly unnecessary for the means of station selection to be operable by the user. If such a control were provided he would use it only on those rare occasions when he moves to a different service area. There is no objection to such a control if it proves the most economical way of arranging the selection, of course, but it is not a necessary control. All the user requirements can be met by providing a form of station selector which can be adjusted by any competent technician.

One method, which is already being applied, is to build the set so that the signal-frequency circuits, and the oscillator if the receiver is a superheterodyne, form an accessible and replaceable sub-unit. One such sub-unit can be made for each channel and station selection effected by changing sub-units.

The method is obviously better suited to the superheterodyne than the straight set, for this requires only two or three tuning circuits, whereas the latter needs ten to fifteen. The disadvantage of the method is that it is still necessary to manufacture different units for different areas and to arrange for their production in the proper quantities to meet the demand. Also the manufacturer must be able still to supply the alternative sub-units for many years so that the viewer who moves to another area can be provided for.

Trimming Range

From the manufacturing point of view it is much better if all sets can be alike in their components and if the differences can be merely ones of adjustment. At first sight, this seems easy, for it would appear to be necessary only to increase the range of the trimmers so that the set could be tuned to any station in the band. It should not be impossible to make inductances adjustable over a sufficient range for this. Allowing for stagger tuning, a frequency ratio of 1.6:1 is needed and this means an inductance ratio of 2.56:1. By using a very thin-walled former a simple metal slug partly of metal and partly of dust-iron will reduce inductance when the one end is inserted and increase it when the other comes inside the coil, thus increasing the total variation obtainable.

A receiver designed on these lines could be tuned to any station in the band by a competent technician equipped with the proper apparatus. However, there is rather more in changing frequency than just re-trimming circuits. In the sound channel, changes in the Q of the coils with frequency may seriously affect the performance and, in particular, the amount of sound-channel rejection obtained. Towards the high-frequency end of the band an increase of Q is desirable to maintain the sound-channel rejection. With slug tuning, however, the Q is likely to decrease very considerably at this end of the band.

Then the input resistance of a valve decreases with frequency. It is approximately inversely proportional to the square of frequency. This may or may not be serious, for there is a possibility of devising a correcting network to mitigate this natural tendency. If this proves to be impracticable, however, then there is no doubt at all that the changing input resistance will very seriously affect the performance and call for circuit changes for different frequencies. Couplings are another factor which may need alteration. There is the aerial feeder to first-grid coupling circuit for one, there are the sound-channel rejector-circuit couplings for a second and there are the band-pass type couplings, if they are used, for a third.

It is clear, therefore, that the design of a straight set embodying ten to fifteen tuned circuits is by no means a simple matter. The superheterodyne scores heavily in this respect, for the bandwidth, sound-channel rejection and gain are obtained chiefly at the fixed intermediate frequency. Only the signal- and oscillator-frequency circuits need alteration for a different station,
and a considerable variation in their performance over the band is tolerable.

The superheterodyne, however, has its own troubles. It is well-known that even when only the reception of one station is being considered it is necessary to choose the intermediate frequency very carefully if the picture is to be free from a pattern produced by harmonics of the intermediate frequency being fed back from the output to the input. With an intermediate frequency of the usual order of magnitude, - 5.14 Mc/s - it is impossible to avoid this effect on all stations simply by selecting the frequency and it is necessary to employ very thorough screening and filtering to prevent the feedback. This is quite expensive.

There are, in addition, the possibilities of interference by signals operating in the i.f. band and on the second channel and it is necessary to take precautions against local-oscillator radiation. The attainment of adequate frequency stability in the oscillator is another difficulty which confronts the designer.

All these superheterodyne disadvantages are found in the ordinary broadcast receiver and in spite of them it has become almost universal. There are two reasons for this, one of which does not apply at all in the present-day television case and the other of special forms of interference if its intermediate frequency were made considerably higher than is now customary. If the intermediate frequency were lower than the lowest frequency of the signal band and higher than one-half of the highest frequency of the band, then i.f. harmonic interference would be impossible. The lowest signal frequency is 3.75 Mc/s, the highest 66.75 Mc/s. Therefore, from this point of view the intermediate frequency should be less than 4.5 Mc/s and greater than 33.75 Mc/s.

By choosing a frequency in the band 33.75-41.5 Mc/s, therefore, one drawback of the superheterodyne can be eliminated. It is quite a satisfactory frequency from the point of view of obtaining bandwidth, sound-channel rejection and gain, for all these can be secured adequately at the higher frequency of 45 Mc/s, as is evidenced by all the satisfactory straight sets now produced.

Since such an intermediate frequency is nearer the signal frequency than is at present usual the liability to the direct pick-up of signals on that frequency is increased. As a partial offset to this, signals on the higher frequency are usually rather weaker. Nevertheless, more care in the avoidance of this type of interference must be taken.

The liability to second-channel interference is reduced because of the higher frequency and its elimination should not prove very difficult.

The problem of the oscillator may well be serious. If the oscillator frequency is higher than the signal frequency, the main trouble will be that of obtaining adequate frequency stability. Thus, suppose an intermediate frequency of 35 Mc/s is chosen, then the oscillator must cover from 45 + 35 = 80 Mc/s to 66.75 + 35 = 101.75 Mc/s. These frequencies are rather high for obtaining stability cheaply.

If the oscillator frequency is made lower than the signal frequency there is considerable danger of harmonics of the oscillator causing interference. This is shown by the diagram of Fig. 1 which indicates signal frequencies on one scale and intermediate frequencies on the other. The television channels are marked and the shaded areas represent interference bands, the order of the oscillator harmonic involved being marked in them.

If 35 Mc/s were chosen interference would be experienced from the third oscillator harmonic when receiving Channel 2. For instance, the vision carrier for Channel 2 is to be 51.75 Mc/s. The oscillator would be 51.75 - 35 = 16.75 Mc/s and its third harmonic 50.25 Mc/s. This would beat with 51.75 Mc/s to give a difference frequency of 1.5 Mc/s which would produce a most noticeable pattern on the picture.

Fig. 1. This diagram shows intermediate frequencies with which interference will be found from oscillator harmonics when the oscillator is lower in frequency than the signal: the numbers in the shaded interference areas indicate the order of harmonic involved.
Television Station Selection—

Examination of Fig. 1 shows that there is only one possible intermediate frequency for the avoidance of this effect on all channels. This frequency is 37 Mc/s. A vertical line at 37 Mc/s on the diagram does not cross any shaded area.

With this frequency the oscillator must cover 45 - 37 = 8 Mc/s to 66.75 - 37 = 29.75 Mc/s which is a wide range to cover in a single sweep. The relatively low frequency of the oscillator, however, greatly eases the problem of securing adequate frequency stability.

We cannot, however, yet say that this frequency will be satisfactory, for all the possible forms of interference have not been examined.

Since the oscillator frequency is lower than the intermediate frequency it is necessary to make sure that none of its harmonics falls in the intermediate frequency band. This can be taken as 37 - 2.75 = 34.25 Mc/s to 37 + 0.75 = 37.75 Mc/s with a sound channel at 37 - 3.5 = 33.5 Mc/s.

For Channel 1, the oscillator will be at 45 - 37 = 8 Mc/s and its harmonics will be 16, 24, 32, 48 Mc/s. The third harmonic just misses the i.f. band.

For Channel 2, the oscillator will be at 51.75 - 37 = 14.75 Mc/s and its harmonics will be 29.5, 44.25 Mc/s. Again, they miss the i.f. band.

For Channel 3, the oscillator will be at 56.75 - 37 = 19.75 Mc/s and its harmonics will be 39.5, 59.25 Mc/s.

For Channel 4, the oscillator will be at 61.75 - 37 = 24.75 Mc/s and the second harmonic will be 49.5 Mc/s.

For Channel 5, the oscillator will be at 66.75 - 37 = 29.75 Mc/s and the second harmonic will be 59.5 Mc/s.

The frequency is then satisfactory in this respect.

There is next the possibility of interference from a station which is spaced from an oscillator harmonic in the intermediate frequency. It is similar in nature to ordinary second-channel interference but involves an harmonic instead of the fundamental of the oscillator. The possible interference frequencies, including the genuine second-channel frequencies, are listed in the table.

If these frequencies are compared with the signal bands it will be seen that with one exception none falls within the band of the station being received. The responses are, therefore, in principle capable of being eliminated by signal-frequency selectivity. The exception is in Channel 4. The fourth harmonic of the oscillator when it is set for reception of Channel 4 is 99 Mc/s.

The intermediate frequency will, therefore, be produced by a signal on 99 - 37 = 62 Mc/s and this is within the Channel 4 band of 59 - 62.5 Mc/s.

It is, therefore, probable that this scheme may fail on this channel, which is the Birmingham one. It is possible that this could be evaded by changing the intermediate frequency very slightly, but there is not much scope for this without merely transferring the interference from one channel to another. Thus a shift to 37.5 Mc/s would be impracticable because the sixth harmonic of the oscillator would fall in Channel 1.

Oscillator Frequency

From the interference point of view it seems much safer to have the oscillator higher in frequency than the signal. Frequency stability is then the difficulty and it is rather hard to estimate the requirement until the Birmingham station has been in operation and some experience of the single-sideband transmission has been gained. The requirements for the sound channel can easily be estimated and those for the single-sideband reception of a double-sideband transmission are known. It is to be expected that the conditions in the reception of a single-sideband transmission will not be very different, but they may not be quite the same.

Placing the oscillator higher than the signal in frequency is advantageous from nearly every point of view save that of the oscillator drift. In what follows it will be assumed that it is so placed.

The intermediate frequency is no longer critical and a frequency of about 35 Mc/s is suitable, so far as vision is concerned. The sound intermediate frequency now comes above the vision at 38.5 Mc/s, however, and there is here one possible cause of trouble for it is also 3 Mc/s away from the sound channel of Channel 1. The 3-Mc/s beat between the two may thus find its way into the vision channel by modulating the vision carrier in the frequency changer. It would be wiser to choose a frequency not less than 4 Mc/s below Channel 1. This would make the sound intermediate frequency 37.5 Mc/s and the vision 34 Mc/s.

True second-channel interference on vision could then arise only from stations in the band 113—134.75 Mc/s plus a small extension to cover the i.f. amplifier bandwidth. On sound it could come from the band 116.5—138.25 Mc/s.

If the bandwidth of the signal-frequency circuits is about 3.5 Mc/s, the second-channel frequency is about ten times the bandwidth away, or twenty times the half-bandwidth. A single resonant circuit which is down 1 db only at the edges of its band is therefore down 14 db at the second-channel frequency.

It is difficult to estimate how much attenuation is needed at signal frequency. The second-channel band is an aircraft communication band and so considerable field strengths from nearby
aircraft and ground stations may be experienced. As a minimum an interfering signal should be 30 db below the television signal at the frequency-changer input.

In a television receiver designed for limit range the interfering field strength might well be 40 db greater than that of the television signal and then the receiver should give 70-db discrimination. On the other hand, in areas of strong signals the interfering signal might never be more than 20 db below the television signal and only 10-db discrimination in the receiver would suffice.

Sensitivity

As very large numbers of receivers are used in areas of high field strength, where neither a maximum of gain nor the highest second-channel rejection are needed, it is clearly uneconomic to provide all receivers with them. The right course is surely to design the receiver to suit conditions in the major part of the service area, and to have a pre-amplifier which increases both gain and second-channel rejection for long-range reception.

Suppose, as a basis for discussion, that the basic receiver takes the form of a superheterodyne without a signal-frequency amplifier. The minimum useful signal at the input of the mixer will be of the order of 1 mV. This is a very approximate figure which might well be halved by careful design; it also depends upon how much noise is considered tolerable on the picture. Such a receiver with 30-db second-channel discrimination would be satisfactory over a very large part of the service area.

The simplest form of signal-frequency circuit would be a single resonant and damped circuit which would provide something like 14 db attenuation against second-channel interference. The remaining 16 db or so might be obtained from the aerial, which is normally a resonant structure. However, it is very doubtful if it could be relied upon for this, especially in the case of the higher-frequency channels. For Channel 5, for instance, the aerial would be resonant at about 65 Mc/s in its half-wave mode. The second-channel band is 134-137.5 Mc/s and is quite close to 130 Mc/s at which frequency the aerial is again resonant on a full-wave mode.

It is therefore unwise to reckon on much selectivity from the aerial. Even if the aerial itself were usefully selective, it would probably be impracticable to make full use of it, for it would hardly be possible to keep the feeder properly terminated over the full band of frequencies involved. In the second-channel region, therefore, it is probable that the feeder itself would pick-up interference.

It is, therefore, good practice to include adequate second-channel rejection in the receiver itself and, in general, this will require the provision of two tuned circuits. There is, however, another possibility. Since the whole second-channel band lies outside the television band it is theoretically possible to secure the second-channel discrimination by means of a band-stop filter, *which might be inserted between the feeder and the input circuit of the receiver.

It if proved economically possible a further step could be taken. The bandwidth of the input circuit itself could be made very wide to cover the whole television band—26 Mc/s—and the station selection accomplished by varying only the oscillator. This would be a form of single-span tuning.

Increasing the first-circuit bandwidth nearly 7.5 times would result in a considerable loss of sensitivity. The signal/noise ratio would also deteriorate at least as much. It would probably become considerably poorer because of inter-modulation effects in the frequency-changer.

In practice, therefore, it would probably be better to retain signal-frequency tuning supplemented as necessary by fixed-tuned band-rejection filters.

Oscillator Radiation

One other factor must be considered: oscillator radiation. This can be very serious on these high frequencies, especially if a signal-frequency amplifier is not used. In the case considered with television intermediate frequency at 34 Mc/s, the oscillator operates at one of five frequencies in the band 79 Mc/s to 100.75 Mc/s.

At high-frequencies control-grid injection usually works best in the frequency-changer and the oscillator may provide about 2 V on the grid of the valve. Since the first circuit impedance may be 2 kΩ, this is very roughly a power of the order of 2 mW. A single-tuned circuit may reduce this by 8-9 db and the feeder will introduce 1-2 db loss.

The oscillator power fed to the aerial may thus be as much as 200 μW. The signal power collected by the aerial may be only 0.05 μW. The radiated field strength in the immediate vicinity of the aerial may thus be 20 times as great as the field of the television signal.

In the example taken it will not interfere with other television receivers, but it may do with other services, including f.m. broadcasting. It must be very seriously considered, therefore, and the use of a band-stop filter in the aerial circuit is one way of preventing it.

This matter of using fixed filters to reduce interference and radiation is simpler than it may at first appear. Separate band-stop filters for the second-channel and oscillator bands are not necessary: a single low-pass filter can be used instead. If such a filter is given a cut-off frequency of, say, 70 Mc/s it will have little effect in the television band, but give some 12-16 db attenuation per section in the second-channel band. In the oscillator band such a simple filter is less good and may introduce no more than 5 db attenuation per section. It could, however, be greatly increased by using one or two m-derived sections (this is nothing but filter-terminology for one or two tuned rejector circuits).

* Or a low-pass filter, see later.
Television Station Selection—

The basic filter equations are \( LC = \frac{1}{\pi f^2} \) and \( L/C = R \) where \( R \) is the terminating resistance, in this case the feeder impedance of 70 Ω. From the two \( C = \frac{1}{\pi f/R} = 65 \, \text{pF} \), and \( L = \frac{1}{\pi f^2 RC} = 0.317 \, \text{μH} \). The basic form of a filter which should be suitable for the job is shown in Fig. 2. It comprises two prototype low-pass sections and one \( m \)-derived; the last is split into two half-sections, one at each end of the filter, since this improves the termination. Four coils and five capacitors are needed.

A filter of this sort looks as if it would be very cheap and easy to manufacture, but it is not safe to conclude that this is so without further investigation. It is not improbable that very close component tolerances would be needed, but it may be that normal tolerances could be used for some or all of the capacitors if the others, and in particular the coils, were adjustable in manufacture. The coils will need only four or five turns and might well be self-supporting and adjusted in production in the filter unit by squeezing the turns closer together or further apart.

In view of all this it looks as though the television set of the future might well take the following general form:

1. Superheterodyne with 34-Mc/s intermediate frequency and local-oscillator frequency above the signal-frequency.
2. No signal-frequency amplification.
3. One signal-frequency circuit trimmable to any television channel.
4. From 1 and 2, only two trimmers for channel selection, both of which are easily adjustable with very little apparatus.
5. Low-pass filter unit for 70-Ω impedance with coaxial input and output connectors, for second-channel interference and oscillator-radiation elimination.
6. Separate one- or two-stage pre-amplifier, also with coaxial input and output sockets, for insertion between the low-pass filter and the receiver in order to increase the sensitivity, second channel rejection, and signal/noise ratio in areas of low field strength. Such a unit could be trimmable to any station in the band with perhaps three or four trimmers; it might also need changes in the values of damping resistors.

The writer feels that a scheme of this nature if carefully worked out might well prove to be the most satisfactory way of dealing with the problem of station selection. As he has pointed out there are other ways of solving it. It is probably impossible to decide the best way from theoretical considerations only and a good deal of experimental work will be needed. In particular, with the superheterodyne it is never safe to dogmatize for there are so many possibilities of interference with it that it is very easy to overlook one which becomes painfully evident when the set is tried.

In any case, television receiver design of the next few years will be especially interesting and there will doubtless be many different methods tried.

One final suggestion: the solution of the problem of oscillation stability might well be the use of an a.f.c. system operated by the sound signal.

DIVERSITY F.M. TRANSMISSION

New System With Synchronized Carriers

These were arranged as a master station and two unattended satellites situated 10 and 17 miles respectively from the main station. The venue was London, the main transmitter being in Kingsway with one satellite at Mill Hill to the north and the other at Knockholt on the southern fringe of Greater London.

Unlike the majority of multi-station a.m. systems, the G.E.C. f.m. version operates on a single radio frequency for all operational messages to and from the mobile vehicles. Separate frequencies are, however, employed for the radio links between the main and satellite stations. The schematic diagram reproduced here gives the various frequencies employed for this particular system.

The use of a common frequency at the main and satellite stations necessitates very accurate synchronization of these transmitters and this is achieved by employing a single master oscillator at the main station, using an appropriate multiple of it for the "broadcast"
transmitter there and another multiple, giving a somewhat higher frequency, which is radiated over link paths to the satellites. Here the frequency is converted to the actual multiple radiated from the main station's broadcast transmitter, and after suitable amplification, is radiated from the satellites' broadcast transmitters.

At no point in the chain is the actual multiple of the master oscillator lost, neither is the link signal, which carries the audio, demodulated.

From the schematic diagram it will be seen that this system is particularly economical in regard to the number of radio frequencies required. The common broadcast frequency employed on this occasion was 97.8 Mc/s, the outgoing control link was on 146.7 Mc/s and the incoming links on 154 and 155.4 Mc/s respectively. More will be said of these two later.

Thus this three-station f.m. scheme is operated with a total of four frequencies only. Some time ago we described a three-station a.m. system, which might be said to be comparable in many respects, since it was operated in the same area, and for this no fewer than nine frequencies were employed.

It may be argued, of course, that the different method of modulation does not wholly account for this saving of channels and that an a.m. system could be operated also with synchronized transmitters. Be that as it may, the fact remains that the number of frequencies mentioned was employed at the time and a more recent two-station scheme, also using a.m., absorbed six radio frequencies.

The main radio frequency is produced by a temperature-controlled crystal oscillator on approximately 1,527 kc/s, and this is multiplied 64 times to produce the broadcast frequency of 97.8 Mc/s at the main station.

A separate train of multipliers is used for the link transmitter and these raise the master frequency 96 times to 146.7 Mc/s. The ratio between broadcast and link frequencies is thus 2 to 3. Similar results can be obtained with other master oscillator frequencies, thus starting at 1,358 kc/s multiplications of 72 and 108 will yield virtually the same broadcast and link frequencies.

Modulation is applied separately to the broadcast and link channels at a very early stage, but in order to compensate for the distance between the main and satellite stations, a pre-determined delay is introduced into the channel going to the main station's broadcast transmitter.

The amount of delay needed to ensure acceptable fidelity seems by no means critical and this is proved by aural tests and by examination of the waveforms of an 800-c/s tone on an oscilloscope, taken in a locality where the field strengths from the main station and one of the satellites was approximately equal.

From the oscillograms it appears that distortion is becoming apparent with four or less sections and also with eight or more sections, so it would appear that for this distance six is about the optimum. Each section introduces a delay equivalent to about 2.5 miles.

The r.f. output from the link transmitter is fed to a vertical dipole aerial giving omni-directional radiation. Variations of this are possible and the link transmitter could, if required feed two separate aerials beamed on their respective satellite stations.

At the satellite the master station's broadcast frequency, in this case 97.8 Mc/s, is extracted from the 146.7-Mc/s signal by first mixing with the 12th harmonic of a local oscillator, dividing the output by three, then mixing in the 4th harmonic of the local oscillator; what emerges is a signal carrying the modulation but at half the required broadcast frequency. A doubler and power amplifier are all that are needed before the signal is radiated.

It should be noted that the link
Diversity F.M. Transmission—

The signal on the outgoing path has not been demodulated. This may appear to be a rather complicated process, but it ensures that the actual frequency radiated by the satellite is independent of the stability of the local oscillator.

As already explained, the mobile vehicle talks back on the common broadcast frequency and its signals may be received at any or all of the fixed stations. When the signals are received at a satellite station they are demodulated and used to modulate a separate link transmitter for relaying to the main station.

The main station might conceivably be receiving the same message from a vehicle simultaneously on three different frequencies, (a) direct on the broadcast frequency, (b) via one of the satellites on its link frequency and (c) from the other satellite on still another frequency. The output from these three receivers is passed to a mixing unit where the one which has the best signal-to-noise ratio is selected and fed into the loudspeaker. This is, of course, quite automatic.

Several miles of London's busiest streets were covered in a radio-equipped vehicle during the course of a demonstration and at no period was the car ever out of touch. Signals were adequately loud and quite free from distortion during the whole time. From the immediate replies that were forthcoming it was evident that all outgoing messages were being received satisfactorily.

Some distortion was apparent when the delay network was removed from the main station's audio circuit, but this was much less than might have been expected and caused very little deterioration in intelligibility.

Finally, a brief description of the mobile equipment may not be out of place, although the transmitter-receivers used for the demonstration are not newly developed models.

The complete set measures 18 x 8 x 8 in. and weighs 35 lb. A double frequency changing superhet circuit is used for the receiver with the second i.f. on 455 kc/s. The first i.f. is dependent on the operating frequency, as this is adjusted to give the required input to the second mixer using the most suitable harmonic of the crystal-controlled oscillator. The i.f. bandwidth is approximately ±15 kc/s for 6db attenuation. Any single channel within the band 30 to 170 Mc/s can be employed, but the circuit would of course have to be pre-set as the equipment is remotely controlled. The audio output is about 1.25 watts.

The r.f. output from the transmitter varies somewhat according to the operating frequency, but at the worst it is not less than 10 watts and at the best 20, the larger amount being obtained at 100 Mc/s and below. The output valve is a new double tetrode, the TT15. The deviation is ±12.5 kc/s for the equivalent of 100 per cent. modulation, which also is the deviation used for the fixed stations.

Power to operate the set is supplied by a 12-volt battery—with optional 6-volt if required—and the consumption is 55 watts for the receiver alone, 95 watts on stand-by position with receiver on and transmitting valves alight and 175 watts on transmit.

The h.t. is supplied by two small motor generators, one for the receiver and another to the transmitter and filtered air for cooling is circulated through the set by fans on the motor generator.

Transmitter, receiver and power supplies are separate sub-assemblies easily removed for servicing. Miniature parts are used extensively and the whole of the equipment is fully tropicalized.

MANUFACTURERS' LITERATURE

Leaflet describing "Araldite" synthetic resin for surface and wire coating, etc., from Aero Research, Duxford, Cambridge.

Lists of components and kit sets for crystal receiver construction from the British Distributing Co., 66, High Street, London, N.8.

Illustrated leaflets describing the TV12 table television receiver and BA11 battery broadcast receiver from Bush Radio, Power Road, W.4.

Descriptive leaflet relating to the AC100 automatic record changing unit from Electrical and Musical Industries, Blyth Road, Hayes, Middlesex.


Supplementary list of "Instanta" relays from Magnetic Controls, 48, Old Church Street, London, S.W.3.


"Flux Facts" (Leaflet Ref. FF449) giving details of the properties of fluxes now available in cored wire solders made by Multicore Solders, Mellier House, Alenmarle Street, London, W.1.

Technical specification of wide-range signal generators. Model 69B, 100 kc/s-50 Mc/s, and Model 69C, 200 kc/s-150 Mc/s, from Taylor Electrical Instruments, 419-124, Montrose Avenue, Slough, Bucks.

Illustrated leaflets of sound-amplifying equipment and commemorative brochure of testimonials relating to the 1948 Olympic Games from Philips.
FOR good interlacing there are two major requirements which a sync-separator circuit must satisfy:

1. The generation of a steep-fronted frame synchronizing pulse from one—preferably the first—of the sequence of broad pulses that form the frame synchronizing signal;

2. The complete elimination of line synchronizing pulses from the frame synchronizing circuits.

It is not easy to separate two pulses of similar amplitude and shape but of different durations such as the line- and frame-synchronizing pulses, whose durations are respectively 10 microseconds and 40 microseconds. Hitherto, very elaborate circuits with several valves, or incorporating costly delay lines, have been necessary for this purpose and consequently good interlacing has been achieved only at considerable cost. It was with economy in mind that the idea of using a transitron circuit, operating under specific bias conditions, first occurred to the author.*

In the following description of the circuit and its behaviour it is assumed that the reader is conversant with the "flip-flop" action of the transitron. The "flip" occurs when the screen grid draws excessive current and drives the suppressor grid sufficiently negative to cut-off anode current. This action corresponds to the "flip" of the transitron cycle. The "flop" occurs when capacitor C1, connected between the screen and suppressor grids, has recharged sufficiently to allow anode current, as well as screen current, to flow. The time constant C1R1 is, however, so chosen that the line-synchronizing pulse finishes before the "flop" action can take place, and the valve consequently returns at the end of the line-synchronizing pulse to its original state with anode and screen currents cut off by the control-grid potential. Thus the anode remains at full h.t. potential throughout the whole period of the line-synchronizing pulse, and no pulse is produced there. A steep-fronted pulse of considerable amplitude is, however, produced at the screen grid and this pulse is used to switch the line timebase.

When the first frame-synchronizing pulse appears at the control grid, the "flip" action takes place as before, but this time the "flop" occurs before the 40-microsecond frame pulse has ended. This is contrived by making the time constant C1R1 less than 40 microseconds. The result is that the circuit produces not only a negative-going pulse at the screen grid but also a steep-fronted negative-going pulse at the anode. This pulse at the anode is used to trigger the frame timebase. The waveforms at the various electrodes are shown in Fig. 2.

The time constant C1R1 should be just over 10 microseconds. With a 50-µF capacitor for C1 and a 1-MΩ variable resistor for R1, a suitable value of R1 can readily be found by observing the waveform at the anode and gradually increasing R1 to a point just beyond that at which the line-synchronizing pulses vanish.

In practice, the line-synchronizing pulses will not vanish completely at the anode, but for most purposes their amplitude is so small compared with that of the

---

ZOOM LENSES
Their Use in the Television Camera

By H. H. HOPKINS, Ph.D., F.Inst.T.

A RECENT innovation in television outside broadcasts has been the introduction of a zoom lens, which is an attachment for converting any ordinary fixed-focus camera lens into a lens of continuously variable focal length. The new lens has been made by W. Watson and Sons, of Barnet, and was used for the first time at the televising of the Cup Final at Wembley this year.

The zoom lens is mounted on the front of the television camera and is operated by rotating an outer cylinder which imparts axial movements to the two inner component lenses, 2 and 3, by means of cam slots, the outer components, 1 and 4, remaining stationary. If suitable movements are given to 2 and 3, the final image remains in focus on the photo-cathode of the television camera, and the focal length of the combined optical system varies. The result is that the size of details in the picture is altered, creating the illusion that the camera is moving towards or away from the scene. The zoom lens at present being used for television enables the image of any detail in the scene to be varied over a range of 4:1 in area, and it will work in conjunction with any camera lens having a front diameter not greater than 2 in and covering an angle of field that is not more than 30 degrees. During zooming, the relative aperture of the combined optical system remains constant, and consequently the brightness of the image also remains constant.

The aberrations of the system are corrected by balancing the positive and negative aberrations contributed by the different surfaces. Any change in the relative positions of the component lenses will, in general, upset this balance, and so it is necessary to restrict the movements to the two inner components and yet give excellent definition. Furthermore, this economy of components results in a greater efficiency of light transmission and also in the elimination of stray light, compared with certain other zoom lenses.

Semi-Automatic Morse Key

RADIO amateurs and many professional operators on this side of the Atlantic are beginning to acquire a liking for the semi-automatic type of morse key so popular in the U.S.A. Once the technique of handling it has been mastered it does unquestionably permit of sustained high speed sending with far less wrist fatigue than with most other types of key.

It gets its description from the fact that the dot constituents of the morse characters are formed automatically by a vibrating spring, the speed of sending being governed by the position of "bob" weights.

The Eddystone model of the key is very well engineered and lends itself for adjustment to almost any speed of sending likely to be required by amateurs and most professionals. It is not a key that would normally be used for slow sending as its special properties show up best at high speeds. None the less it is quite capable of operation at 8 w.p.m. if required. This key has two "bob" weights for coarse and fine adjustment.

A heavy die-cast base is used with rubber feet and there are also two holes for screwing it down. Actually the rubber feet counter any tendency to wander, but a more secure fixing is really desirable. It has a short-circuiting switch and the whole is enclosed by an attractive cover finished in black crackle enamel and chromium.

The makers are Stratton & Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31, and the price is £3 17s 6d.
When these special types arise
you'll find it best to *BRIMARIZE!*

Types 6SA7 and 12SA7 are pentagrid frequency changers of specialised design, widely used in American radio receivers. They have now been superseded by the miniature types 6BE6 and 12BE6, but this substitution requires a change of socket.

Good results may often be obtained by the use of types 6K8GT and 12K8GT respectively, a slight connection change and a lead to the top cap being required. In all cases it will be necessary to re-align the receiver, preferably throughout.

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McMURDO Moulded Valveholders

Recognised as the Most Reliable Valveholders
As one of the many functions of the general-purpose communications receiver with which we are here concerned is for merchant ship work, it has been designed to comply with certain requirements laid down by the Postmaster-General as to specification and performance.

One of the requirements for a set of this kind is that it must provide a continuous frequency coverage over the band 100 kc/s to 25 Mc/s. For certain ships a curtailed range may be permissible but in order to cater for all requirements the full coverage has been provided. In addition, an extra-low range of from 13.5 to 26 kc/s is included.

With this wide coverage the problem arises of where to place the intermediate frequency. Below 100 kc/s is not very satisfactory, especially for reception over about 1 Mc/s. In this receiver the problem is neatly circumvented by providing two i.f.s and selecting the most suitable for the band of signal frequencies in use.

The actual coverage of the receiver is somewhat greater than the minimum requirements for ship-borne apparatus. There are eight ranges marked, for convenience, A to H inclusive. A is the highest frequency range and H the lowest. H covers 13.5 to 26 kc/s; G, 95 to 250 kc/s; F, 240 to 600 kc/s; E, 585 to 1,550 kc/s; D, 1.5 to 4 Mc/s; C, 3.8 to 8 Mc/s; B, 7.7 to 16 Mc/s and A, 15.5 to 32 Mc/s. It will be seen that for ranges G to A inclusive there is a useful overlap in all cases.

As regards the use of the intermediate frequencies, on ranges H and F an i.f. of 110 kc/s is used since it is well outside the coverage of either. On ranges G, E, D, C, B and A, one of which includes the 95- to 250-kc/s band, an i.f. of 465 kc/s is employed. This i.f. could not, for very good reasons, be used on range F which covers 240 to 600 kc/s. Nothing is to be gained by employing 110 kc/s on the higher frequency ranges as the signal discrimination would be somewhat unsatisfactory.

The changeover from one i.f. to the other is automatic, being performed by the waveband switching so that the operator has no need to concern himself with it and, of course, mistakes cannot arise. Two complete sets of i.f. transformers and two crystal filters are embodied in the i.f. unit. The arrangement of the circuit between the mixer valve and the first i.f. stage is given in Fig. 1 which shows also the circuit switching for the two narrowest bandwidths.

**Test Report**

**Redifon Model R50**

*Wide-Range Tropicalized Communications Receiver*

The Redifon R50 communications receiver has an attractive front with well-balanced controls.
Redifon Model R50—

In all there are five bandwidth positions; two include the crystal filter and give either 150 kc/s or 1.5 kc/s. The three other positions without the filter give 11 and 17 kc/s respectively.

The narrowest bandwidth is obtained with the crystal filter working into a high-impedance load which in Fig. 1 is the 1-MΩ resistor in the subsidiary circuits A or B. The next widest, 1.5 kc/s, is obtained by modifying the load into which the crystal works, in the case of either of the subsidiary circuits A or B, the former on 110 kc/s and the latter on 465 kc/s, they are adjusted to provide an impedance of the order needed to open the bandwidth to 1.5 kc/s.

With the waveband switch set to any of the other three positions the crystals are short-circuited and the bandwidth is determined by the coupling between the primary and secondary circuits of the transformers in the latter part of the i.f. amplifier. The couplings can be varied by switching in the appropriate parts of tertiary coils which augment the inductive coupling between the primary and secondary windings.

Looking down on to the top of the chassis with the screens removed can be seen, on the right, the i.f. sub-assembly; in the centre the ganged tuning unit and on the left the subsidiary units. The switch assembly in the right-hand front corner is the metering network.

In order to achieve adequate selectivity with the crystal filters, twelve high Q tuned circuits are employed in the i.f. amplifier on either 110 kc/s or 465 kc/s. Each of the 24 circuits—12 only are, of course, in use at any time—are temperature compensated, the dust iron cored coils having two padding capacitors across them, one of a negative and the other of a positive temperature coefficient. Trimming of the i.f. circuits is effected by adjustable dust cores.

In all, three stages of amplification are employed in this unit, the valves being EF39s. Two only are included in the a.g.c. system and they receive a portion only of the total a.g.c. voltage available.

The rear end of the set is reasonably orthodox, a double diode (EB34) acting as detector and a.g.c. stage with another EB34 functioning as an optional noise suppressor. It can be switched in or out as required and there is also a control for setting the threshold point at which the suppressor begins to operate.

D.C. voltage for automatic gain control is derived from the primary circuit of the last i.f. transformer and applied, after some delay, to the two r.f. stages, and as already mentioned, in part to two of the i.f. valves but leaving the mixer and last i.f. uncontrollable.

In some communications receivers the a.g.c. system becomes inoperative when the b.f.o. switch is set for c.w. reception, but in the Redifon R50 a.g.c. continues to operate, but with a much longer time constant than for telephony.

A.G.C. can, however, be suppressed if desired and this facility is embodied in a four-position switch marked “AVC-NS.” In one position a.g.c. functions as usual, in another it is inoperative and all control of volume is by the r.f. and a.f. gain controls, in a third position a noise silencer with a.g.c. is brought into circuit while in a fourth position the

---

Fig. 2. The b.f.o. and noise suppressor circuits of the Redifon R50. Included also is the “AVC-NS” switch. It will be seen that two complete circuits for 110- and 465-kc/s i.f.s. are incorporated.
noise silencer is used without a.g.c.

Audio amplification is provided by an EF37 voltage amplifier and a 6V6 power valve with negative feedback from the anode circuit of the 6V6 to the anode of the EF37.

Because alternative i.f.s are provided, the b.f.o. stage must generate heterodyne oscillations for either the 110- or 465-kc/s channels as required. An EF37 valve and a parallel-fed Hartley circuit, with entirely separate circuits for each frequency, is employed for this purpose. Both circuits are temperature compensated and the change from one to the other is synchronized with the i.f. selector. Details of the b.f.o. oscillator and of the noise silencer are given in Fig. 2.

In order to obtain a good signal-to-noise ratio and, perhaps what is of greater importance, an adequate image signal discrimination on the higher signal frequencies, two r.f. stages with EF39 valves are provided. These are followed by a mixer consisting of the hexode part of an ECH35 and a separate oscillator, which function is performed by a L63 triode with its grid joined to the normal oscillator grid of the ECH35 for voltage injection. The triode anode of the ECH35 is earthed.

There is little out of the ordinary in this part of the circuit except that each tuning capacitor has dual sections of 224-pF maximum. One section only is used on the three highest ranges but both are used in parallel on all other bands. These circuits, and those in the local oscillator, are frequency stabilized by a combination of negative and positive temperature co-efficient capacitors. The sectional circuit in Fig. 3, which shows the local oscillator, indicates these compensating capacitors, the negative temperature type having a short horizontal bar below the capacitance value. Also included is the dual tuning capacitor and the oscillator waveband switching.

This receiver has provision for remote control and also for diversity reception if required. The screen grid supply lead for the i.f. and r.f. valves is accessible at the output socket and by simple switching, or by a relay, periods up to this speed of sending.

Power supply for this receiver is provided by a separate unit and normally this will 1 a.c. operated. In addition to the usual rectifying and smoothing circuits the power unit contains a voltage regulator tube giving a stabilized h.t. supply to the mixer grid and the oscillator anode. The a.c. consumption is 80 watts. For battery operation there is another power unit and this has a rotary converter for h.t. supply. There are also available supply units with rotary converters for various d.c. voltages up to 220.
Rediff Model R50—

A receiver of such high selectivity as the R50 must of necessity possess extremely good frequency stability. From the brief foregoing description it will have been seen that quite a lot has been done to ensure that this condition prevails by the judicious use of temperature compensated circuits and stabilized voltages.

But these precautions alone would be of little value unless they were supplemented by good mechanical rigidity. It is unusual to find quite such a massive construction as in the R50.

The individual sub-assemblies, as well as the main framework, are well braced to withstand the hazards of transit and to stand up to the stresses that must be imposed during rough weather on board ships at sea. Rubber suspension is used for the r.f. unit, with which is incorporated the gauged tuning capacitors, largely to combat any likelihood of microphony.

Although light alloy is used extensively in the construction of the set, it is not a light-weight receiver. The chassis alone weighs 55 pounds and, enclosed in a sturdy metal cabinet it weighs 92 pounds. The dimensions are 14\frac{1}{2} x 21 x 22\frac{1}{2} in.

The set is fully tropicalized and while miniature components are included no attempt is made at miniaturization. When out of its cabinet every part of the set is readily accessible which makes for easy maintenance and testing.

In order that a quick check can be made on the set under working conditions a comprehensive metering system is embodied. A single meter is employed and this can be switched to measure the anode currents of r.f., oscillator and i.f. valves and the cathode currents of the a.f. amplifiers.

The performance of the R50 is fully in keeping with what might be expected of a set of this kind. With a little care in tuning and judicious selection of the bandwidth, a weak signal can be separated from between two quite powerful ones and held almost indefinitely provided the transmitter frequency is fully stabilized.

After the initial warming up the oscillators settle down to their work and remain remarkably steady.

Remote Control Extension Loudspeakers

Two of the three new models in the "Stentorian" range of extension loudspeakers, made by Whitley Electrical Radio, Mansfield, Notts, are fitted with push-button switches for remote control of the receiving set.

The system is the Whiteley "Long Arm" remote control in which a relay controlling the mains supply to the set is operated through three-wire extension leads from any loudspeaker position. When the set is switched on from another room, only the loudspeaker in that room is operative, all the others remaining silent. Alternatively, when the set itself is switched on manually, none of the extension loudspeakers will work unless specifically required.

Six-inch permanent-magnet units with die-cast chassis are used in the "Bristol" loudspeakers which have plywood fronts with rounded corners and are enclosed at the back with perforations in the covers to relieve back pressure. Constant-impedance volume controls are fitted and a choice of output impedances is provided.

The frontal dimensions of the "Beaufort" are 12\frac{1}{2}in x 10\frac{1}{2}in and of the "Bristol" 10\frac{1}{2}in x 9\frac{1}{2}in; both are 4\frac{1}{2}in deep. Prices, with and without transformer, are: "Beaufort" £3 15s, £3 7s 6d; "Bristol" £2 19s 6d, £2 13s 6d. A cheaper model, the "Bedford," with 5in unit, but without the "Long Arm" control feature costs £2 5s 6d or £1 19s 6d without transformer.

More Copies of "Wireless World"

As announced last month, the Government's decision to increase the allowance of paper for technical periodicals makes it possible to print more copies of Wireless World. Starting with the August issue (published 26th July) there should be enough for all anticipated requirements. But the number of copies will still be limited, and so it will be necessary for an order to be placed with a newsagent.
INDOOR TELEVISION AERIAL

Compressed Dipole for Strong-Signal Areas

By N. M. BEST and P. J. DUFFELL (Antiference Ltd.)

WITHIN a radius of approximately five to ten miles from the television transmitter at Alexandra Palace, the standard dipole-and-reflector aerial system, mounted at chimney level, provides a greater signal than is absolutely necessary for the operation of a receiver. For installations nearer to the Alexandra Palace, even a single dipole without reflector may be sufficient to overload the set at its lowest sensitivity level. The insertion of an attenuator between aerial and receiver then becomes necessary.

In practice, it is found that an aerial mounted indoors gives satisfactory results over a fairly wide area. The physical dimensions of the standard H-type aerial make it unsuitable for indoor installation, and the indoor aerial is usually made physically smaller than the standard dipole, with some attendant loss in electrical efficiency.

The most important factors to be considered are:

(a) Sensitivity.
(b) Bandwidth (the aerial must cover sound and vision channels).
(c) Feeder matching (normal receiver input is approximately 70 ohms and the feeder must have the same impedance).

The first two factors (a) and (b) may be affected by altering the shape of an aerial, and (c) is affected by any change of aerial input impedance.

There are several possible ways of constructing small television aerials.

The grounded quarter-wave aerial is one in which the earth is replaced by a half-wave horizontal rod, the centre of which is at earth potential. It is sketched diagrammatically in Fig. 1 and in practice, using co-axial cable, the inner conductor is connected to the bottom of the vertical quarter-wave rod, and the outer conductor to the centre of the earth rod.

The input impedance of this type of aerial is approximately 40 ohms, and the effective height is half that of a standard dipole. Although it is suitable for installation in a loft, it is physically cumbersome because of the earth system.

A second form of aerial is known as the bent-rod type, and is probably patterned on an American type of aircraft antenna. The effect of bending the rods is an increase of bandwidth and a loss of sensitivity. Commercial types of this aerial are made to be installed in the V of the roof. The sensitivity is usually low because the pick-up portion is the projection of the inclined rod on the vertical plane.

A dipole of normal shape can be physically shortened by capacitance end loading or inductance loading. Capacitance loading involves mechanical difficulties and may be ignored, but an inductively loaded aerial is comparatively simple to construct.

The first two kinds of aerial referred to are only really suitable for installation in a loft. Many set owners, however, live in blocks of flats and similar buildings, and are often not permitted to install outside aerials. One disadvantage of an aerial installed in a living-room is that it is particularly susceptible to alterations of the electrical field due to movement of persons in the room; but with a careful choice of aerial position this effect can be greatly reduced. In any case, during a television broadcast it is hardly likely that there will be sufficient movement of persons to cause annoyance. A useful type of indoor aerial, therefore, would be one suitable for either the living-room or the loft, and the design of such an aerial is discussed in this article. It is based on a simple inductively loaded dipole with a maximum overall length of approximately five feet six inches.

Consider the case of a dipole shortened to five feet and using rods of 3-in diameter.

In order to make the system resonant at 45 Mc/s it requires loading with an inductance of approximately 2.0 µH, and it then has an input resistance at 45 Mc/s in the region of 20 to 30 ohms.

The coil loading, of course, narrows the bandwidth, and it is estimated to be approximately 3 db down at 43.6 and 46 Mc/s. Ob-

An aerial mounted indoors gives satisfactory results over a fairly wide area. It is usually made physically smaller than the standard dipole.

jections to this method are, therefore, the narrow bandwidth and the low input resistance. If the feeder mismatch is considered throughout the band, then the bandwidth becomes narrower still. Some improvement can be obtained by increasing the diameter of the rods, but they have to be unwieldy in size to get the necessary bandwidth.

The reactance of a dipole varies with frequency either side of resonance in the manner shown in...
Indoor Television Aerial—
in Fig. 8. The uncompensated compressed
dipole, curve (b), shows a reactance varying from
—257 ohms to +127 ohms and considered in conjunction with
curve (b) of Fig. 7, shows a very poor ratio of reactance to resis-
tance at the edges of the band. The compensated compressed di-
pole, curve (c) is inductive throughout the band varying from
+222 ohms to +4 ohms. It can be seen that the ratio of re-
actance to resistance compares favourably with that of the
standard dipole, and provided that the measured input resistance
is mainly useful radiation resistance and not loss resistance, the
aerial bandwidth should be comparable with that of the standard
dipole. Actual field strength

measurements showed the com-
pressed dipole to be — 6 db ± 1
db down in sensitivity on the
standard dipole throughout the
band, thus substantiating the
results expected from impedance
measurements.

In order to match the com-
presst dipole to a 70-ohm feeder
a series resistor of approximately
30 ohms was added, but as the
standard dipole and the com-
presst dipole with and without
series resistance in Table 2. The
Table shows comparisons of
matching in terms of the reflection co-
efficient \( \rho \).

\[ \rho = \frac{Z_R - Z_L}{Z_R + Z_L} \]

and becomes zero when \( Z_R \), the ter-
mating impedance, equals \( Z_L \), the
line impedance; i.e., reflection is elimi-
nated.

Inductively load-
ing a dipole aerial in
order to reduce its
overall length and make it suitable for indoor installation, results in loss of bandwidth and sen-
sitivity. Successful compensa-
tion for the loss of bandwidth can be obtained, however, by the use of a short-circuited
stub matching line of very low
impedance, which, in combination,
with the loaded dipole, provides
useful reactance cancellation over

Fig. 7. Curves of aerial input re-
actance.

Fig. 8. Curves of
aerial input re-
actance.

As the aerial is mainly intended
for use in areas of good signal
strength the loss of sensitivity is
tolerable and is far outweighed by
the advantage of the reduced size,
approximately to one-half of that of
the standard dipole.

**DIALLIST’S PROBLEM**

THIS should not be read until the
simple problem set in "Random
Heaven's" (page 279) has been tackled. The correct answer is (b). When capaci-
tors are connected across a source of h.t.
voltage the p.d.s across them depend on
their leakage resistance and not on
their capacitance. Suppose 2,000 V is
applied to two series capacitors, one
of which has an insulation resistance
of 300 MΩ and the second an insulation resistance of 100 MΩ. Then there will be a p.d. of 1,500 V across the first and of 500 V across the second. If both are rated at 1,000 V d.c. working the first will soon break down. The full
voltage will then be applied to the second, which will also break down.

In practice it is not possible to manu-
facture capacitors of identical insula-
tion resistance. For example in France, at any rate, the provision of individual shunt re-
sistors is compulsory. The resistance of these is less than the insulation resistance of the capacitors, but high
enough to ensure negligible losses.

Owing to the presence of these re-
sistors it does happen that the
 capacitors are discharged rapidly when
the source of h.t. voltage is switched
off. Hence, if you plumped for (c) you
may award yourself a gentle pat on the
back.

**Civil Aviation Communications.—A**
second edition of the Civil Aviation
Communications Handbook (MCAP4)
has been published. It contains the
international regulations and communi-
cations procedures with which aircraft
registered in the United Kingdom have
to comply. It is obtainable, price
7s 6d, from H.M. Stationery Office.
The pamphlet "Radiotelephony Pro-
cedure" (MCAP6a) continues in use as the
standard reference document for Part I of the qualifying examination
for the Flight Radiotelephony Opera-
tor’s Certificate of Competency.
The Siting of Aerials

We claim that "Belling-Lee" television aerials are mechanically and electrically superior, but if erected without due regard to local interference, and/or the proximity of a corrugated iron shed or gas holder, then the "Belling-Lee" best is no better than the cheapest worst.

No aerial is a "cure all," some are made better than others, stand up to the weather, without leaning away from the prevailing winds, etc. Some have had superior electrical knowledge built into them, which tells when used in fringe areas.

We consider it bad practice to recommend the most expensive aerial of a range when a cheaper model will suffice.

Both the "H" type and the "Veerod" television aerials for Midland frequencies are superior, but if one experienced in these matters makes full use of such characteristics for the removal of "ghosts" or interference. Again, sometimes it is advantageous to use the building on which the erection is being carried out to screen the dipole from obvious interference such as a busy cross road, and in other cases height is the most important thing. Experience of hundreds of such cases is most useful. The average wireless Dealer will not make mistakes that he cannot rectify when they come.

Hum in the Receiver.

We have heard a lot about humming aerials, and we have cured this trouble, but we have recently had a number of requests to cure hum in the receiver. Now, this is a form of interference which we do not claim to cure. The hum is a low frequency phenomenon which may be mains borne on D.C. mains or an inherent property of the receiver itself.

Our interests are in radio frequency interference, which, as readers of this page know, shows up on the picture of a television receiver as "ghosts," spots, feathering, or bars, and on the sound channel, or on broadcast receivers as crackles, plops, bangs and sizzling noises which may be eliminated from the receiver by the use of one or more of the following methods:—

1. Correct choice and siting of an outdoor aerial.
2. For broadcast reception, an anti-interference aerial*3.
3. Fitting a mains filter*4.

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S.R.E. for all purposes

Philips have supplied through traders and others throughout the world S.R.E. for almost every conceivable application. While specialized equipment is produced whenever necessary, a very wide range of standard apparatus units minimizes the need for this, and simplifies installation and maintenance.

As it can be shown to be much better engineering practice to use one large amplifier instead of a lot of little ones to feed one load, the standard range includes three large rack amplifiers.

Features include triode valves throughout, four push-pull stages, no electrolytics, and three separate anode supplies.

250 watt ............ List Price £255
500 ,, ............ List Price £325
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S.R.E. available through the trade on hire purchase or rental terms.

PHILIPS ELECTRICAL LIMITED

This is the new list giving descriptions of the 162 Standard types of "Somerford" Transformers and Chokes together with details of 28 types of Replacement components suitable for commercial receivers.

This COMPLETE range will meet ALL your normal needs

The requirements of the Electronic Industries are many and varied. It is to meet such demands that the "Somerford" range of Transformers and Chokes exist. No matter whether you are engaged in radio, the manufacture of industrial or domestic appliances, or laboratory work, if you are looking for components that will give you accuracy and dependability at an economical cost, you will do well to choose GARDNER products. Research, skill and modern manufacturing methods have been combined to produce components that will withstand the most arduous working conditions and meet the exacting demands of present day standards. The "Somerford" range comprises 162 different types—a type for every normal need.

Ready for IMMEDIATE DELIVERY

Full details and specifications will be sent on request.

GARDNERS RADIO LTD
SOMERFORD : CHRISTCHURCH : HANTS
LAST month a scale of two counter was discussed and its mode of operation explained. It will be remembered that by combination of \( n \) scale of two circuits, a division ratio of \( N = 2^n \) can be obtained. This series of numbers (2, 4, 8, 16, 32, 64, ... etc.) is only occasionally useful, so it will be worth discussing how other division ratios can be obtained.

It was pointed out last month that the scale of two shown was essentially a symmetrical circuit, and it may be said to possess two-fold symmetry. If now an analogous circuit can be designed having \( r \)-fold symmetry, where \( r \) is any number greater than 2, it may be expected to have a division ratio of \( r \). Many such circuits have been developed at different times, and they are commonly called ring counters. One with which the writer is familiar will now be discussed as a representative of its class.

In order to see how such a ring circuit is constructed, it is only necessary to consider a ring of 3, as from it rings of greater number can be derived by analogy.

Fig. 1 shows a ring of three which follows much the same plan as the scale of two already discussed. All those components which have the same value are similarly labelled in order to make the symmetry more apparent. In the waiting condition only one valve is conducting, and since there are three valves there are three possible stable states.

Let us assume that \( V_A \) is conducting initially. Then the potential at \( P_A \) is less than that at \( P_B \) and \( P_C \). We may loosely say that the potential at \( P_A \) is “negative” and that it is “positive” at \( P_B \) and \( P_C \). Now consider the grid of \( V_B \). It is fed through equal resistors, \( R_4 \) to one positive \( (P_B) \) and one negative \( (P_A) \). The grid of \( V_C \) is connected to one positive \( (P_B) \) and one negative \( (P_A) \). The grid of \( V_A \) is connected to one positive \( (P_B) \) and a second positive \( (P_C) \). Hence the grid of \( V_A \) must be positive with respect to the two grids by an amount sufficient to ensure that \( V_A \) continues to conduct. As \( V_A \) alone is conducting, the common cathode potential must rise slightly above the grid potential of \( V_A \) (assuming no grid current). Consequently the grid potentials of \( V_B \) and \( V_C \) must be more negative with respect to the common cathode than that of \( V_A \) by an amount sufficient to hold both at or beyond cut-off.

If now a short positive pulse of sufficient amplitude is applied to the input terminal, \( V_A \) will be momentarily cut-off. Its anode potential will rise in consequence and this rise is preferentially transferred to the grid of \( V_B \) through the coupling condenser. When the input pulse subsides the grid of \( V_B \) is left momentarily more positive than that of any other grid, so that the circuit locks itself into the second stable state with \( V_B \) conducting, and the other two valves cut off. It is easy to see that another input pulse transfers the conduction to \( V_C \), and after a third pulse the original state is resumed. Obviously one (positive)
Electronic Circuitry—
pulse can be derived from any one of the anodes for three input pulses, and the circuit divides pulses by three. The buffer stage discussed last month is quite suitable for driving this ring, and also for extracting an output pulse.

A ring of greater number than three can be derived directly from Fig. 1 provided it is remembered that there must be a symmetrical d.c. connection from every grid to every other anode, and at first sight there seems to be no reason why a ring of any number should not be possible. There is a practical limit here, however, because conduction in one valve must provide a potential change at all other grids sufficiently large to hold all other valves at or beyond cut-off. If we make the simplifying assumption that the resistances \( R_a \) of Fig. 1 are infinite, it is found that the potential available to cut off each valve other than the conducting one is only \( a \frac{1}{n-1} \) times the change of anode potential of the conducting valve; where \( a = \frac{R_3}{R_1 + R_3} \) and \( n \) is the number of valves in the ring. Hence the larger \( n \) is made, the more difficult does it become to design for entirely reliable operation. In practice, of course, there is a finite amount of stray capacitance in a maximum counting rate must be expected. With sufficient care in design and using modern high-slope valves with a very short grid base, a ring of ten, capable of operating at 50–100 kc/s, could probably be constructed successfully.

In practice, of course, there is little point in attempting a ring of ten directly, as it is both easier and more economical to use a scale of two and a ring of five in cascade. A scale of 12 might be constructed from two scales of 2 and a ring of three. A scale of 100 could conveniently be made up thus: \( 2 \times 5 \times 2 \times 5 = 100 \); and a scale of a gross: \( 2 \times 2 \times 3 \times 2 \times 2 \times 3 = 144 \). Since any number other than a prime can be reduced to a product of primes, it is obviously only necessary to make rings whose division ratios are prime numbers. Of these, 3, 5, and 7 are quite practicable, while 11 or more would usually be regarded as tricky and doubtful. Thus with rings of 3, 5, and 7 allied with scales of two, a division ratio of any number reducible to factors not exceeding 7 can be made. By this means division ratios of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 24, 25, 27, 28, 30 . . . etc. can be obtained and next month we shall consider how the missing numbers may be filled in.

Thyratrons are frequently used in d.c. circuits as sensitive relays, firing on the application of a small voltage pulse. It is a property of a thyratron that once the valve has broken down the grid has no further control.

Extinguishing Thyratrons

Fig. 2. Two methods of resetting a thyratron.

An alternative method of re-setting a thyratron, which is occasionally useful, is shown at (b). A resistance \( R_a \) is placed in series with the load, and a condenser \( C \) is momentarily short-circuited to the negative h.t. line with the switch \( S \). The time constants \( CR_a \) is long enough to maintain the potential across \( C \) less than the running voltage of the thyratron for the time required to ensure de-ionization—generally 200 microseconds is sufficient. The resistance \( R \) is used to ensure that \( C \) is discharged immediately prior to the closure of \( S \). This arrangement is sometimes useful, for example when only a single-pole change-over contact is available for resetting, and some secondary circuit must be reset with the other contact as shown at (b). There is nothing very novel about this arrangement; the same method of arc extinction is often used in d.c./a.c. convertors.
In all the foregoing work, when comparing tubes of different sizes, it has been assumed that all linear dimensions except those of the actual triode have been multiplied by $k$. This assumption does not wholly agree with normal commercial practice, since it is customary to maintain constancy of neck diameter.

It was stressed in the introduction that the solution of these cathode-ray tube problems depends entirely on the postulates made. However the complexity of the solutions varies greatly with the postulates. We saw for example that to postulate constancy of cathode loading involves appreciably more working than the assumption of constant beam current. And if we inject the still additional requirement that the neck diameter is to be constant then the treatment is still further complicated.

This arises because we can no longer use postulate (1); that is, the principle of geometrical scaling. This principle requires that all the linear dimensions of the system must be scaled and we are now deliberately departing from this by multiplying the screen diameter by $k$, while maintaining constancy of size in the deflector-coil region.

A solution therefore demands special knowledge of the effects of deflection. The following additional fact is necessary and sufficient to solve the problem of change of screen size at constant resolution.

"If the beam width, coil shape and size, and the scanning angle, are all kept constant, then the deflection defocusing is proportional to the distance between the centre of deflection and the screen."

In this statement the term 'deflection defocusing' means the difference in the linear size of the spot at the centre and the edge of the screen. The application of postulate (2) enables us to deduce that the deflection defocusing is independent of the anode potential.²

We now illustrate this by repeating the solution of the first problem, with the additional requirement that the neck diameter and scanning coils are to be unchanged. The general theory is a little too cumbersome to be given here, but the method can be seen by reference to Fig. 3. In the original tube the crossover at $T$ is imaged by the thin lens at $XY$ on to the screen at $S$. $CD$ represents the centre of deflection. The derived tube has its screen at $S'$, where it is assumed that the axial position of $S'$ is such that for constant scanning angle the diameter of $S'$ is $k$ times the diameter of $S$. Now the resolution of the derived tube is to be the same as that of the prototype. Therefore the deflection defocusing is to be $k$ times as great as on the prototype just as the spot diameter when undeflected is also to be $k$ times as large. But the distance from the centre of deflection to the screen on the derived tube will be very nearly $k$ times that on the prototype. Hence it follows from the extra fact given about deflection theory that the condition of making the deflection defocusing $k$ times as large on the derived tube is closely approximated by maintaining constancy of beam width $B$ in the deflector coils. Since we are keeping constant beam angle from the triode, the new position for the focusing coils is found by projecting back lines from $S'$ through $C$ and $D$. These cut the rays from the triode at $X'Y'$ which is the new position for the focusing coil.

On the prototype tube the linear magnification between the triode and spot is $M_1 = \frac{ES}{TB}$ and on the new tube it is $M_2 = \frac{AS'}{TA}$. Let the crossover diameter on the prototype tube be $\Delta$. Then with the previous notation, the requirement of constant resolution gives

$$\frac{kM_1\Delta}{\sqrt{V_1}} = \frac{M_2\Delta}{\sqrt{V_2}} \quad (8)$$

Equation (8) compares with (2) and differs only on account of the change in geometrical magnification brought about by the alteration of the position of the focusing coil.

As in the first problem equation (1) defines the condition of equality of screen brightness, so that (1) and (8) permit us to calculate $V_2$ and $\lambda$, $M_1$ and $M_2$ are most easily found graphically.

Fig. 3. Geometrical derivation of tube of larger screen diameter at keeping neck diameter and scanning angle constant. Note that only the conical portion of the glasswork is changed.

Approximation based on the value of $M_2/M_1$

Provided that the process of extrapolation is not carried too far, examination of the geometry of typical television cathode-ray tubes will convince the reader that the ratio $M_2/M_1$ is very nearly equal to $k$. If we now insert this value in equation (8) we immediately get, after cancellation of common terms,

$$\frac{1}{\sqrt{V_1}} = \lambda \sqrt{V_2} \quad (8a)$$
Cathode-Ray Tubes for Television

which oddly enough is exactly the same equation as that relating to the earlier case where the neck diameter was varied in proportion to the screen diameter and the spot size was to be held constant. The solution of this equation together with (1) has already been given (2nd column, Table 1) this being the case of constant cathode loading.

However to avoid any possible confusion this working is repeated in Table 2, since the postulates are entirely different, and the identity of (8a) with a previous equation is merely coincidental.

One important fact emerges from a comparison of Tables 1 and 2. Compare column 2 in Table 1 with column 1 in Table 2. Both operations result in a picture linearly k times as large as on the prototype and of the same surface brightness. Both operations require the same increase in anode voltage and the same increase in cathode loading. But the operation on Table 1 yields a tube of higher intrinsic performance than that given by Table 2, since we normally seek to obtain the smallest spot size, all other factors being constant. This fact is a result of the use of a larger neck diameter (and greater neck length) on the tube derived by Table 1. It is a valid general deduction that the absolute electrical performance of a tube of given screen size can be improved by an increase in neck length and neck diameter.

APPENDIX

Grid voltages are always referred to cathode potential. The triode is said to be modulated when the grid potential is such that cathode current flows. For any fixed geometry and fixed anode voltage, denoted by V, there is a definite negative grid voltage, denoted by V_e, at which cathode current just ceases to flow. V_e is termed the cut-off voltage. The grid voltage V_g is always assumed to lie between the cut-off voltage and zero, but positive grid voltages are excluded. The grid drive, V_g, is defined as the magnitude of the difference between the cut-off voltage and zero, but positive grid voltages are excluded. The grid drive, V_g, is defined as the magnitude of the difference between the cut-off voltage and zero, but positive grid voltages are excluded. The grid drive, V_g, is defined as the magnitude of the difference between the cut-off voltage and zero, but positive grid voltages are excluded.

TABLE 2

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Screen Diameter multiplied by k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Operations</td>
<td>Neck diameter, scanning coils constant. Position of triode in neck constant. Focus coil moved towards triode (if k&gt;1). Scanning angle constant, see Fig. 3.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geometrical Changes Made</th>
<th>Triode Dimensions</th>
<th>× k^{1/n}</th>
<th>× k^{1(1+n)}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cathode-grid Spacing*</td>
<td>× k^{2/n}</td>
<td>× k^{2(1+n)}</td>
</tr>
<tr>
<td></td>
<td>Anode Voltage</td>
<td>× k^{2}</td>
<td>× k^{2(1+n)}</td>
</tr>
<tr>
<td></td>
<td>Cut-off Voltage</td>
<td>× 1</td>
<td>× k^{4/3(1+n)}</td>
</tr>
<tr>
<td></td>
<td>Grid Drive</td>
<td>× 1</td>
<td>× k^{4/3(1+n)}</td>
</tr>
<tr>
<td></td>
<td>Scanning-Coil Current</td>
<td>× k^{1/n}</td>
<td>× k^{1(1+n)}</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical Changes Made</th>
<th>Beam Current</th>
<th>× 1</th>
<th>× k^{2(1+n)}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spot Diameter</td>
<td>× k</td>
<td>× k</td>
</tr>
<tr>
<td></td>
<td>Beam Angle α</td>
<td>× 1</td>
<td>× 1</td>
</tr>
<tr>
<td></td>
<td>Screen Brightness</td>
<td>× 1</td>
<td>× 1</td>
</tr>
<tr>
<td></td>
<td>Cathode Loading</td>
<td>× 1/k^{2/n}</td>
<td>× 1</td>
</tr>
</tbody>
</table>

* This adjustment to be made additionally to that effected by the scaling of the whole triode.

TABLE 3

<table>
<thead>
<tr>
<th>Anode potential (kV)</th>
<th>Grid potential (V)</th>
<th>Width of raster to make 400 lines just merge (S) (mm)</th>
<th>S√V</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-30</td>
<td>73</td>
<td>127</td>
</tr>
<tr>
<td>4</td>
<td>-40</td>
<td>69</td>
<td>138</td>
</tr>
<tr>
<td>5</td>
<td>-50</td>
<td>62</td>
<td>139</td>
</tr>
<tr>
<td>8</td>
<td>-80</td>
<td>48</td>
<td>136</td>
</tr>
<tr>
<td>9</td>
<td>-90</td>
<td>45</td>
<td>135</td>
</tr>
</tbody>
</table>
For all practical purposes the cut-off voltage \( V_c \) is proportional to the anode voltage \( V \), geometry being held constant. Furthermore the author has shown elsewhere\(^1\) that to useful engineering accuracy, the cathode current \( I_k \) in most normally proportioned triodes is given by Equation (6). Thus the cathode current increases as the \(\frac{7}{2}\) power of the grid drive for constant cut-off voltage.

This equation, it will be noted, does not explicitly involve the triode geometry except in so far as this affects \( V_c \) for a defined anode voltage \( V \). In point of fact it would be astounding if so simple a law could accurately represent the cathode current for an arbitrarily wide range of triode shapes. Although it does not do this it is a useful guide. Reference \( 1 \) gives further information on the limitations of this formula.

When the grid of the tube is made more positive (i.e., the grid drive is increased) then the beam angle in Fig. 1(b) is also increased. Very roughly, the beam angle increases linearly with drive as shown in Fig. 4. Here the idealized shape of the beam angle/grid voltage curve for varying cut-off voltages is displayed where the cut-off voltage variations are due to change in anode potential only and are not due to changes in triode geometry. It will be seen that the maximum beam angle occurs at \( V_c = 0 \) and is independent of the anode potential. This last fact is a consequence of postulate (2). It can further be shown\(^2\) that

\[
\sin \alpha = \frac{D}{\frac{3}{2}} \left( \frac{V_a - V_c}{V} \right) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (a)
\]

where \( D \) is the grid hole diameter and \( f \) the anode-to-grid spacing.

Another very important consequence of Fig. 4 and Equation (a) is that the beam angle \( \alpha \) remains constant if both the modulus of the grid voltage and the anode potential are multiplied by the same constant.

![Fig. 4. The relation between the beam angle \( \alpha \) and the grid voltage of the tube.](image)

**PORTABLE TELEVISION**

The measurement must therefore be based on a technique which is consistent with this definition. One such method is as follows. A fixed number of lines is applied to form a raster, and the latter is contracted in a direction at right angles to the direction of each line until the lines just merge into each other. The width of the raster \( S \) is then proportional to the spot diameter.

Table 3 summarizes such measurements for a 10-in television cathode-ray tube. 400 lines each 150-mm long were used. The last column indicates that \( S / V \) is nearly constant so justifying the principle. The latter however also has an appreciable basis in theory.

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B.B.C. Charter • Teleciné Equipment at A.P. • Olympia Plans • Birthday Honours

Committee of Inquiry

Since announcing the constitution and terms of reference of the B.B.C. Committee of Inquiry the Lord President of the Council has stated that Sir Cyril Radcliffe, who was appointed chairman, has had to resign owing to his appointment as Lord of Appeal. He is now Lord Radcliffe. His successor has not yet been announced.

The terms of reference of the Committee, which consists of eleven members including the chairman, are: "To consider the constitution, control, finance and other general aspects of the sound and television broadcasting services of the United Kingdom (excluding those aspects of the overseas services for which the B.B.C. is not responsible) and to advise on the conditions under which these services and wire broadcasting should be conducted after December 31st, 1951 [when the present Charter ends]."

N.P.L. Annual Visit

Much interest was shown by visitors this year in the Electronics Section, where component parts of the A.C.E. (automatic computing engine) are being developed and made to the requirements of the Mathematical Division. Generators of pulses of ½-nsec duration and 1-nsec spacing were demonstrated, and also a "dynamizing" circuit for translating decimal numerals into binary form, in which the presence or absence of any power of 2 in sequence is indicated either by a pulse or space. With this system a number with 10 significant figures on the decimal scale is registered in 30 nsec, and can be kept in storage until required by circulating in a closed circuit, part of which involves the transmission of sound waves in a column of mercury.

Also in the Electronics Section was a display comprising the N.P.L. moisture meter and some simple devices involving photo-cells and capacitive effects to advertise the fact that the N.P.L. is willing to collaborate with manufacturers in the application of electronics to industry.

New Equipment at A.P.

Two new sets of teleciné equipment, one made by Cinema-Television, and the other by E.M.I., have been installed at Alexandra Palace, where they are now being used for televising films.

![Television Equipment at Alexandra Palace](image)

Televising Films. General view of the new teleciné apparatus recently installed at Alexandra Palace. On the left is part of the E.M.I. equipment and on the right that supplied by Cinema-Television.
B.B.C. Appointments

Consequent upon L. W. Hayes' resignation as head of the B.B.C. overseas and engineering information department to take up the post of vice-director of the Comité Consultatif International des Radiocommunications in Geneva, changes in the organization of the department have now been formed into what is to be known as the engineering secretariat, and the engineering training department have been appointed B.B.C. engineering director and head of the engineering training department.

F. C. McLean, M.B.E., B.Sc.

The overseas engineering information department, the engineering secretariat, and the engineering training department have been appointed B.B.C. engineering director and head of the engineering training department.

OBITUARY

We record with regret the death of N. R. Campbell, Sc.D., who was in the G.E.C. research laboratories from 1919 to 1944 when he retired. He was aged 60. Prior to joining the G.E.C. he was appointed to the Cavendish Research Fellowship at Cambridge University and was for a short time at the National Physical Laboratory. His research work was very varied ranging from investigations into the mechanism of the discharge of spark plugs to the theory of 'noise' in thermionic valves and circuits. It was on the latter subject that he contributed, with others, a number of articles to our sister journal, Wireless Engineer. He was a Fellow of the Institute of Physics.

We also record with regret the death of J. G. Wright, a founder member of the I.E.E., who was in the Ministry of Supply. Most of his 26 years Army service has been in Royal Signals. He was in charge of signal communications during the evacuation of Palestine and has just vacated a Deputy Chief position for nearly four years. Sir William Coates has been appointed Chief Physicist in the research and development laboratories of the Dubilier Condenser Company, has been elected a Fellow of the Institute of Physics.

BIRTHDAY HONOURS

H. Faulkner, B.Sc., M.I.E.E., deputy engineer-in-chief, G.P.O., has been appointed a C.M.G. He joined the designs section of the G.P.O. engineer-in-chief's office in 1913 and after serving in the Royal Engineer's Signal Corps (1914-1918) he was transferred to the G.P.O. radio section. He was a member of the team responsible for the design of the Rugby station and was its first officer-in-charge (1925). He has held a number of executive offices and is now responsible for the radio development and radio maintenance branches. He was joint leader of the British delegation to the recent high-frequency broadcasting conference in Mexico.

C. R. Sturley, Sc.D., who was in the Ministry of Supply, has been appointed to the Cavendish Research Fellowship at Cambridge University and was for a short time at the National Physical Laboratory. His research work was very varied ranging from investigations into the mechanism of the discharge of spark plugs to the theory of 'noise' in thermionic valves and circuits. It was on the latter subject that he contributed, with others, a number of articles to our sister journal, Wireless Engineer. He was a Fellow of the Institute of Physics.

The death is also announced of R. E. Gale, who was manager of the high-frequency and instrument sections of Philips works at Tooting. He was aged 47 and had been with the company twenty years.

PERSONALITIES

Sir William Coates has been appointed chairman of the Government Television Advisory Committee in succession to Lord Trefgarne who has held the position for four years. Sir William is also a member of the recently appointed B.B.C. Committee of Inquiry.

Kathleen A. Gough, B.Sc., M.I.E.E., chief physicist in the research and development laboratories of the Dubilier Condenser Company, has been elected a Fellow of the Institute of Physics.

Brigadier E. J. H. Moppett has been seconded from Army duties to become chief inspector of electrical and mechanical equipment in the Ministry of Supply. Most of his 26 years Army service has been in Royal Signals. He was in charge of signal communications during the evacuation of Palestine and has just vacated a Deputy Director of Signals' appointment at the War Office.

E. C. Cherry, M.Sc. (Eng.), A.M.I.E.E., has been appointed to the City and Guilds Readership in Telecommunications endowed by Standard Telephones and Cables to provide facilities for post-graduate teaching and research in this field. He was attached to T.R.E. during the war and has been on the staff of the City and Guilds College since 1947.

IN BRIEF

Increases of 13,100 "sound" licences and 6,750 television licences during April brought the total in Great Britain and Northern Ireland at the end of the month to 11,823,600.

St. Paul's Sound System.—A sound reinforcement system has been installed in St. Paul's by Panchromatic Reproducers, a subsidiary of Pye, to combat the famous echo of the cathedral. This has been done by fitting the loudspeakers under the chairs. To obviate the need for connecting wires, an induction system has been adopted. The output from the amplifiers is fed via a control desk in the nave to large wire loops on the ceiling of the crypt. Copper bands round each of the rows of chairs equipped with speakers provide the necessary pickup.

"Radio Valve Data".—This publication is now available in a second impression (with amendments to date of issue). It gives characteristics of 1,000 British and American receiving valves and replaces the former Valve Data Supplement which, in pre-war days, was a much- appreciated annual feature of Wireless World. The price is 3/6, or, by post from our Publisher, 3/9.

Birmingham Television.—The modifications to the "Superheterodyne Television Unit," described in the February and March, 1949, issues, necessary for the reception of transmissions from Birmingham will be given in our next issue.

C.R.T. Guarantee.—Although the British Radio Valve Manufacturers' Association does not consider an extension of the basic guarantee period of six months on cathode-ray tubes justifiable or economic, it has decided to amend the provision of the existing guarantee. Up till now the guarantee period for free replacement of tubes has been six months and that on a replacement tube the balance of the
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World of Wireless—

guarantee period on the original tube. It has now been decided that for a trial period of twelve months, from June 1st, each tube, including free replacement, shall carry the full six months’ guarantee.

S.T.C. Endowment.—Standard Telephones and Cables has endowed a Readership, to be known as the Henry Mark Pease Readership in Telecommunications, in the City College of the Imperial College of Science and Technology, South Kensington. The late Henry Mark Pease was managing director of S.T.C. until 1948 and took an active part in the formation of the British Broadcasting Company being one of its original directors. E. C. Cherry, M.Sc., has been appointed to the Readership.

Cavity Magnetron Award.—The Royal Commission on Awards to Inventors has fixed a £5,000 to be shared among the three scientists responsible for the development of the cavity magnetron. They are Professor J. T. Randall, Professor Sir H. A. Emery and Professor J. Sayers, both of Birmingham University.

Radio Navigation.—The Thomas Gray Medal and Prize (1949) of £50 was awarded by the Society of Arts to Capt. J. Klinkert, an instructor at the Sir John Cass Nautical School, London, for his essay on "The Applications of Radar to Navigation."

Eddystone "480":—A typographical error appeared in Stratton's advertisement on page 3 of the June issue. The length of the hourglass given as "equal to nineteen inches per hour". This should be ninety.

Scottish Branch of the Engineers’ Guild was inaugurated at a meeting held in Glasgow recently. This is the fifth branch of the Guild to be formed during the past few months.

FROM ABROAD

Italy has ordered 46 high-constancy crystal-drive equipments from Marconi’s for synchronizing its many broadcasting stations which will have to share wavelengths as, under the Copenhagen Plan, Italy has only three exclusive frequencies. The monthly frequency drift of these equipments is given as not more than 2 in 100.

Finland is to install a new 100-kW medium-wave Marconi broadcasting transmitter. The special aerial coupling and tuning units for the directional aerial to be used in conformity with the provisions of the Copenhagen Plan are also to be provided by Marconi’s.

Pakistan’s Director of Radio is proposing to install receivers in schools and for community listening and is desirous of securing information from British manufacturers as to whether they are in a position to supply for the purpose. Most of the sets will need to be battery fed. Particulars should be forwarded to Z. A. Bokhari, Radio Pakistan (H.Q.), Karachi, Pakistan.

Exporting Television.—Scophony—Baird have appointed D. E. Wiseman, who was, until recently, the company’s production and sales director, as overseas representative and he is now visiting North America to investigate potential markets for the Baird transmitterless a.c./d.c. television set which employs a mains aerial.

South Africa.—Provisions are made in the amended Broadcast Bill now before the South African Government for the South African Broadcasting Corporation to be allowed to erect transmitters outside the Union. Under the existing Act the activities of the B.B.C. are restricted to within the Union. Tenders have been invited by the Corporation for the supply of 2 kW of transmitters for the new commercial programme. It is hoped to radiate by the end of the year.

Denmark.—Transmissions from Denmark’s experimental television station began on May 1st. Some details of the Philips transmitter were given in our May issue.

Nairobi’s bilingual broadcasting service, which is provided by Cable and Wireless, is to be augmented by the addition of a new 2 kW medium-wave transmitter ordered from Marconi’s.

INDUSTRIAL NEWS

Marconi’s marine communication receivers "Mercure", the "Teleluna" and "Electra" have been granted the P.M.G.'s certificate of type approval as conforming to the recently issued specification for ships' general purpose receivers.

Welwyn Electrical Laboratories.—All departments of this company, except the London sales office, are now at the new factory at Bedlington Station, Northumberland. (Tel.: Bedlington 2181.)

Ekco.—The Public Hall, Hadleigh, Essex, which was purchased by E. K. Cole in 1946 for use as a store, is to be used by the company for the production of broadcast receivers thereby releasing space at the main factory for the additional production of television sets.

Advance Components, Ltd., advise us that the damage caused by the recent fire at their factory at Back Road, Walthamstow, London, E.17, is not as extensive as first estimated. Production has been resumed but deliveries of some types of generator and constant-voltage transformers may be delayed a little.

Lee Products (Great Britain), Ltd., have transferred their head office and main distributing centre to 90 Great Eastern Street, London, E.C.2. (Tel.: Wireless 8290.)

Kaysales, Ltd., manufacturers of "Precision" receivers, have taken over the Electronics Section of the business of S. H. Muffett, Ltd., of Mount Ephraim Works, Tunbridge Wells, Kent, and M. Lehrer has joined the company as chief engineer.

G.E.C. Research Laboratories have taken a 21-year lease of the building in the Wembley Exhibition Grounds as an additional laboratory.

Industrial Finishes Exhibition.—The extension of industrial finishes planned to be held in September has been postponed to September, 1950. Details are obtainable from the Organizing Secretary, 26 Old Brompton Road, London, S.W.7.
All types of MICROPHONES, STANDS and SPEAKERS available from stock including 12 in. GOODMAN P.M. SPEAKER

30-Watt RECORD REPRODUCER in metal case
PRICE 30½ Gns.

10-Watt RECORD REPRODUCER with MICROPHONE STAGE, in case
PRICE 25½ Gns.

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This AMPFLIFIER has a response of 30 c/s to 25,000 c/s within 4db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-ampifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 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, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish. As illustrated, Price 36½ Gns.

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This unit with 4 built-in, balanced and screened microphone transformers, normally of 15-30 ohms impedance. Has 5 valves and selenium rectifier supplied by its own built-in screened power pack: consumption 20 watts.

Suitable for recording and dubbing, or large P.A. installations since it will drive up to six of our 50 watt amplifiers, whose base dimensions it matches. The standard model has an output impedance of 20,000 ohms or less, and any impedance can be supplied to order.

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Makers of Transformers for the Electronic and Electrical Industries.
How Many Kinds Are There?

By "CATHODE RAY"

This symbol (presumably short for "quality factor") has become generally accepted as the prime virtue where r.f. components are concerned. It has even been incorporated in trade names. So recent statements that Q-meters don't read Q may have sounded to some like a tampering with the eternal verities.

What exactly is Q? Although it has been in common use for so long it has been slow to be officially recognised. Perhaps that is because a thing that has gone about with several different meanings seems hardly respectable in official circles.

Its roots lie in the early days of broadcasting, when transmitters were low-powered and none too easily heard with the single-valve or crystal receivers of that period. So the demand was for tuning coils that would make the most of the feeble r.f. voltages picked up. Next, when stations multiplied in number and power, the problem was not so much to tune in the wanted station as to tune out the unwanted ones. All this time the wireless amateurs' papers were full of advice on coils—practical advice on how to wind better coils, and theoretical advice on the underlying principles. It was shown that the coil which could give the strongest signals was also the most selective (though the optimum tapping or coupling depended on which quality was needed most).

The first prescription for achieving this double benefit was to reduce the r.f. resistance as much as possible. While quite true so far as it went, this was not the whole truth—it was soon realised that coil A might have a lower r.f. resistance than coil B and yet be less efficient in the two essential respects of sensitivity and selectivity. A resistance of 20 ohms would be bad in a medium-wave coil, but good in a long-wave coil. To make a fair comparison one had to take into account their inductions, and the frequencies at which they were used. So the need was felt for a single figure that would include all the factors concerned.

As a matter of general principle a standard of goodness, or a "figure of merit," is preferable to a standard of badness such as r.f. resistance.

That was where the term "circuit magnification" or "magnification factor" (abbreviated "m").

In the course of time the Americans, thinking on similar lines, began to use the expression "Q." As it was usually defined as

$$Q = \frac{\omega L}{R}$$

It was generally assumed to be another name for "m," which it has tended to ousted. But some slightly different definitions of Q appeared from time to time, and in the absence of prompt and firm action by acceptable authority, a state of uncertainty set in, and the term "Q" was generally avoided by the most precise people. Everybody else, however, found it too convenient for such scribings to prevail, and a Q-meter became one of the most used tools in almost every radio laboratory, while lots of people who hadn't the least idea what it really meant discovered in Q a reactance, 2πfL (abbreviated to ωL), we have:

$$V = \frac{\omega L}{R}$$

The interesting thing, of course, is the ratio of V to v, because V is the "output" voltage, which can be used or passed on to the next stage; v being the input, derived perhaps from an aerial or a valve coupled by a primary winding. In any reasonable tuning circuit V is considerably greater than v, so it was natural to call V/v the magnification. We have, then:

$$m = \frac{V}{v} = \frac{\omega L}{R}$$

If we reckon from the capacitive reactance, 1/ωC, we get

$$m = \frac{1}{\omega CR}$$

which comes to the same thing—in Fig. 1, at least.

Instead of approaching the matter in this theoretical way, one may prefer to inject an actual voltage into a real tuned circuit and measure the output voltage across it; m is then directly 1/m.

As a matter of general principle a standard of badness, or a "figure of merit," is preferable to a standard of goodness, or a "figure of merit," is preferable to a standard of badness such as r.f. resistance. It was generally assumed to be another name for "m," which it has tended to ousted. But some slightly different definitions of Q appeared from time to time; and in the absence of prompt and firm action by acceptable authority, a state of uncertainty set in, and the term "Q" was generally avoided by the most precise people. Everybody else, however, found it too convenient for such scribings to prevail, and a Q-meter became one of the most used tools in almost every radio laboratory, while lots of people who hadn't the least idea what it really meant discovered in Q a...
Q—
a valuable addition to their sales talk.

Many people in the radio business can get along quite well with the single easily-absorbed fact that a high Q means good selectivity and signal amplification. That is the great merit of the expression; it means something in terms of practical results. One does not need a university education to grasp its general significance. I take it, however, that if you were content with rough ideas you wouldn’t be reading this; so we will now proceed to consider the meaning of Q in greater detail.

Most of the controversy on the subject arises from the fact that no actual circuit is so simple as Fig. 1. L, C and R are shown there as separate components, but of course that is a theoretical simplification. R represents the total of the various forms of resistance and loss throughout the circuit. Normally most of it is the resistance of the coil, so L and R together are often assumed to represent the coil: but the capacitor is bound to have some resistance, so for more exact analysis one would divide R into two portions, attached to L and C respectively. We shall see later that if R is not substantially smaller than \( \omega L \) and \( 1/\omega C \) it is necessary to be particularly careful how \( m \) and \( Q \) are defined or measured.

Other complications occur because in practical circuits the capacitor contains some inductance, and the coil contains some capacitance. The inductance of a well-designed capacitor is usually negligible except at very high frequencies; but the self-capacitance of a coil is by no means negligible, and is responsible for the largest discrepancies between different ways of arriving at \( Q \).

For one thing, as we shall see, it raises questions about how the input voltage \( v \) is brought into the circuit.

At very high frequencies there is not even an appearance of \( L \) and \( C \) being separate—the tuning circuits are composed of parallel rods or cylinders, or of hollow spaces, in which \( L \) and \( C \) are inextricably mixed up and distributed. What about \( Q \) then?

We shall leave that question until later, and assume first that the frequency is moderate enough to let us represent the actual tuned circuit reasonably accurately by a diagram made up of separate lumps of \( L \), \( C \) and \( R \). That being so, it is usually satisfactory to consider the coil as if it were composed as shown in Fig. 2, in which \( C_o \) is the self-capacitance.

Comparing this with Fig. 1 we see that the coil is itself a complete resonant circuit. It is not possible to open the circuit to insert a signal source directly in series as in Fig. 1—the dotted line is a reminder that the items within it are only theoretically separable—but its equivalent can be performed by inductive coupling. The frequency at which a coil resonates on its own is called the self-resonant frequency. Although coils (especially if permeability-tuned) can be employed in this fashion, it is unusual to do so, because it allows the resonant frequency to be affected so much by stray capacitance. Nearly always the coil is used with a separate tuning capacitance.

Although the r.f. resistance of a capacitor can be kept very much smaller than that of a coil, it may not always be negligible. So it is necessary to make quite clear whether one is considering the \( Q \) of the coil alone, of the capacitor alone, or of the whole circuit. Just now we shall assume that the capacitor is perfect (zero resistance; infinite \( Q \)), so the \( Q \) of the coil is the same as the \( Q \) of the circuit.

Assuming also that the voltage \( v \) is introduced in series with \( L \) (in practice, by inductive coupling) connecting a perfect tuning capacitor across the terminals in Fig. 2 makes no difference in principle. It comes directly in parallel with \( C_o \), and for purposes of calculation two capacitances in parallel can always be replaced by one equal to their combined values; so the actual circuit is unchanged. But if the signal source is connected in series with the coil (which is not just \( L \) but the whole combination inside the dotted line), we have a different circuit arrangement, Fig. 3. The question then arises; are we concerned with the true inductance of the coil (L) or the inductance as it appears to be at that particular frequency, supposing that the dotted line contained only inductance and resistance is in Fig. 4? The apparent inductance \( (L') \) is not quite the same as L—it must be greater, to make up for ignoring \( C_o \) and \( R' \) is not the same as \( R \). If they both differed in the same ratio, then the value of \( Q \) (taking it to be \( \omega L/R \)) would be unaffected, but as it happens they are not. The textbooks show that

\[
R' = R\left(\frac{C + C_o}{C}\right)
\]

and

\[
L' = L\left(\frac{C + C_o}{C}\right)
\]

so what we may call the apparent \( Q \), denoted by \( Q' \) and equal to \( \omega L'/R' \), is

\[
Q' = \frac{\omega L'}{R'} = \frac{\omega L}{R\left(\frac{C + C_o}{C}\right)} = \frac{Q}{\left(\frac{C + C_o}{C}\right)}
\]

When the external tuning capacitance \( C \) is very much larger
than the self-capacitance $C_0$ the difference between $Q$ and $Q'$ is not worth bothering about. A typical self-capacitance is 6 pF, and if the added capacitance were, say, 3000 pF, $Q' = \frac{3000}{300} = 0.98Q$; the difference would be only 2%, which is less than the probable error of most Q-meters. But if no $C$ is used the apparent $Q$ is zero, no matter how high the true $Q$ may be! So the distinction ought not to be completely ignored.

Opinions have differed as to which $Q$ is the right one, or in fact whether either as defined above is right. To settle the question some people appeal to basic principles and others to practical sense. To serve its purpose of expressing the goodness of a tuning circuit or component it would obviously be a great advantage if the definition corresponded to the method of use. So we had better consider how tuning circuits are used.

In a typical broadcast receiver there are three main kinds of tuned circuits, shown in rough outline in Fig. 5. There is first the r.f. circuit, $L_1C_1$, into which the input voltage is inductively injected from the aerial, and the output taken from across $C_1$. Next there is the i.f. primary, in which the mode of operation is reversed; the input is received directly across the terminals of $C_2$ and the output is imparted inductively, proportionately to the current flowing in $L_2$. Lastly the secondary, $L_2C_2$, which works similarly to $L_1C_1$.

None of these tuned circuits corresponds to Fig. 3; in all of them the self-capacitance of the coil is effectively in parallel with the external tuning capacitance, making a total of $C + C_0$, tuned by the true inductance $L$ and damped by the true r.f. resistance $R$. There is no need to bother about $L'$ or $R'$—or $Q'$. The typical examples just shown cover the vast majority of tuned circuits in actual use.

It is clear then that $Q$ corresponds to practical affairs more closely and more often than $Q'$. But what about the methods used for measurement? The bare bones of the usual type of Q-meter are shown in Fig. 6. A variable-frequency oscillator is provided to pass a measurable current $(I)$ through a known low resistance $r$. The r.f. voltage developed across $r$ is therefore $Ir$, and it corresponds to the signal source in Fig. 3. The output voltage $V$ is measured by a valve voltmeter across $C$, when $C$ or the frequency of the oscillator has been adjusted to cause resonance, indicated by maximum $V$.

We must conclude, then, that the quantity which applies to the commonest methods of use is $Q$, but that the quantity actually measured by the commonest method is $Q'$. And therefore that when these methods giving $Q'$ are used, the readings should be multiplied by $C + C_0$ to bring them to $Q$. The instruments are, or should be, calibrated in $C$, and can be used to measure $C_0$. As we have already seen, the correction is hardly worth applying when $C$ is many times greater than $C_0$; but omitting to apply it when $C$ is not much greater than $C_0$ gives results which differ largely from the true $Q$.

A Q-meter is very handy to use, but is subject to another error—serious at the higher radio frequencies—due to $r$, which makes the instrument read lower than it should by increasing the resistance of the circuit being tested. Even if $r$ were directly in series with $R$, so that it could just be deducted from it, one would have to calculate $R$, which is a nuisance with an expensive instrument that is supposed to read $Q$ directly without any need for calculation. But actually $r$ is in series with $R'$, so to be strictly correct one would have to apply the factor relating $R$ to $R'$. In fairness to Q-meters I must admit that $r$ is usually small enough to be neglected except in high-$Q$, very-high-frequency circuits, and also that some Q-meters work on different principles. When measuring very good coils one might also have to allow for the losses due to the valve voltmeter and the tuning capacitor. So it is as well not to be too impressed by the apparent direct-readiness of an instrument having a pointer moving over a scale marked "$Q"." It's great advantage is that it does give quite quickly and easily a figure that can be used for comparing one coil with another, even though that figure may often differ appreciably from the true $Q$. The instrument can also be used for a variety of other measurements if one is prepared to do a few simple calculations.

But if one is prepared for that there is a lot to be said for an alternative method—the method in which the frequency of the oscillator is read at resonance and also at the two settings, one on each side of resonance, at which the voltage across the tuned circuit is 70.7% (i.e., $1/\sqrt{2}$) of its maximum reading (Fig. 7). Then if $f_r$ is the resonant frequency and $f_1$ and $f_2$ respectively the higher and lower of the other two:

$$Q = \frac{f_r}{f_2 - f_1}$$

In this method, the oscillator
Wireless World
July, 1949

Q is loosely coupled to the coil under test; there is no need for the r.f. ammeter or the resistance r; the result is given directly in true Q; and the method can be used in circumstances where the Q-meter fails. And of course it is very much cheaper.

The reason why it gives true Q is that the input voltage is inductively coupled to the coil under test, so is in series with the tuned circuit as a whole. In Fig. 6, by contrast, the input voltage is in series with only one of the two capacitance branches; C₀ forming a sort of bypass.

There is another feature about Fig. 6, which is of practical importance only when Q is exceptionally low, but is interesting theoretically. We have not defined "magnification factor," and l have yet to come across a really water-tight definition, but it seems to be generally agreed that it is V/u in Fig. 4 when the circuit is at resonance, as indicated by a maximum reading of V. If you ask whether this is not identical with what we have been calling Q', the answer is—not exactly. If you look up any good textbook that deals with resonance you will see that the frequency at which the voltage across the resonant circuit is maximum is not quite the same as the frequency giving series resonance. As a matter of fact, it depends on whether the maximum is arrived at by adjusting the frequency or by adjusting the tuning capacitance. Now Q (and Q'), as we saw in connection with Fig. 1, are based on the theory of series resonance. But Q-meters, which are the practical embodiments of Fig. 4, are so arranged that resonance is judged by the maximum reading of V. So really they are magnification-factor meters.

The relationship between m and Q' can be worked out. The calculation is rather involved, but as a matter of interest the result, assuming resonance is obtained by varying the frequency of the oscillator, is:

\[ Q' = \sqrt{m^2 - 1} \]

For example, if \( m = 2 \), \( Q' = 1.8 \) — a 10% discrepancy; but if

\[ m = 10, \quad Q' = 9.96 \] — only 0.4% different.

If resonance is obtained by varying C:

\[ Q' = \sqrt{(m^2 - 1)} \]

The discrepancy is slightly larger in this case, but is still utterly negligible for normal tuning circuits. It should not be forgotten when dealing with very "flat" circuits, however.

In the alternative (Fig. 7) method, too, resonance is judged by maximum V; but the resulting error is even smaller than in the previous cases. The calculation still have to be 12 kc/s, but the Q to give that selectivity would be

\[ \frac{f_2}{f_1} = 100. \]

For constant selectivity, then, Q has to be proportional to frequency; so the quantity that indicates narrowness of bandwidth is not \( Q = \frac{\omega L}{R} \), but \( Q = \frac{L}{R} \) the "time constant." At any given frequency, however, it is true to say that selectivity is directly proportional to Q.

This may be a good moment at which to point out another advantage of Q as a standard, compared with R. We have already seen that it is a fairer guide to the effectiveness of a coil because it takes into account its inductance, and also it is a measure of goodness rather than badness, and directly tells one the output voltage produced at resonance by a given input voltage. The other thing is that R, unlike ordinary d.c. resistance, is by no means constant. Most of the losses included in it tend to increase with frequency. Over a limited range of frequency, such as that covered by a tuning coil, the resistance R is usually roughly proportional to frequency. So, since \( Q = \frac{2\pi L}{R} \) over the same range of frequency Q is roughly constant. Only roughly; but at least it is more nearly constant than R.

So far we have been considering Q as a property of a coil, which is the same thing as the property of the whole tuned circuit, if losses outside the coil are negligible. But one often sees references to the Q of a capacitor or other component. The same principle holds; it is the ratio of reactance to series resistance; with capacitive reactance, \( Q = 1/\omega CR \).

When considering a resonant circuit it is often useful to know its equivalent parallel resistance, or dynamic resistance. Denoting it by \( R_d \), and the reactance (inductive or capacitive) by X, the ratio \( R_d/X \) is the same as X/R, which is what we know as Q. So if we know that the reactance of a tuning coil in the anode circuit of a valve is, say 1000\( \Omega \), and its Q is 100, then it acts as a coupling resistance of 100,000\( \Omega \). (Because \( R_d = QX \). And of
course its series r.f. resistance is 10 \( \Omega \) (\( = \frac{X}{Q} \)).

Nowadays most of the interest is focused on those frequencies which the Editor conveniently gathers together under the single abbreviation “e.h.f.” (i.e., everything over 30 Mc/s). At such frequencies the concept of a circuit composed of lumped L and C more or less breaks down. That being so, the concept of Q, if it can be made to apply, is more useful than ever, because of the difficulty of measuring L and C and of knowing what they signify when one has measured them. So Q has recently been redefined in more general terms as:

\[
2\pi \text{ times the energy stored} \div \text{energy dissipated in the circuit per half-cycle.}
\]

Simple lumped circuits such as Fig. 1 are particular cases, in which Q as defined in this general way simplifies to \( \frac{X}{R} \) or whatever is appropriate. So accepting the newer definition doesn’t make it necessary to unlearn the old.

There are, however, a few bogus definitions, such as the reciprocal of the power factor, that ought to be scrapped, however nearly right they may be in most cases.

You may ask how the energy stored per cycle in an e.h.f. circuit can be measured. Well, the most convenient form for definition is not necessarily the most convenient form for measurement; and in this case measurement is best tackled indirectly. It is sometimes possible to measure the decrement, or rate of dying-away of oscillations. But the most generally convenient is the Fig. 7 method, which holds good even with resonant cavities for centimetre waves. Frequency is the most accurately measurable quantity there is; so the only other thing to provide is an indicator to show when the voltage or current amplitude is 70% of maximum—roughly 3 db down.

Summing up the main points:

1. The modern definition of Q, completely general in its application, is based on the ratio of energy stored to energy dissipated in the circuit.

2. Applied to lumped circuits, this is equal to the ratio of the reactance (purely inductive or capacitive) to the series resistance (in its widest sense, covering all losses).

3. This \( \frac{X}{R} \) ratio is also equal to the ratio of \( V \), the voltage across the whole reactance of one kind in a circuit at series resonance, to \( v \), the voltage injected in series—the ratio known as circuit magnification factor (\( m \)). But when, as is usual, resonance is judged by the maximum parallel voltage, there is a discrepancy between \( m \) and Q, which is negligible unless Q is in the lower single-figure range.

4. If Q or m is measured by the type of circuit shown in Fig. 3, the result is the apparent Q, or Q', equal to Q\( \left( \frac{C}{C + C_0} \right) \). Since this is almost the only practical way of directly measuring m, in practice m is the same as Q' (neglecting the discrepancy mentioned above).

5. Q, however, can be measured by other methods (such as the frequency-variation method, Fig. 7) which give true values directly, and these correspond with the conditions under which tuned circuits are most commonly used (Fig. 5).

**NEW RADIO-GRAMOPHONE**

A two-position tone control gives normal and extended frequency range on gramophone records in the latest Marconiphone Model ARG19A. The auto-changer handles up to ten 10in or 12in records. On the radio side, a four-valve plus rectifier superhet covers short, medium and long waves. Three extra positions on the waverange switch give two preset stations on medium and one on long waves. The price is £84 11s. 4d. including purchase tax.
TRIODE-DIODE VOLTMETER

Made from War Surplus Parts

By T. A. LEDWARD, A.M.I.E.E.

INTENDED for audio-frequency work, the voltmeter to be described has a linear scale from 0.1 to 1 volt. It is not suitable for d.c., but this limitation enables a stable zero to be obtained without special balancing arrangements.

The instrument was constructed from ex-Government components, including the metal case, at low cost.

A Type No. 194 receiver provided the case and valves. This receiver contained many additional parts, including two further valves, a VR91 and an EF50. The 0-100 microammeter, ex-Admiralty pattern W622, had a specially masked scale which required repainting and scaling.

The circuit arrangement was considered with some care and it will be useful to explain the reason for certain features. The first requirement was an approximately linear scale of 0.1 volt. The second was a reasonably high input impedance.

The linear scale requirement was met by the use of a diode, but a range of 0.1 volt with diode only and a 0-100 microammeter would have meant an input impedance of only about 5,000 ohms.

A pre-amplifier valve was therefore used. The input impedance now depends upon two things: the grid shunt resistance and the effective input capacitance of the valve. The latter factor, of course, lowers the input impedance as the frequency is raised.

A value of 1 megohm was chosen for the grid shunt resistance. The effective value of the input capacitance, using a VR65 valve is approximately 75pF.

An important feature is the arrangement of circuit whereby the stray capacitance from anode to earth is maintained as low as possible.

Consider Fig. 1: in order to deal satisfactorily with the lower frequencies, the condensers C1 and C2 must be large, say 4µF. They must also have a very high insulation resistance, which rules out electrolytics. The bulk will, therefore, be appreciable, and the capacitance to earth will be fairly high. Fig. 1 is, therefore, unsatisfactory for a wide range of frequency. Now consider Fig. 2: by placing C1 and C2 on the earth side of the circuit, the stray capacitance from anode to earth is unaffected by the size of these condensers. The indicating instrument is now raised to about 180 volts d.c. above earth potential, but the a.c. potential above earth is negligible and there will be no hand capacitance effects.

The final circuit of the voltmeter, together with values of components, is shown in Fig. 3. Separate 6.3-volt heater supplies will be required and the h.t. supply should be approximately 7 mA at 250 volts.

Higher voltage ranges may be included, if desired, by adding a voltage divider similar to that described in Wireless World dated June, 1944.

BOOK RECEIVED

Elements of Electromagnetic Waves.

This book is of American origin and treats electromagnetic waves mathematically. There is an introductory chapter explaining vector algebra which is freely used in the subsequent text. The book finishes with a chapter on radiation in which simple forms of aerial are considered.
SHORT-WAVE CONDITIONS

May in Retrospect : Expectations for July

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

During May, maximum usable frequencies for this latitude decreased very considerably by day, in accordance with the normal seasonal trend. The night values, however, instead of showing the usual increase, decreased very slightly, perhaps owing to the disturbed conditions during the first half of the month.

The month was slightly less disturbed than April, ionosphere storms being observed on 2nd-9th, 11th-14th and 31st, 12th and 13th being exceptionally disturbed, and a very great magnetic storm also being recorded during that period.

Working frequencies for the month were, on the whole, very low, relatively few contacts being established over 30 Mc/s. Thus long-distance communication on the 28-Mc/s band was seldom reliable, particularly in eastward and westward directions. During the night no frequencies below 7 Mc/s were really necessary.

There was a marked increase in the rate of incidence of Sporadic E, in accordance with the usual trend, and many amateur openings via this layer have been recorded for the first time this year, mostly from Eastern and Southern Europe. Frequencies as high as 50 Mc/s were occasionally propagated by this medium.

Four ”Dellinger” fadeouts were recorded in May, on 5th, 7th, 8th and 9th, the fadeouts on 5th and 7th being particularly violent.

Sunspot activity in May was considerably less than in April. Three large sunspot groups crossed the central meridian of the sun (on 5th, 11th and 31st), and all of them were associated with reception disturbances which occurred around those periods, the disturbances following the second group being particularly intense.

Long-range tropospheric propagation was observed on a number of occasions, particularly in the second half of the month.

Forecast.—It is probable that there will be very little difference between the m.u.f.s for July and June, as in the Northern Hemisphere daytime and night-time m.u.f.s usually reach their respective annual minimum and maximum values during this period.

As in June, although daytime communication on very high frequencies, like the 28-Mc/s band, is not likely to be frequent, over many circuits frequencies like 15 and 17 Mc/s will remain regularly usable until midnight. During the night frequencies lower than 11 Mc/s will seldom be required. For medium distances, up to about 1,800 miles, the E and F layers will control transmission for considerable periods during the day.

Sporadic E is usually very prevalent in July, and communication over distances up to 1,400 miles may be possible by way of this medium on frequencies greatly in excess of the m.u.f.s for the regular E and F layers. Frequencies as high as 60 Mc/s may be occasionally reached for a short time. However, it is impossible to predict when such communication may occur, owing to the irregular behaviour of Sporadic E.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during July for four long-distance circuits running in different directions from this country. (All times GMT). In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the regular layers:

Montreal: 0000 15 Mc/s (10 Mc/s) 0100 11 „ (15 „) 0200 15 „ (10 „)
Buenos Aires: 0000 17 Mc/s (22 Mc/s) 0100 15 „ (19 „) 0000 11 „ (16 „) 1000 17 „ (23 „) 1000 21 „ (26 „) 1200 17 „ (22 „)
Cape Town: 0000 15 Mc/s (20 Mc/s) 0100 11 „ (16 „) 0200 17 „ (24 „) 0800 21 „ (28 „) 1800 17 „ (22 „) 2100 12 „ (19 „)
Chungking: 0000 11 Mc/s (14 Mc/s) 0500 10 „ (20 „) 2300 11 „ (14 „)

Good Reception

Below is listed a few of the leading Television Manufacturers who approve the use of Antifference Aerials with their receivers. A high percentage of Televisers now in use operate with Antifference Aerials.

ANTIFERENCE AERIALS

67 BRYANSTON ST., LONDON, W.1
Unbiased

Nauseating Nomenclature

A GREAT many laymen, led astray by glib-tongued and facile-fisted lay journalists, seem to have got it into their heads that there is some subtle difference between radio waves and what they call radar waves. It is difficult to explain to them that there ain't no such animal as a radar wave, any more than in the realm of sound there are such things as echo waves, or audar waves, as I have little doubt that some of these cliché coiners would term them.

I was trying to explode the radar wave superstition the other day by means of a mechanical analogy—always a dangerous thing, as invariably it breaks down and brings the creator down with it, as it did in this particular case in more senses than one.

To lend force to my argument I used a punch-ball to demonstrate my analogy. In an unguarded moment, carried away by my enthusiasm, I was floored physically by what I termed the ball's radar wave, and metaphorically by a bespectacled and loathsome-learned-looking schoolboy who pointed out, quite rightly, that the ball's return was not due to any reflection effect but to the release of the energy which my original blow had caused to be stored within its spring support. This regrettable incident made me give up further attempts to educate the technically illiterate masses, but a recent report from the U.S.A., which states that cooking is now being carried out by what is called "radar waves," has brought my missionary zeal to the fore once again. I can stomach this sort of thing with as little success as I can stomach the results of this offensive inside-out sort of cooking. According to the newspaper report the innards of a chicken, instead of being first removed, were cremated, and the flesh done to a turn, whatever a turn may be.

Apart from my aesthetic objections to this sort of cookery, which causes my physical gorge to rise as much as the misuse of the term radar causes my technical gorge to perform the same evolution, I object strongly to it being termed new. I, myself, was privileged to be present, over three years ago, at a private demonstration of this sort of inverted cookery by one of its pioneers, which I duly reported in these columns (March, 1946). For the benefit of those of you who have perverted gastronomic tastes, I would mention that the American demonstration was on a frequency of 23 Mc/s; but to me giblets are giblets, whether cremated or not, and I will have none of it.

Wrist Radio

THE vogue of the personal portable or miniature receiver threatens to develop into an epidemic or even become a permanency as more and more manufacturers give us their versions of it. Quite frankly, I don't like any that have so far appeared. My complaint is that none of them is small enough to shove into one's pocket without making an unsightly bulge. The ignorant and ill-informed may well ask "why do you want to shove one into your pocket anyway?"

This is, of course, precisely the question which was asked of an ancestor of mine when he made a similar complaint about the bulkiness and unpocketability of turnip watches. My point is that the whole idea of the personal portable is that it is intended to be carried on one's person. It should, therefore, be no larger than a watch or a cigarette lighter.

Seven years ago (March, 1942) I published in these columns a photograph illustrative of the American trend in personal portable design, which was towards something like a Leica camera. Both British and American "Leica" models of an improved type are now available, but they would be still more improved if they were made less conspicuous to carry and protected from damage by means of an ever-ready leather case like their photographic counterparts.

But now that ultra-midget valves, components and batteries are available for pocket hearing aids surely we can get down to something smaller than the Leica camera. In my opinion, it can be done by once more borrowing an idea from the photographic world; there is no shame in it, or at any rate the photographic fraternity do not think so as they don't hesitate to borrow the micro-ammeter and the photocell from us and call the combination an exposure meter.

Appareley the Germans regard the Leica as a bit old fashioned as they now go in for a "wristwatch" camera weighing less than a couple of ounces and giving a negative of 4 x 3 millimetres. I need hardly say that this puts users of conventional miniature cameras into the same class as they have so often contemptuously consigned me and my old wet-plate outfit.

What I would like to see is British radio manufacturers following this thoroughly praiseworthy example and turning to the production of wrist radio. The volume from such a set would enable me to hear, without disturbing others, all that I wanted to when away from my home receiver. This surely is the sole aim and purpose of a "personal" receiver.

Radio manufacturers please copy.

Whilst on the subject of miniaturization there is another piece of equipment which could more readily be carried on one's person if suitably adapted. I have often wondered why the practice of the Melanesian native, who carries his treasures slung in the pierced and extended lobe of his ear, has not been copied by users of hearing aids.
LETTERS TO THE EDITOR

Export Opportunities • Why Record Supersonic Frequencies? • Circuit Diagram Conventions • Measuring Circuit Magnification • Simple Wobulator • B.B.C. South Coast Service

Canadian Trade Possibilities

There would appear to be little effort on the part of many British manufacturers of electronic apparatus and components to realize the market potential for their products here in Canada.

I came to Canada eighteen months ago from the U.K. and, in my present work as Senior Communication Engineer, the Canadian prospects for many British lines have been brought forcibly to my notice.

Contrary to expectations, some American products retail at higher prices than their British counterparts and are frequently of inferior quality.

In view of Britain's present economic plight and the favorable import position applying to British products in the general class of electrical, wireless and radio apparatus (with the important exception of domestic radio receivers) the apparent sales lethargy on the part of many manufacturers in my opinion warrants the strongest censure.

Some British manufacturers have done nothing, possibly overawed at entering the arena with the American juggernaut; others have blindly accepted the first Canadian agency without regard for status or standing there appears to be little control over the Canadian selling price, which rises steeply.

In view of this adverse selling factor, direct British group representation would appear to have many points in its favour. In short, is there any valid reason why bodies such as the Radio Component Manufacturers' Federation, S.I.M.A., etc., should not set up their own Canadian distributor units?

Such a step should ensure more effective representation to the retailer and customer with more reasonable distribution overheads. It would also permit more adequate range or spare stocking and customer service that can be expected from an agent handling a product for the most profit with least effort.

In conclusion, may I stress the part that Wireless World itself could play in fostering increased electronic exports to Canada. Every effort should be made to increase the Canadian circulation with paper restrictions eased on this account. I can assure you that your coloured issue for March last agreeably surprised Canadian colleagues and, in particular, many of the advertisements and prices. In a country where American periodicals serve as a buyer's guide, the vital role of Wireless World cannot be over-estimated and, indeed, wider Canadian circulation is a vital pre-requisite to increased British exports in this field.

T. S. Dutton.
Valois, Quebec, Canada.

Thévenin's Theorem

In my recent article on Thévenin's Theorem (March issue), I showed, perhaps, some disrespect towards M. Thévenin in suggesting that he was something of an interloper and that credit for the theorem really belonged to Helmholtz.

M. Simon, of 'SOTELEC,' Paris, gently implied as much in sending me a copy of his biographical appreciation of Thévenin, containing a reproduction of Thévenin's original paper setting out the theorem in question.

As a result of correspondence with M. Simon and with Prof. G. W. O. Howe (on whose Wireless Engineer Editorial of July, 1943, my remarks were based) the following concise summation of the words of Prof. Howe seems to be a fair statement of the facts:

"(a) Thévenin deserves the credit for setting out the theorem very clearly and making it generally known, and

(b) Helmholtz had described and used it thirty years before."

To which may be added that Thévenin, like nearly everybody else, was unaware of Helmholtz's statement.

I am indebted to M. Simon and Prof. Howe for kindly contributing from their knowledge to an agreed conclusion on what seemed at first rather controversial.

"CATHODE RAY."

Recorded Supersonic Frequencies

In the report of the discussion on commercial disc recording, following the lecture by Mr. Mittell (Wireless World, February, 1948, p.)
Letters to the Editor—

67), it was stated that "even when the response of the reproducer, or of the ear of the listener, was restricted, the subtle improvement resulting from the records of high, even ultrasonic, frequencies could be detected. It was thought that this might be explained on the basis of improved transient response."

If the ear responds to a transient sound by virtue of its waveform, as it seems to be substantiated by certain evidence, then it is conceivable that a person who is deaf to high frequencies could hear a steep-fronted transient almost, if not quite, as well as a person with normal hearing. The conventional explanation in terms of Fourier Analysis would lead to the conclusion that a person whose hearing is deficient in high frequencies would be unable to hear a steep-fronted transient. The quoted improvement which occurs with the recording of inaudible frequencies may be explained by either of two mechanisms. First, it might be through hearing the intermodulation products of two or more frequencies, of which at least one is above audibility. Alternatively it might be through the greater fidelity with which the transients are recorded.

It should not be difficult to devise tests, if this has not been done already, to determine (1) whether the ear responds to transients by virtue of their waveform and (2) whether intermodulation products or transients or both are responsible for the improvement from supersonic recording.

Can any of your readers give a lead in this direction?

F. LANGFORD SMITH.
Amalgamated Wireless Valve Co.,
Sydney, N.S.W.

"Drawing Circuit Diagrams"

L. BAINBRIDGE-BELL, in the May Wireless World, appears to be bugging a horse that has already passed the post. Precise recommendations on all the subjects raised have been made in British Standard 530:1948, which he himself quotes; surely it is better to accept these recommendations as they stand.

It is because of individual preferences, both in circuit-drawing practice and in symbols generally, that so much confusion has arisen in the past. This confusion can only be reduced by general acceptance of recommendations made by a fully representative body. If, for some particular reason, a given organization finds it necessary to depart from a specific British Standard, by all means let it do so; it is a different matter if such an organization or individual tries to foist its preferences on others.

Bainbridge-Bell over-stresses the risk of draughtsmen's errors. The danger of a blob at a junction being obscured can be avoided by making the blob big enough to be seen. Ordinary letter stencils provide the means; thus, the "O" of a standard No. 1 stencil, fully inked in, is admirable for most purposes, though when the drawings are used for line blocks the size must be related to reduction wanted. Such innovations as that suggested in Bainbridge-Bell's penultimate sketch are commendable provided the reader knows what they mean; generally an explanation is necessary. In the instance quoted "the path BC" is sufficiently explanatory without resorting to a symbol which is meaningless to those not in the know.

London, N.W.

"Q-Meter Controversy"

I WAS interested in the correspondence printed in the June Wireless World concerning "Q" meters. As my firm are the manufacturers referred to by "F. H." as making the first British instrument of this kind, may I add two further comments?

Our instrument was called a Circuit Magnification Meter as, like "F. H.", we felt that the use of the term "Q Meter" was, to say the least, inappropriate and rather smacking of technical jargon. We continue to use the longer title. Dr. Sheridan notes with surprise the use of an injection resistor and points out its shortcomings at higher frequencies. This type of circuit is used in our Circuit Magnification Meter, but its defects are well realized. By careful design it will give reasonable performance up to about 30 Mc/s, but begins to fall off above that. In a high-frequency circuit magnification meter covering 15 to 170 Mc/s, the injection method has been abandoned and an inductive injection method is used. This is shown in the attached functional diagram. Series injection is still used, but the virtual injection resistance is made so small that the reactance of its residual inductance is very much greater than its resistance, even at the lowest working frequencies. To facilitate measurement of the voltage applied to the test circuit, the injection inductance L is tapped down on a much greater inductance L, so that a known fraction of the voltage is taken. The voltage across L is measured by one diode voltmeter and then across the tuned circuit by another.

A further interesting arrangement is that by feeding suitable fractions of the d.c. outputs of the two voltmeters in opposition to a d.c. amplifer with a meter in its anode circuit used as a null detector, the values of Q factor may be read from the dial of a calibrated potentiometer (range Q 75 to 1,200). The advantages of this system are that the calibratable element in the circuit carries only d.c.; there is no necessity to know the absolute value of the e.m.f. injected into the test circuit; only one meter is required and the null reading system inherently has good stability and independence from supply voltage fluctuations. This circuit is covered by British Patent Application No. 2520/48.

E. D. HART.
Marconi Instruments, Ltd.
St. Albans, Herts.

Calibrating a Wobbulator

WITH reference to the article by K. C. Johnson on his new wobbulator circuit, I feel he has over-emphasized the difficulty of calibrating it on the television band.
I have the circuit in use, and have devised a simple but very accurate method of continuous calibration, or "strobing," as it might be termed. The normal circuit is set going, with the unit feeding the receiver and the receiver feeding the 'scope; then the signal generator is loose-coupled to the input tuned circuit of the receiver. As the wobbulator sweeps through the signal generator the frequency a "blur" is produced on the curve on the 'scope; this marker pip moves along the curve as the generator is tuned through the band, and enables the exact frequency of any humps, etc., to be read instantly, and also enables the scope to be used without any paper scale.

The accompanying sketch was drawn from a 'scope trace, using a normal t.r.f. vision receiver. As will be seen from the sketch, the heterodyne pip is fairly sharply and narrow. This is due to the narrow frequency response of the 'scope amplifier, which, for this purpose, is clearly desirable.

DOUGLAS M. GIBSON.
Ashford, Kent.

"Copenhagen Comments"  
I SHOULD like to reply to the comments of Mr. R. Cleghorn (Wireless World, May, 1949).

Germany not having been represented in the Broadcasting Convention at Copenhagen did not get three channels, but two for each zone of occupation; i.e., in total eight channels. Indeed, none of them is a clear one, and, moreover, the limit of power to 105 kW each is very unfavourable.

Whether the consequence Mr. Cleghorn is afraid of will appear and whether Germany will annex some channels slimly will supervise the German broadcast branches of military governments for many years to come and the broad- casters will have to be satisfied with only a limited taste. It will hardly be contested that the large proportion of recorded items on the Third Programme limits quality.

Signal strength from the long-wave Light Programme is fairly good, but reception is obtained by atmospheric interference during the summer months in particular. On the medium waves, the West Regional transmitter at Start Point provides the strongest signal, but fades, whilst the quality appears generally slightly inferior to that from Brookmans Park, on the same programme, presumably due to land-line defects. The latter transmitter is free from fading since the installation of the new mast aerial, although signal strength does not appear appreciably greater, and is certainly inadequate to stand out from the many sources of interference, whether man-made or natural.

Would it not be possible, even if the need for economy prevents the installation of any further transmitters, for the Kingston transmitter to radiate the Home or Light Programme during those hours when it is not needed for its own service?

D. C. SMITH.
North Lancing, Sussex.

CORRECTIONS

The last paragraph of the article "When Negative Feedback Isn't Negative" (May issue) should read "... try using a high anode coupling resistance for the middle stage and lower values for the two outer ones." Incidentally, the reference to the article by C. F. Brockelsby in Wireless Engineer should have been to the February, 1949, issue.

In "Contrast Expansion" (June issue) in the 95th line of Col. 3, "40.dc/s " should read "40-50/60Hz."

The price of the Labgear electronic relay (advertisement on p. 22, June issue) should be £5 5s.

In the Valradio advertisement on p. 69, June issue, the model number should be 280/110, for "H.F. and R.F." read "R.F. and A.F."
Random Radiations

By “Diallist”

DX Television

Spending a few days recently at a little place on the Suffolk coast which is just about 100 miles as the crow flies (or the wave waggles) from Alexandra Palace, I was surprised to notice quite a sprinkling of the H-type television aerials, which are now such familiar objects of the sky line of Greater London and the Home Counties. In this small East Anglian town I counted five during casual strolls and probably the number would have been doubled or trebled had I set out on a determined search for them. The owner of one television set told me that reception, though chancy, was quite excellent at times. He was kind enough to invite me to “look in.” Unfortunately, it was just one of those days. A hazy image might appear for a second, but it could not be held; most of the time there was nothing on the screen but “noise.” He and the other owners of television receivers in the locality have, I imagine, something of the thrill that old hands used to get out of long-distance radio in the early days of medium-wave and short-wave broadcasting. All of us were very certain that DX work was worth while, no matter how many fruitless vigils into the small hours we might have spent. It’s clear proof of the urgency of television aerials and of signal-frequency amplifying units. I’m not going to say that any kind of complex arrangement will be any use; indeed, I’m sceptical about signal-frequency amplifying units not only for television but for radio too. A similar arrangement, however, is necessary for television if good reception is to be had. All of us were very certain that DX work was worth while, no matter how many fruitless vigils into the small hours we might have spent. It’s clear proof of the urgency of television aerials and of signal-frequency amplifying units.

They Want It

The fact that people living in places far beyond the normal service area of the London television station think it worth while to install television is clear proof of the urgency of the demand for television services all over this country. People definitely want television; they are prepared to pay for receiving sets and they will put up with poor or chancy reception rather than have nothing at all. To me, at any rate, it seems that the B.B.C.’s progress in providing a network of transmitters should be speeded up. All sites should have been selected by now, or should anyhow be chosen within the next few months. Since the Powers That Be have guaranteed the continuance of the 405-line, 50-frames-per-second transmissions, the B.B.C. would do well to decide upon a standard design for its transmitters and to place orders right away for ten or a dozen of them. If these and the necessary radio links were ordered in bulk, both time and money would be saved. There’s a point, too, about those radio links. The main centres will presumably have their own studios, O.B. equipment and so on; interconnections will enable any of them to originate programmes to be radiated by all or any of the others. But has it occurred to anyone to combine some or all of the radio links (or coaxial cable repeater stations) with small, unattended and automatically operated transmitters? Were this done, to take one example, in the country traversed by the London-Birmingham links, the whole service area might have the form of a dumb-bell —circles of 30 or more miles radius round London and Birmingham and between them an area of approximately rectangular shape some 15 to 20 miles in width. There are, of course, difficulties; but are they too formidable to be overcome?

Aerials and Amplifiers

It would, I feel sure, pay those concerned with the manufacture of television aerials and of signal-frequency amplifying units not only to study reception conditions in outlying districts, but also to conduct instructional campaigns in “fringe” areas and those still farther from transmitting centres. In talking to people living in such parts of the country I’ve found, first of all, that the ordinary man who buys a television set hopes for the best does not realize that there are means whereby his chances of good reception could be improved; secondly, that not a few of the radio dealers who supply the sets are not much better informed. One of them assured me that the multiple aerial array was just a stunt of no real value, and another was equally sceptical about signal-frequency amplifying units. I’m not going to say that any kind of complex aerial, even with a perfectly matched feeder, will make good reception a certainty in places where it is now the exception rather than the rule. Nor would any sensible person claim that additional s.f. amplification will always do the trick. Either or both, however, may so much increase the chances of good reception in such places as to make all the difference between its being worth while or not to invest in a television receiving set.

A Tricky Business

The New York Magazine Radio-Electronics has just inaugurated a scheme which may have interesting results. Publishing a letter from a resident in Borneo, who wants to buy American components and so on but can’t owing to currency export restrictions, the Editor suggests that the only way out of the difficulty at the moment is a return to primitive bartering methods by making swaps. He fully appreciates the difficulties and the exasperation of those radio addicts who yearn to possess this American gadget or that, but can’t get leave to send so much as a lone dollar abroad. To help them he proposes to run free of charge a section of classified advertisements by radio folk living in such countries. In these adver-
tisements (which must not exceed 40 words) the dweller in a currency-restricted country can state what he wants and what he has to offer in exchange. It's a grand idea and a generous one in these hard times. The big snag, though, may prove to be the fact that most of the currency-restricted countries have also a mass of complicated import regulations. Were you to succeed in swapping this or that for, say, an f.m. receiver kit, you might find it impossible to steer your prize through the offshore minefield of import licences, etc.!

Effects
A cousin of mine who writes plays for the B.B.C. invited me recently to go to a rehearsal of one of hers. I had a good many surprises, not the least of which was that, for a half-hour item due to be broadcast at 5 p.m., morning rehearsals took place from 10.30 to 1 o'clock and that these were followed by another lot from 2 to 4. The effects in particular have to be rehearsed most carefully for timing. Most of them were produced from records on the four turntables of a play-back instrument and I was able to see the working of the apparatus which enables any part of a record to be selected with absolute certainty. The pick-up is held by a rigid arm mounted tangentially to the grooves of the disc and travelling along a finely graduated scale. Shortly before a particular effect is required the needle is lowered into the groove; the controller then fades it in and out at the proper moments.

Another One to Try
In its June issue Toute la Radio had a quiz which contained one poser that may be of interest to readers of Wireless World. Here it is. If the output terminals of a high-voltage d.c. supply have two or more capacitors connected across them in series, these capacitors are always shunted individually by resistors of high values. This precaution is necessary:
(a) To reduce ripple;
(b) To prevent the capacitors from "blowing up";
(c) To discharge the capacitors when the h.t. voltage is switched off and so to guard against accidents.

What's your view? The answer is given on page 258.

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**Automatic Muting**

Valve noise produced by inherent thermal effects is utilized to short-circuit the loudspeaker automatically when no signals are present. It is known that the noise voltage is considerably increased during such times, and this is stated to be due to the action of the automatic volume control in the case of amplitude-modulated signals, and to the fact that the presence of the carrier shortens the actual duration of the thermal effect in the case of frequency-modulated signals.

In the "no-signal" condition shown, a circuit LC in the anode of the a.f. amplifier V1 collects the noise voltage, which lies well above the normal signal frequencies fed to the loudspeaker L, and passes it through rectifier circuits L and Ri to the grid of a valve V, to operate a relay S controlling short-circuiting contacts Sr on the speaker. When a signal is received, the charge built up on the condenser C quickly leaks away through the rectifier D and high resistance R. The charging of the condenser takes place more slowly through the rectifier D and high resistance R, so preventing the relay from being operated during brief periods of fading.


**Super-regenerative Circuits**

Relates to the type of circuit that is designed to respond to the receipt of a pulsed signal, as used in radar, by the instant transmission of an identification signal. To ensure satisfactory threshold conditions, it is necessary to reduce the free oscillations that normally occur in the tuned circuit of the super-regenerator to negligible proportions, and for this purpose the circuit is usually damped by a low-resistance shunt. This involves a serious loss of power in the response signals, but the same tuned circuit is used both for transmission and reception.

According to the invention, the difficulty is solved by using as the damping device a diode which is connected across the tuned circuit, and also to a source of positive potential. During standby conditions, the positively biased diode has a comparatively low resistance; but when the super-regenerator is triggered into transmission, oscillations rise to a high level and then serve automatically to "open-circuit" the diode by charging a condenser connected between its anode and the tuned circuit.


**Television Cabinets**

The cabinet is made in two parts, the upper of which contains the viewing screen and is arranged to telescope inside the lower or main casing, with a vertical movement, so as not to disturb anything that may normally be placed on top of the cabinet.

The main casing contains the cathode-ray tube, which is mounted to project the picture downwards on to a spherical mirror, from which it is reflected back through a correcting lens or to an inclined plane mirror, fixed in the upper part of the casing, and finally on to a vertical ground-glass or opalescent viewing screen. The lifting of the viewing movement of the upper part is conveniently controlled by means of a small electric motor, through worm gearing and vertical guide rods, an automatic stop and slip clutch unit being provided to prevent damage to the equipment.


**Intervalevel Coupling**

The grid of the amplifier V1 is coupled to the grid of the previous stage V through a step-down tapping on a coil L, which is chosen so that the impedance of the whole coil bears the same ratio to the impedance of the part of the coil between the tapping T and the ground, as the capacity between the grid and all the other elements of the amplifier V1 bears to the capacity between the anode and all the other elements of the amplifier V. More particularly, the grid-cathode capacity of V1 is reflected by the coil as a smaller capacity between the anode and cathode of V. The sum of the capacities concerned is represented in dotted lines at C1, and is calculated to resonate with the coil L at the working frequency, the normal coupling condenser C being too large to have any appreciable effect.

A useful increase in effective amplification is secured by the arrangement shown. In an eight-stage receiver for pulsed signals the overall gain is stated to be more than three times that normally given.

*The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), May 20th, 1945. No. 612472.*

**Remote Control System**

Signals transmitted in the form of television symbols grouped into characteristic patterns, are used for the selective control of distant apparatus. A chequered arrangement of black-and-white squares, for instance, provide a very large number of distinctive patterns by suitably re-grouping the unitary squares. Further variety can be introduced by the stepped rotation of any given pattern.

At the distant end, a photoelectric relay is operated only when the pattern reproduced on the viewing screen of a television receiver conforms to a predetermined code. In order to ensure secrecy, provision is made to vary the line and frame frequencies, and to switch over from progressive to interlaced scanning, from time to time, in accordance with master control signals radiated from the transmitter.


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, 29, Southampton Buildings, London, W.C.2, price 2/- each.
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<td>£8 0</td>
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<tr>
<td>Pullin Series 100, 10,000 O.V., A.C./D.C.</td>
<td>£8 0</td>
</tr>
<tr>
<td>Mullard Master, Valve-Tester, A.C. Mains, 5,000 Test cards</td>
<td>£8 0</td>
</tr>
<tr>
<td>Roberts portable Valve-Analyser and Test-Meter, latest model</td>
<td>£11 0</td>
</tr>
<tr>
<td>Pye Workshop service and Test Rack, latest model</td>
<td>£36 0</td>
</tr>
<tr>
<td>Avo Capacity and Resistance Bridge, as new</td>
<td>£8 0</td>
</tr>
<tr>
<td>Avo 75's, as new, £12 10 and</td>
<td>£13 0</td>
</tr>
<tr>
<td>Hunt’s Capacity and Resistance Bridge, latest model</td>
<td>£11 0</td>
</tr>
<tr>
<td>E.M.I. Audio Oscillator, 0–100 KC's, with chart</td>
<td>£11 0</td>
</tr>
<tr>
<td>Latest Model B.S.R. A/F Signal Generator, 2–400 Kc's</td>
<td>£11 0</td>
</tr>
<tr>
<td>Wharfside 1611, P.M. Latest Model</td>
<td>£8 0</td>
</tr>
<tr>
<td>Goodman's 12in. P.M.'s, As new</td>
<td>£10 0</td>
</tr>
<tr>
<td>Goodman's 12in. P.M.'s. As new</td>
<td>£4 0</td>
</tr>
<tr>
<td>Rola 12in. P.M.'s, As new</td>
<td>£4 0</td>
</tr>
<tr>
<td>Cossor Double Beam 'Scopes.</td>
<td>£4 0</td>
</tr>
<tr>
<td>Taylor Valve-Testers, Model 45A, 45SF, with charts, As new</td>
<td>£12 10</td>
</tr>
<tr>
<td>Ferranti AC/DC Test-Meter, 1,000 O.V.</td>
<td>£4 0</td>
</tr>
</tbody>
</table>

Hundreds of other items too numerous to list at Bargain Prices. Please state requirements. No lists and no C.O.D., cash or cheque with order. All items listed are CARRIAGE PAID.
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MAINS TRANSFORMERS

16/6 POSTPAID

Coulphone Mains Transformers are made to the highest electrical standards and are fully guaranteed. We supply them to the Ministry of Supply Atomic Research Station, so they will no doubt meet your requirements.

Special quotations for quantities and types to order.

Standard Replacement Types. Drop-through chassis type with top shroud. Impregnated and interleaved.

Screened Primaries tapped for 200/230/250 volts.

(a) 250-0-250 v. 0.1 A. 6.3 v. 4 A. O.T.
(b) 250-0-250 v. 0.1 A. 6.3 v. 4 A. O.T.
(c) 350-0-350 v. 0.1 A. 6.3 v. 4 A. O.T.

(F**) 300-0-300 v. 0.1 A. 6.3 v. 4 A. O.T.


MODEL A. For use with 2 gang tuning condenser.

80 mA or any triode bands frequency changer.

MODEL B. For use with 2 gang tuning condenser. R.F. Stage for 6K7G, or 6K9G. Nine iron dust core coils. £2/17/6.

COULPHONE 9-WATT HIGH FIDELITY AMPLIFIER. Built to famous Williamson circuit but with push-pull G540 for higher power output. Linear response from 20--60,000 c.p.s. Power supply for feeder unit or tone control unit brought out to octal socket. £5 6/6.

EX G.M.T. SURPLUS. COULPHONE offer the best bargains. Over 200 items in our illustrated catalogue. If interested please send extra 2d. stamp—It will save you £x.


MODEL B DE LUXE (Illustrated above). High gain R.F. stage operative on all wavebands. £5 10/8 to £6 8/6. Price ex. ranges of Bandpan, 15-11.25. 16.4-17.4. 19.5-20.5. 24.5-29. 30-42.5. Large colour printed glass dial. 10cm. aperture. Horizontal drive. Wave range indicator and magic eye. Switched pick-up sockets. Volume and Tone Controls. Completely aligned ready for connection to any amplifier. Price less valves £1/17/6.

Valves required, 6F2G, 6L4G, 6X4G, 6720. £2 12/5.


Terms: C.W.O. or C.O.D.

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TRANSFORMERS & CHOKES

All "Varley" products are manufactured from the highest quality materials. Transformers etc., are individually wound and have interleaved windings with ample insulation, ensuring freedom from breakdown.
The comprehensive range of Shielded and Open type Transformers available meets the requirements of every circuit. Write for list etc.

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EXTENSION SPEAKERS

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* Attractive Appearance
* Sound Value for money

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Richard Allan

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AT GOOD SHOPS EVERYWHERE

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CALEDONIA RD. BATLEY YORKS

Wireless World
July, 1949

The RIMINGTON JEWEL
will bring new life to
GRAMOPHONE REPRODUCTION

* Reproduces the maximum recorded frequency range.
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* Preserves the higher frequencies delicately imprinted in the record, so easily destroyed, and reproduces them!
* Jewel well set and angle correct.
* Contained in plastic box well packed and mounted.
* LIFE. It is not possible to state categorically the life of a jewel point, but in the interest of quality it is advisable to replace the jewel after 1000 playings—it is a matter of personal discretion.
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RELIANCE

Wire-wound and Composition types, Single, Ganged, Tandem Units, Characteristics: linear, log., semi-log., non-inductive, etc. Full details on request.

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Trimmer CAPACITORS

SYDNEY S. BIRD & Sons, Ltd
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDLESEX
Firms: Emball 3079-1 "Gram, "Capacitor, Enfield"
At last a gramophone motor to match the performance of the famous Connoisseur Pick-up.

**SPECIFICATION:**

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

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

Retail Price, complete with Pick-up £15 19s. 6d. plus £6 18s. 2d. P.T.

... without Pick-up £13 5s. 0d. £5 14s. 10d. P.T.

Coupling Transformer when required 13s. Od.

Made by

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**PRECISION COMPONENTS**

**CORD DRIVES**

Now available in five types as illustrated (left to right) Standard, R/V, Reverse, "D" type and "A" type.

**GANG CONDENSERS**

A wide range is now available in 1, 2, 3 or 4 gang types of various capacities.

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Special Features

- Eight miniature valves
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- Eleven inch pointer traverse
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for Radio and Television Components

The CABOT 25 Watt
HIGH QUALITY AMPLIFIER

Incorporating negative feedback, suitable for any use where sound amplification is required.

SPECIFICATION:— Separate mike and gram inputs for mixing. Mike input suitable for standard Magnetic or Lightweight pick-up. Tone control. Output 25 Watts into 4-8 or 15 ohms. Input 110-230v 50-60 Hz. Amplifier suitable for any use where sound amplification is required.

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ELMOTHOLYTEX, 4 MFD 500 v. BRS60, 1/2-each. 36/- each. NEW STOCK.

P.M. SPEAKERS, 8/12, with transformer, in wall case. £3-10-0 each.

POWER UNIT, employing a 25GF and a high voltage rectifier 6Y5/6,00, together with a 1 v. condenser, 22 K. and other components. 12½ net free.

TELEVISION UNIT, 8EP stages; 1 detector and 1 video amplifier, complete with 4 valves, adjustable iron core coils, etc., brand new, only 65/-.

PLAN POSITION INDICATOR UNIT. Brand new! Ex-U.S. Navy. Employing 40 useful valves. 2 Cathode Ray tubes, 2 Monitor tubes, 12 diodes, 12 milliammeters, etc. The following are the valves: 13 6N7GT, 2 6L6GT, 2 6L6, 6 6L4G, 1 5H45, 1 25AVG, 1 72AVG, 2 25GT.

SPECIAL PRICE £15-0-0.

SLOW MOTION DIAL. With Vernier 001-1 reduction. Front of panel mounting.

WINTERHEAD SLOW MOTION DRIVES, ratio 501, 6/8 each.

AMR SNOOKS KIT, including 22 Valves individually boxed, 16 6N7T, 2 6L6T, 2 1210, also many useful relays, Rectifiers, Condensers, and a Dynamo set with extended outputs to work as a powerful motor on 300-550 A.C. mains without alteration. 125 items in all, brand new, properly packed. V.G. complete.

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CRYSTAL MULTIPLIER UNIT, 8 to 30 Mc/s with switch diodes, 807 Oscillator and tuning control. Brand new with 2 807 valves, instruction books, etc. 55/- each.

SENSITIVE Meters. Full scale 25 Microamps. 2 jm. dial, scaled 0-500, 5700 each.

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We specialise in AMATEURS' WINDINGS, TRANSFORMERS, ALL TYPES, CHOKES, PICK-UP COILS, INSTRUMENT COILS, Etc.

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Here is a new development of importance to all users of speciality capacitors. HUNT-INGRAM CAPACITORS, previously marketed as “Ingram-Mycalex”—are now available with the pooled marketing and technical resources of the two companies behind them. For heavy duty work and limited space, Hunt-Ingram Capacitors offer great advantages and show savings in costs where they can be applied. Available in standard units or made to order for special requirements, both mechanically and electrically, in a wide variety of shapes. For Blocking and Bypass in High Frequency Heating and Radio Transmission; High Altitude Airborne Equipment; Delay Networks in Pulse Circuits; Voltage Dividers; Stabilising Units, etc.

**TYPICAL STANDARD UNITS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Cap. (pF)</th>
<th>Overall Dim (x x x)</th>
<th>Approx. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1A</td>
<td>10,000</td>
<td>6½” x 13” x ½”</td>
<td>7 lb, 3 oz.</td>
</tr>
<tr>
<td></td>
<td>5,000</td>
<td>6½” x 13” x ½”</td>
<td>5 lb, 14 oz.</td>
</tr>
<tr>
<td>Full load: 70 kVA at 500 KC to 10 MC per sec. Peak Wkg. 10 kV.</td>
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</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Cap. (pF)</th>
<th>Overall Dim (x x x)</th>
<th>Approx. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4A</td>
<td>150</td>
<td>2” x 4½” x ½”</td>
<td>5 oz.</td>
</tr>
<tr>
<td>Full load: 8 kVA at 500 KC to 10 MC per sec. Peak Wkg. 15 kV.</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Full list and details on application.

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ESTABLISHED 1901
“You’re CERTAIN to get it at ARTHURS!”

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

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- Avo Model 7, high resistance...... £19 10 0
- Valve Tester.......................... £16 10 0
- Test bridge.......................... £11 0 0
- Avo Minor, AC/DC model.............. £8 10 0
- Electronic Test Macer................ £35 0 0
- Signal Generator..................... £25 0 0
- Taylors Meters. List on request.
- Decca Pick-ups........................ £6 14 6
- Decca Head for Gerrard.............. £4 11 0
- Adaptors................................ 3 0

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**The Twenty Million Megohmmeter.** A new instrument for Research and Industry. Covers the entire resistance range from 0.3 to 20,000,000 M.C.G. Ohms. Two test voltages, 85 and 500, are provided. A six-inch mirror scale enables readings to be taken accurately and quickly. Designed for testing cables, resistors, capacitors and all insulating materials.

**Lawrences.** Special High Quality Transformers for Television. E.H.T. Type TV/9. Primary 230 v. 50c. Secondaries 0-5, 500 v. at 8mA. 2-5kV at 4A. Fully impregnated. Upright mounting. 25/-.

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BAFFLE SPEAKERS

These new Stentorians were a sensation at the B.I.F. — everyone who saw and heard them agreed that they are unequalled for value, reproduction and appearance.

Compare them with any other make of speaker, and remember, that both the Beaufort and Bristol have press-button remote control for use with the "Long Arm," an exclusive Whiteley feature. All three are finished in highly-polished walnut veneer.

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Size 12½" x 10½" x 3½". Permanent magnet type speaker (die-cast unit). 6" diam. Capacity 3 watts. Constant impedance volume control. Price £3.15.0 (with transformer). £3.7.6 (without transformer).

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Size 10½" x 9½" x 3½". P.M. Unit 6". Capacity 3 watts. Constant impedance volume control. Price £2.19.6 (with transformer). £2.13.6 (without transformer).

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Size 9½" x 8½" x 3½". P.M. Unit 5". Capacity 2½ watts. Complete with volume control. Price £2.5.6 (with transformer). £1.19.6 (without transformer).

NO PURCHASE TAX

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REMOTE CONTROL

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MAGNETIC T.V. PARTS

We were fortunate last month in being able to obtain a set of T.V. parts which were made by a famous Company for a television manufacturer who, unintentionally, purchased for the "castle." These parts which are suitable for 120, 100, or 12.5 m. magnetic tubes are offered to you at approximately half of the present day cost. The units concerned are:-(1) A 24 inch frame on which are mounted the frame and line deflection coils, and the focus coils. (2) An E.H.T. Transformer. A diagram showing the wiring of a suitable circuit. The necessary values for this circuit, which are H.P. Factors, can be obtained from us. Of course, you can't have to stick to the original circuit. Any conventional circuit will do equally well.

In view of the set of 6 items as listed above is only £10, 10s, 0d., and as a limited number only are available, we suggest that you order by return.

- Lists of the supply the circuit separately at 20/6. per copy and further we will deduct the £10, if you buy the kit within 2 weeks.

**Electrolytic Condensers.** (Only new stock from best manufacturers.)

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
<td>2 mfd. 450 v.</td>
<td>1/6</td>
</tr>
<tr>
<td>8 mfd. 450 v.</td>
<td>1/6</td>
</tr>
<tr>
<td>16 mfd. 450 v.</td>
<td>1/6</td>
</tr>
<tr>
<td>8 X 8 mfd. 450 v.</td>
<td>1/6</td>
</tr>
<tr>
<td>16 X 16 mfd. 450 v.</td>
<td>1/6</td>
</tr>
<tr>
<td>32 X 32 mfd. 450 v.</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Midget Transformer.** 3-pole, 0.00005, fitted with transformer, and complete with perspex dust cover. These condensers made by "Plessey" are of the type used for tuning professional receivers. Price is 6/6, plus 1/6 postage.

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**TELESONIC RECEIVERS,** brand new, complete with four 1.5 v. Hiva Midget valves ideal for making your own personal portable 32/6. Each paid.

**INSERT 1.5 v. CELL BATTERIES,** long life, fill with plain water and have continuous use. Ideal for every purpose. 3 for 2/6. Paid.

**MAKE YOUR OWN CRYSTAL SET,** with polished terminal box complete with volume control, resistance, etc. 1/6 each. Paid.

S. KERSHAW
93/95 PERSHORE STREET, BIRMINGHAM, S.

**ELECTROMAGNETIC PHONE INSERTS**

- Miniature 60 Ω permanent magnet balanced armature units. Reed drive, corrugated metal diaphragm. As used in Admiralty sound-powered telephone handsets, giving instant communication without batteries or transformers. Each paid.
- Paddock 3 gang trimmers, ceramic armature units. Reed drive, corrugated used for toning personnel receivers. Price 6/6, plus 6d. postage.

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- STANDARD SIGNAL GENERATOR TYPE 59-A. By B.B. 0 to 16,000 cycles on two dials, 0 to 600 v. or 0 to 10,000 cycles on one dial, with modulator. Price £20.
- STANDARD SIGNAL GENERATOR TYPE 91.00. By Tufnol, Rod. Formed from pure copper. Price £20.
- STANDARD SIGNAL GENERATOR TYPE 59-A. By B.B. 0 to 16,000 cycles on two dials, 0 to 600 v. or 0 to 10,000 cycles on one dial, with modulator. Price £25.
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(496)
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R.T.M.C. (Ealing), Ltd., pioneers of the Williamson amplifier, new range. Our most recent development, R.T.M.C. 1-5, has been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions on which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NOW AVAILABLE

Partridge News

-And in oil if required-

Illustrated is a typical Partridge Transformer (Type DN) in its Muncat Screening Box. It is mentioned with rary to remind you that all Partridge Precision Components (standard or "to specification" types) are now available as hermetically sealed units.

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**Radiograms**

- **Price list of components and equipment.**
- **British Valves and B. & Sons.**
- **J. Bull & Sons - Universal Types.**
- **Wireless World Advertisements.**
- **July, 1949.**

**Equivalent Chart with Quick Reference Index, 1/8.**

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**Control Boxes for BO48 and BO48 Receivers.**

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- **For motion drive on existing spindle.**
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- **£17.3.**
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Type DT.4

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Sensitivity: At 1000 Kc/s 400 cos. 80 % mod. (straight) 3 millivols for 1 volt R.M.S. (ave.), 1 microvolt for 1 volt R.M.S. (ave.).

Max. undistorted output in both cases 1 volt R.M.S.

Supply required: 250 v. 30 ma. 6.3 v. 2amps.

Controls: Tuning, Volume, Tone, Wave-change and Selectivity (T.R.F. or Superhet).

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This is a most type U.K.A. jamming transmitter, con-
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