Components of undoubted MERIT

The range of "WEARITE" time-proven products embodies all your needs in Mains Transformers, I.F. and Miniature I.F. Transformers, "HYPERLOY" Chokes, Vibrators, Coils and Ceramic Switches. Your dealer should be able to supply from stock. If any difficulty, write to us giving his name. If you haven't yet had our Catalogue giving full information on "WEARITE" Components, write today.
This is a miniature all-glass single-ended heptode with a filament consumption one twelfth that of a pen-torch bulb. An obvious role for it is in portable receivers, especially of the "personal" calibre.

In this country the triode-hexode is so popular that not everybody may be sure how to use the heptode, or pentagrid, particularly as there are several different kinds. So here are a few notes on the DK91.

The prescribed range of H.T. voltage is 45 to 90, but $g_2+g_4$ (used as the oscillator anode) must be limited to 67½, by a dropping resistor if necessary.

This skeleton circuit diagram is merely to show how the valve should be connected; the details of tuning arrangements can follow conventional lines. An alternative scheme, for making the whole mutual conductance of the valve effective in the oscillator, is to take the + H.T. lead from the I.F. transformer via the oscillator reaction coil instead of direct. Any voltage-dropping resistor must be inserted on the $g_2+g_4$ side of the reaction coil and shunted by the by-pass capacitor. It is then not available for sharing with the screen of the I.F. valve.

Normally, however, the oscillator section is quite capable of providing sufficient amplitude without help from the I.F. anode. Such help, too, is liable to be varied by A.G.C. bias on $g_3$.

The amplitude of oscillation is not at all critical, and there is little to be gained by striving earnestly to keep it at optimum all the time; it is generally more important to economise in H.T. current. The amplitude is measured by a micro-ammeter in series with $R_1$. Although 200µA is recommended, the effective optimum, with $V_{g_2+g_4}=45$ or so, is nearer 100µA, and there is not much loss of signal even at 50µA. Fortunately the optimum increases with $V_{g_2+g_4}$. The less oscillator voltage on $g_2+g_4$ the better; the reaction coil should be comparatively small.

A.G.C. may be applied to the DK91; the grid base is roughly one fifth of $V_{g_2+g_4}$. It is important that the $g_3$-to-cathode impedance at oscillator frequency should be low, otherwise the action of $g_3$ may be upset by oscillator voltage from $g_2+g_4$. It is true that it can be neutralized out by a few pF from $g_1$ to $g_3$, but there is no need for this complication if the previous condition is fulfilled.

This is the seventeenth of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from the address below. Technical Data Sheets on the DK91 and other valves are also available.

THE MULLARD WIRELESS SERVICE CO. LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

Advert of the Mullard Wireless Service Co. Ltd.
Business Radio

As we told our readers last month, "business radio" is the term that has now been officially chosen to describe low-power radio-telephone communication systems as used by public utility vehicle and car-hire services, newspapers, towage companies, doctors, etc. The term seems to be an unhappy one—just another example of our seeming inability in the world of wireless to coin the apt name for the new thing. Perhaps our readers can think of something better before it is too late to prevent the title from passing into the language.

But enough of terminology; though the name may be bad, the thing itself is good. More precisely, it is all to the good that radio communication is being extended into fields where it can add to the comforts, amenities and efficiency of life, though perhaps on a rather more humble and less spectacular plane than in some of its older applications. So far as this country is concerned, the kind of radio communication that we are now considering is virtually new: the Post Office, as the supreme licensing authority, has hitherto tended to regard the less serious uses of radio with some disfavour. We are glad that the official attitude has now changed, and that the G.P.O. is now giving sympathetic consideration to applications from all kinds of potential users. The task of allotting licences must be an unenviable one, as many of the applications are apparently of the type that can only be described as frivolous. It is certainly not the intention of Wireless World to advocate the granting of licences for anything approaching such purposes; radio channels are too precious for that, and a "free for all" in the part of the spectrum allocated to low-power telephone services would in the long run be disastrous.

While the whole matter is admittedly in the experimental stage it would perhaps be unwise to enquire too closely into the principles under which licences are, or should be, allotted. On the broadest issue, the good of the community as a whole must clearly come first. Also, no wireless man nowadays will quarrel with the principle that radio licences should be withheld when other means of communication are adequate.

The position at present seems to be that channels are allotted in relation to the nature of the intended communication and its estimated importance. Thus, a service of the highest importance is granted, so far as possible, an exclusive channel, while those with less substantial claims must share with a large number of other users. This should provide a workable basis for the scheme as a start; indeed, it would be almost impossible to devise any other system with so many points in its favour. By balancing importance of the proposed service against exclusiveness of the channel allocated the dispensation of a rough-and-ready kind of justice between applicants should be made fairly easy. The alternative—summary refusal of a licence for purposes judged to be unimportant—would be likely to lead to greater injustice, and would restrict the natural growth of the service.

Problems of Control

Nobody wishes to see "business radio" entangled in a maze of red tape, especially at this early stage, but fairly close control is clearly essential. The problem, as usual in communications, is to pack as much interchange of useful information as possible into the minimum number of channels. The less important users of the service can rarely expect anything approaching exclusive channels: there must be a good deal of sharing and "waiting turns." This implies some knowledge of, and experience in, the niceties of operating procedure. There must also be a strict ban on "chatter."

Maintenance of the apparatus is likely to present a problem, and we suggest that in this matter something may be learned from the early days of wireless. It would probably suit many users—especially the smaller ones—to obtain their gear on a hire and maintenance contract rather than by outright purchase.
SOME of the Government-surplus radar units now on the market lend themselves admirably to conversion to an oscilloscope. In particular, the Admiralty Type 6A or 6B and the R.A.F. Type 10QB/24 are suitable for this, and these three units are essentially identical.

The cathode-ray tube is of the electrostatic type with a 64-in green screen of short persistence; its type number is VCR97 (= CV1097). The unit includes four VR91 (= CV1091 = Mullard EF50) valves and three VR54 (= CV1054 = Mullard EB34) valves, as well as a large number of capacitors, resistors, and potentiometers, and most of the parts in it find application in a conversion.

There are many ways in which such a conversion can be performed and the type of oscilloscope circuit adopted must depend on two factors—the main purpose for which the oscilloscope is required and the material available. It was decided in this case to make the oscilloscope of the general-purpose type, but to bear in mind the particular requirements of television. These last demand an especially good frequency response at low and high frequencies and the ability to handle a wide range of input voltages. In addition, means must be provided for supplying the time-base generator with a synchronizing input of suitable phase, since with the pulse waveforms of television a particular phase of input is desirable for a good lock.

The complete circuit diagram of the oscilloscope is shown in Fig. 1. Everything, apart from the power supply, is included on the original radar chassis and the power supply is built on a new chassis beneath it. It will be seen that the signal amplifier comprises three EF50 valves and provides a push-pull output. The synchronizing signal is taken from the output of the

SOMESORT SIGNAL

This front view shows the controls.

**Signal Amplifier.**—The first valve $V_1$ is a straightforward amplifier having a variable resistor $R_3$ in its cathode lead which functions as a gain control. It provides a range of control of approximately 70:1. The coupling resistor $R_4$ is given a fairly low value (3.5 kΩ) in order to secure a good high-frequency response.

The output of this stage is taken to $V_2$ which forms the input valve of a paraphase pair. The input to the second is secured from the resistance network $R_6$, $R_7$, $R_{16}$ and $R_{11}$ joining the two anodes. Because of the low value coupling

**General**

**Signal Amplifier.**—The first valve $V_1$ is a straightforward amplifier having a variable resistor $R_3$ in its cathode lead which functions as a gain control. It provides a range of control of approximately 70:1. The coupling resistor $R_4$ is given a fairly low value (3.5 kΩ) in order to secure a good high-frequency response.

The output of this stage is taken to $V_2$ which forms the input valve of a paraphase pair. The input to the second is secured from the resistance network $R_6$, $R_7$, $R_{16}$ and $R_{11}$ joining the two anodes. Because of the low value coupling resistors $R_7$ and $R_{14}$ and the un-bypassed cathode resistors $R_9$ and $R_{19}$ the inherent stage gains are not high. A balanced output from the stage is not obtained, therefore, by feeding the grid of $V_2$ from the junction of equal value resistors between the valve anodes. Accordingly, while on one side the resistance is 30 kΩ ($R_8$) on the other it is 37 kΩ and comprises $R_{19}$ of 30 kΩ in series with the parallel combination of $R_9$ and $R_{11}$ of 10 kΩ and 20 kΩ respectively.

An output is taken from the slider of $R_{11}$ through a buffer stage $V_3$ to the saw-tooth oscillator for synchronizing. The voltages to earth at the two ends
of R₁₁ are approximately equal but of opposite phase and the centre is at earth potential. Consequently zero sync signal is obtained with the slider at the centre. Turning the control one way gives a sync signal of one phase, turning it the other way gives one of opposite phase.

The anodes of V₅ and V₆ are coupled to the horizontal deflector plates of the tube through C₆ and C₇ via the switch S₂. This enables the deflector plates to be disconnected from the amplifier and joined instead to an alternative input, "Input 2." This is desirable when the oscilloscope is used for the examination of large voltages. With the amplifier in circuit a range of input voltages of approximately 0.05-35 V p-p is catered for, by means of the gain control ratio of 70:1 and a 10:1 change of picture size. Without the amplifier the range is extended up to 120 V p-p, since the deflection sensitivity for the voltage used is 12 V per cm. Input 2 is not, of course, push-pull.

When the amplifier is in circuit the response is limited by the intervalve couplings, but is adequate down to 50 c/s. At the high-frequency end it is -3 dB at 550 kc/s, 6 dB at 950 c/s and -20 dB at 3 Mc/s. It is adequate for all normal purposes in investigating the pulse waveforms encountered in television equipment.

**Time-Base.** The oscillator V₁₆ generates a saw-tooth waveform which is applied to the grid of V₅, and feeds the first valve V₆ of the paraphase pair V₅ and V₆. The input circuit to V₅ is somewhat

---

**Modifying an Ex-Government Radar Unit**

By J. F. O. VAUGHAN

is a Transistor-Miller integrator. The frequency coverage is from 12.5 c/s to 10 kc/s obtained in three ranges by means of S₃ and S₄, the fine control being by R₂₄. The series resistor R₉ limits the frequency range provided by R₂₄. Sufficient overlap between ranges is still obtained, however, and its inclusion prevents the very rapid change in frequency which would otherwise occur at low values of R₂₄. It is also necessary as a safety measure, for if it were omitted it would be possible to connect the grid of V₅ direct to +H.T. with the probability of damage to V₅.

The output of V₅ is a negative-going saw-tooth at the anode and feeds the first valve V₆ of the paraphase pair V₅ and V₆. The input circuit to V₅ is somewhat
General-Purpose Oscilloscope—

unusual and the circuit is similar
in form to that of the paraphase
valve V7. A pair of resistances
R26 and R27 is connected between
the anodes of V4 and V5 and the grid
of V5 is fed from a tapping
through C14. Negative feedback
occurs to a degree depending
on the position of the slider on R26
and this acts as a sweep amplitude
control. Since except at full
amplitude, which is rarely
needed, C14 and R26 are within the feed-
back loop their effective time
constant is greatly increased and
the coupling causes very little
distortion even at 124 c/s.
Because the anodes of V4 and
V7 are substantially the same as
that in the signal amplifier, but
the coupling resistors R25 and R35
are increased to 10 kΩ since a
lower limit of high-frequency
response is sufficient. Because of
the higher value resistors a large
output is obtainable and is useful,
since it permits expansion of the
centre of the sweep to examine
details of waveforms. Two equal
resistors R31, R33 are used for the
paraphase feed, but one is shunted
by R32 to produce the inequality
needed for balanced output.
The tube is fed through C16 and
C17, and here the finite time
constant does introduce some
distortion of the sweep waveform
at very low frequencies. If
desired, this distortion can be

Two pictures of the radar
chassis before modification
are given here—a
general top view on the
left and an under-chassis
view above.

The circuit diagram of the original Indicator Unit Type 6A or 6B is given here for convenience in identifying parts.
Other similar units differ slightly in detail.
and it is biased by $R_{14}$ of 5 kΩ in its cathode. This value of resistor is necessary in order to limit the anode current of $V_4$ to a value which does not interfere with the operation of $V_5$. If a lower value is used, $V_5$ will not oscillate unless there is a synchronizing signal of some sort. $R_{18}$ is not bypassed, as there is no need to obtain maximum gain from the valve.

Prevent any feedback from the oscillator into the signal amplifier. Such feedback would produce a distorted trace. $V_4$ has its anode tied directly to the screen of $V_5$.

$R_{19}$ (100 kΩ) in the screen is inserted merely to limit the screen current. No bypass capacitor is used here, either.

C.R. Tube. The X- and Y-shifts are obtained from $R_{28}$ and $R_{47}$ respectively. These are connected to the H.T. supply of the signal amplifier and there is about 100 volts across them. This is sufficient to move the trace in the vertical direction from top to bottom edge of the screen, but owing to the lower sensitivity of the tube in the X-direction, it can shift the time base sideways by only about half the screen diameter. This is usually sufficient, however, to enable any part of the waveform under examination to be brought to the

(Top left) This view of the modified chassis shows the sync valve $V_4$ and the switch and terminals for Input 2.
(Top right) An underview of the chassis showing the timebase components. (Bottom left) In this view the parts of the signal amplifier can be seen. The control shaft of $R_{28}$ has been removed for clarity. (Bottom right) Here the general arrangement of the parts above the chassis is clearly shown.
General Purposes Oscilloscope—
centre of the tube. Owing to the very long time constants (2½
seconds) of the couplings to the X-plates, it takes several seconds
for the trace to come to rest after the X-shift control has been
moved.

The potentiometer which supplies the tube voltages is the same
as in the original circuit, except

that the value of the brightness control, \( R_{45} \), has been changed
from 500 kΩ to 100 kΩ. The former value gives too critical a
control. To avoid further changes the value of 500 kΩ is maintained
by inserting a 470-kΩ resistor in series with \( R_{49} \). This means that
a small proportion of the available E.H.T. voltage is wasted, but this
is unimportant as the trace is

adequately bright and the focus is
quite good. The purpose of \( R_{44} \)
of 39 kΩ is to provide a minimum
bias. The two ends of \( R_{41} \) (across
the brightness control resistors)
are bypassed to earth by \( C_{19} \) and
\( C_{24} \). These two capacitors have

not to withstand the full E.H.T.
voltage. The grid is decoupled
to the cathode by \( C_{18} \). This

resistor \( R_{44} \) in series with the C.R. tube grid is part of

the original wiring. It has been

left in so that, by disconnecting
\( C_{18} \) modulation can be applied to
the grid if required.

Power Supplies. The E.H.T.
supply is provided by \( T_1 \) which has an
E.H.T. winding of 1,000 V
R.M.S. a rectifier L.T. winding of
4 volts tapped at 2 volts, and a
tube heating winding of 4 volts.
The tapping on the rectifier L.T.
winding is to enable either 2- or
4-volt rectifiers to be used as
desired; the unused lead should
be taped or otherwise safely insulated. Smoothing is provided
by \( C_{25} \) and \( C_{26} \) separated by \( R_{42} \).
From the circuit diagram it can be
seen that \( C_{24} \) and \( C_{25} \) are in
parallel. More of this later.

\( T_4 \) supplies H.T. and L.T. to
the signal amplifier and time base.
The H.T. winding is 330–0–350 V
R.M.S. The rectifier L.T. winding
is 5 volts tapped at 4 volts to
enable 4- or 5-volt rectifiers to be
used (again the unused lead should
be taped) and the valve-heater
winding is 0.3 volts. Owing to the
very low frequency at which it is
sometimes necessary to run the
base-time it has been found that
separate smoothing for the H.T.
feeds to the time-base and signal amplifiers is essential as other-
wise the consequent cross-talk
results in a curved trace. \( C_{29} \) and
\( C_{34} \) are two sections of an 8–8-μF
electrolytic capacitor. \( C_{29} \) and \( C_{34} \)
are each similar 8–8-μF capaci-
tors having the two sections
joined together to form 16-μF
capacitors. \( L_2 \) and \( L_3 \) are the
separate smoothing chokes for the
time-base and signal amplifier
respectively; \( L_1 \) is the common
first filter choke.

The three output leads from the
E.H.T. supply are all at high
to voltage to chassis but have only

---

**LIST OF COMPONENTS**

- **Resistors**
  - \( R_{11}, R_{22}, R_{23}, R_{41} \)
  - \( R_{12}, R_{13}, R_{20}, R_{26} \)
  - \( R_{13}, R_{24}, R_{29}, R_{30} \)
  - \( R_{47}, R_{10}, R_{34} \)
  - \( R_{32}, R_{31}, R_{32}, R_{36} \)
  - \( R_{21} \)
  - \( R_{33} \)
  - \( R_{38} \)
  - \( R_{48} \)
  - \( R_{49} \)
  - \( R_{50} \)
  - \( R_{52}, R_{53} \)

- **Capacitors**
  - \( C_{2}, C_{3}, C_{10}, C_{11}, C_{12}, C_{29} \)
  - \( C_{24}, C_{25}, C_{26} \)
  - \( C_{28} \)
  - \( C_{29} \)
  - \( C_{30} \)

- **Valves**
  - \( V_1, V_2 \)
  - \( V_3 \)
  - \( V_4 \)

- **Transformers and Chokes**
  - \( T_1 \)
  - \( T_2 \)
  - \( L_1, L_2, L_3 \)

- **Valveholders and Plugs**
  - B9G wafer-type for \( V_1 \), \( V_2 \), \( V_3 \), \( V_4 \)
  - Belling-Lee

---

**Wireless World** May, 1948

**www.americanradiohistory.com**
are in parallel, the latter on the power supply chassis, and the former on the oscilloscope chassis. This component was left in place as it acts as a useful anchorage for one end of \( R_{51} \). The capacitor \( C_{25} \) in the power unit is necessary, however, as 0.02 \( \mu F \) would not be enough for smoothing purposes.

The photographs show that the C.R.T. chassis is supported by the front panel, and by two strong brackets at the rear. Aluminium has been used for these parts, as well as for the power-pack chassis, as it is easy to work, and strong enough to carry the weight. The clearance between the two decks is just enough to accommodate the chokes and the transformers. The capacitors \( C_{14} \) and \( C_{15} \) are mounted above the chassis, and as the upper frequency limit is only 10 kc/s the capacitance to chassis of these components does not have any detrimental effect. The arrangement relieves congestion below the chassis. The other capacitors \( C_{14} \) and \( C_{15} \) are metal-cased tubular types mounted beneath the chassis.

Great care must be taken to maintain good insulation of the leads connected to the grid of the oscillator. If there is a leak to chassis oscillations may cease when \( R_{44} \) exceeds a certain value, as the operation of the circuit depends upon the tendency of the grid potential to rise to the + H.T. level.

Care must also be taken over insulation in all circuits where 5-M\( \Omega \) resistors are used and, in particular, of \( R_{43} \) and associate components. Excessive surface leakage in the case of the 5-M\( \Omega \) resistors will affect the low-frequency response adversely, while leakage across \( R_{51} \) will make it impossible to black out the trace.

No provision has been made in this model to enable direct connections to be made to the X- and Y-plates, since it is not often needed in ordinary work. If it is needed for any special purpose the modifications are obvious.

No arrangements for blacking out the trace during flyback are included because simple methods have a certain drawback. If it is desired, it can be fitted by including a 5-k\( \Omega \) resistor in the grid lead of the tube and connecting a 50-pF, 1,500 V capacitor from the tube grid to the anode of \( V_{6} \). The saw-tooth is positive-going on the anode of \( V_{6} \) and the capacitor and resistor differentiate it and produce a pulse waveform on the tube grid which is negative-going on the flyback.

This simple scheme works excellently, but has the defect that the brightness of the trace varies considerably with the setting of the Fine Frequency Control. This is because the flyback time tends to be independent of frequency, so the scan/flyback ratio decreases with frequency, and in the derived pulse wave the mean level alters. The effect could doubtless be overcome by using a D.C. restoring diode at the tube grid, but this seems a complication which is hardly worth while.

**Anti-Interference**

Two reports dealing with the subject of electrical interference with radio reception have recently been issued by the Educational Research Association (15, Savoy Street, London, W.C.2).

"The Measurement of Radio Interference by the Modified Reception Set R206, Mark 1," describes the conversion into an interference measuring set of an ex-Army receiver. A limited number of these receivers will be made available for industry. The report costs 13s 6d.

"Radio Interference Tests on an Electrified Railway" (price 1s 6d), details measurements of interference in the frequency range 0.6-5 Mc/s at various points and at varying distances from the track.
Dry Battery Developments

The R.M. Mercury Cell

By R. W. HALLOWS, M.A. Cantab, M.I.E.E.

There can be no doubt that there is a real demand today for a primary dry cell of greater efficiency than those which are passed over the counter in response to our demands for "refills" for our pocket flash-lamps, or to replace the run-down H.T.B.'s (and it may be the filament-heating batteries) of portable wireless receivers, or those of the stationary type, which must be used when and where no suitable mains supplies of current are available. Nor is it only the consumer who has this feeling. Designers of a multitude of different kinds of valve-operated devices, intended to be independent of mains supplies, have long held that they were being let down by those whose advances in the realm of primary cells might have been expected to keep pace with progress in electronics.

The cold, hard facts are: (1) that the only type of dry primary cell now generally available is identical, save for minor improvements, with that used by our grandfathers; and (2) that, apart from air-depolarizer types (whose size and weight rule them out for use in portable apparatus) Leclanché cells suffer from the defect that the depolarizer never, so to speak, catches up with its job. In other words, the internal resistance of the cell rises steadily under discharge, with a consequent drop in E.M.F. To fall into line with the vicious circles and vicious spirals of which so much is heard nowadays, we may describe the discharge curve of such a cell, under intermittent load, as a vicious saw-tooth! The tip of no tooth is quite as high as that of the one immediately before it; the valleys between the teeth reach continually lower levels as the discharge periods follow one another.

The dry Leclanché cell has its good points. It is reasonably cheap to produce and fairly light; in use it is as nearly trouble-free as makes no matter; its shelf-life is reasonably good in its usual form, and, if made up in inert form, it can be stored for years with little deterioration. But, though valve designers have done wonders in producing battery-operated valves which continue to perform remarkably well despite a falling off in both filament and anode voltages, that vicious saw-tooth discharge curve is a very big, bad wolf.

I am far from saying that the Ruben mercury cell, developed by the P. R. Mallory Company of Indianapolis, U.S.A., gives all the answers to our prayers. It doesn't.

![Fig. 1. Discharge curves of a mercury cell 1.19in dia. and 0.46in deep, weighing 1.1 oz.](image)

To begin with it costs more than the dry Leclanché cell. Again, its open-circuit E.M.F. is only 1.34V compared with the rather over 1.5V of the Leclanché. But it represents an entirely new cell, constructed on lines different from those of any other; and a cell roughly 5in in diameter by 7in deep, weighing just over 3oz, will supply 31mA continuously for 37 hours with a closed-circuit voltage of 1.0-1.2V. A smaller cell of half the weight will furnish 18mA within the same voltage limits for a similar period. A larger type, with a weight still well under the ounce, has a life (to a cut-off of 1V) of 60 hours under a load of 32mA, 76 hours at 25mA and 91 hours at 20mA. Fig. 1 shows discharge curves for the largest type of mercury cell. This is 1.19in in diameter by 0.46in in depth and weighs 1.1 oz.

Figs. 2 and 3 show two different methods of cell construction. In the rolled-anode cell (Fig. 2) the negative element is a strip of zinc foil, placed between two strips of alkali-resistant absorbent paper and rolled up. The paper serves to hold the electrolyte, a solution of caustic potash (KOH). The zinc roll is separated by a barrier of dense, alkali-resistant dialysis paper from the depolarizing anode, which consists of a pellet of mercuric oxide (HgO). The copper cover of the cell makes direct contact with the zinc anode and so forms the negative terminal. It is insulated by a scaling gasket of synthetic rubber from the steel can, which is in direct contact with the cathode and forms the positive connection.

The pressed-powder-anode cell (Fig. 3) is basically similar, save that its anode consists of a pellet of powdered zinc.

It will be noticed that the cell is the exact opposite of the dry Leclanché in that its can is positive. Another constructional difference which makes for increased compactness, is this. In the Leclanché cell the bulkiest component is the sac of depolarizer surrounding the cathode. This is eliminated, since the mercuric oxide cathode helps to produce an automatic depolarization within the cell.

The chemical reactions in the cell are of a very complex nature and they have not yet been fully worked out. The authors of a paper read before the Electrochemical Society of America last year admit this. "They give, at the same time, some exceedingly

interesting facts about the working of the cell. They show, for example, that from 80% to 90% of the active materials of the cell are used up during discharge. Compare this with the Leclanché dry cell, which always "dies" with much of its zinc unconsumed.

The Ruben-Mallory (R.M.) cell is symbolized as follows by the authors of the paper mentioned:

\[
\text{Zn} / \text{Zn(OH)}_2(s), \text{KOH (aq)}, \text{HgO(s)} / \text{Hg}
\]

where \(s\) = solid and \(aq\) = aqueous.

The overall reaction is:

\[
\text{Zn} + \text{H}_2\text{O} + \text{HgO} \rightarrow \text{Zn(OH)}_2 + \text{Hg} + \uparrow \text{ZnO} + \text{H}_2\text{O}.
\]

No ingredients will suffice for the making of a dry cell of practical value unless they are such that a condition of chemical equilibrium is reached and maintained when the cell is on open circuit. To put it in another way, the electrolyte must, on open circuit, quickly reach a condition in which it is unable to attack the zinc. This happens in the Leclanché cell because very shortly after the introduction of the electrolyte of sal ammoniac (NH₄Cl) and water, the solution becomes saturated with positive ions of zinc chloride: mutual repulsion, therefore, prevents the entry of further such ions into the electrolyte—until the cell is put on closed circuit.

In the mercury cell equilibrium is reached rather slowly after a complicated series of reactions. Immediately after it has been made the O.C. voltage is about 1.36. This falls sharply to a little above 1.35 within 24 hours. There is then a further slower fall to the normal O.C. voltage of 1.34. It is known that zinc oxide and potassium zincate are formed during this "settling down" period.

When the cell is placed under load sufficient zincate ions are available to make the oxidation products almost entirely ZnO and Zn(OH)₂: there is hardly any possibility of the formation of gaseous hydrogen.

The internal resistance of the cell is not stated, but from the flash currents (that is the peak currents registered on momentary connection to an ammeter) as given by the makers it would appear to be higher than that of a small Leclanché cell. Flash currents range from 0.5-0.8A for the smallest R.M. cells to 1.1-1.8A for the largest. From good-quality Leclanché cells of the sizes used in H.T.B.'s of various capacities one usually obtains flash currents of from about 2A to 5A. The important point, however, is that the internal resistance of the R.M. cell remains substantially constant under loads of approximately 100mA per square inch of cathode surface area.

The shelf-life of the cell is good. Tests made on cells stored for two years and three years show results little inferior to those given by cells of the same batches shortly after manufacture.

To sum up: the R.M. cell is revolutionary in its design (no other cell has electrodes and electrolyte completely sealed in a metal case) and in its performance (no dry cell now in use can match the constancy of its E.M.F. under heavy loads); but is it going to revolutionize methods of L.T. and H.T. supply in portable apparatus? It was so used very satisfactorily by the American fighting services during the war; but in wartime expense is not often a primary consideration. I welcome the R.M. cell because it represents a breakaway from accepted methods and accepted standards of far too long standing. I do not believe that in its present form and at its present price it is likely to oust the dry Leclanché cell. But the new ideas which it incorporates are capable of interesting developments and it may well point the way to the really efficient dry cell for which we have for so long been waiting.

**Addendum**

By D. W. Thomasson

Mercury cells are now being made by Mallory Batteries, Ltd., of Belfast: the only British-made cell commercially available at the present time is the RMB-3. This single-cell unit measures \(\frac{1}{8}\) in diameter and \(\frac{1}{2}\) in height, and is stated to have an average
Dry Battery Developments—capacity of 1.45 ampere-hours. The maximum continuous drain is 65 mA, but much heavier currents may be drawn intermittently. Internal resistance is of the order of 2.5 Ω.

This cell has been used to some extent for hearing aids, and is especially suitable for use with the new sub-miniature valves being produced by Mullard and Hivac. One cell suffices for four amplifier valves of this type, or two amplifiers and one output.

It has also been used to provide a comparison standard in a pocket instrument for the measurement of light transmission. The high voltage stability is of considerable value here.

No HT batteries made up from these cells are available, but production to special order would be considered.

The British-made cell is shown here actual size.

Discharge curves for British-made Mallory cell. Discharge rate, 65mA; recovery discharge 1mA.

The photograph shows the general appearance of the cell and the graph indicates the high voltage stability.

The “Phasitron”

Application in Sound Amplification

As a result of investigations into the causes of parasitic oscillations in frequency changers (see Wireless World, August 10th, 1939) J. A. Sargrove has evolved a sensitive method of detecting small phase differences. When an R.F. voltage is applied to the suppressor grid (Gs) of a pentode under certain conditions, a voltage of similar frequency is induced at the working grid (G2), due to electrons which, by virtue of their velocity, are able to penetrate the positive screen grid (G3) and impinge on G2.

If a tuned circuit is connected between G2 and earth, the phase of the induced voltage varies as the circuit is tuned through resonance, and the anode current of the valve which depends upon the relative phase of the voltages on G2 and G3, fluctuates first above and then below its mean value. The anode current/phase characteristic includes a steep straight portion which is chosen for the operating point, and it is then possible to record minute changes of capacitance in the tuned circuit. The efficiency of indication is proportional to the square of the mean frequency and at 40 Mc/s the full length of the anode-current/phase characteristic is swept for a change of 0.1 pF.

The system responds to step changes of capacitance and can be used as an ultra-micrometer. When used in association with a condenser microphone the frequency response could be flat from zero to 1 Mc/s (sub-sonic as well as super-sonic) depending on the mechanical characteristics of the diaphragm. The upper limit is set by the filter circuits necessary to eliminate the R.F. component of the output.

At a meeting of the British Kinematograph Society on March 10th, J. A. Sargrove, in collaboration with D. A. Ball and N. Leivers, read a Paper on “Phase Modulation Principles Applied to Sound Recording” in which a new condenser microphone for film recording studios incorporating the “Phasitron” system of amplification was described. The condenser diaphragm is only 3/16 in diameter and causes the minimum disturbance of the sound field. It was pointed out that as the excitation is at 40 Mc/s it might be possible to radiate the microphone output from a small folded dipole and so have a number of microphones, working on slightly different frequencies, hidden on the film “set,” with a remote pickup and mixing control unit behind the cameras, thus obviating the complication of overhead booms and trailing cables.


This, the 25th edition of the amateur Radio Relay League of America’s Handbook, has been completely revised and now contains 25 chapters of theoretical and practical matter. It reflects the growing interest of American amateurs in V.H.F. and microwaves, containing as it does practical descriptions of apparatus for use on frequencies up to 21,000 Mc/s.

V.H.F. is dealt with far more comprehensively than hitherto but not at the expense of the still ever popular H.F. bands. Transmitters and receivers to suit all needs are to be found in chapters 5 to 10 inclusive.

The data on American type valves is as comprehensive as ever and this year a table of klystrons has been added. There are two pages of tabular matter on cathode-ray tubes and several of the types listed were used in American Service equipment.

The Handbook is obtainable in this country from A. F. Bird, 60, Chandos Place, London, W.C.2, at 17s 3d including postage, or it can be ordered through the Radio Society of Great Britain (for delivery direct from the U.S.A.) at 12s 6d including postage.
Rectifier's it's plain to see can be BRIMARIZED with an *SB3

THE Brimar metal rectifier type SB3 is a big brother to the popular SB2 and is rated at 250 volts, 65mA. It is fitted with an insulated bracket and may be mounted horizontally on chassis or cabinet as required.

The SB3 will replace the 117Z6GT in the usual American AC/DC/Battery receiver and will substitute for the rectifier sections of types 117N7GT, 117P7GT and 117L/M7GT. In such receivers, the filament supply for the battery valves is taken from the rectified H.T. via a suitable dropping resistor.

After Brimarizing, the H.T. should be between 80 and 100 volts and this must give 1.4 volts across each filament section. To obtain these readings the line cord may need adjustment, an average value being 800 ohms for a mains input of 230 volts.

If modulation hum is present, it may often be eliminated by fitting an 8 mF condenser between the screen grid (Pin 4) of 1A7G and chassis.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CHANGE SOCKET</th>
<th>OTHER WORK NECESSARY</th>
<th>PERFORMANCE CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>117Z6GT</td>
<td>International Octal</td>
<td>1. Fit rectifier Type SB3. 2. Connect +ve (Red) tag to Pins 4 and 8 of Valve Socket. 3. Connect -ve (Black) tag to Pins 3 and 5 of Valve Socket.</td>
<td>Receiver will function almost immediately on switching &quot;on,&quot; no warm-up time being necessary.</td>
</tr>
<tr>
<td>NO CHANGE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IMPORTANT: The SB3 is a direct replacement for the rectifier type RD189/11 used in the new "Double Decca" and Collaro "Microgram."

Supplies of Type SB3 may be obtained via your wholesaler from: Standard Telephones and Cables Limited, Valve Works, Footscray. Retail price: 10/6 each.

BRIMAR RADIO VALVES

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

The next issue will BRIMARIZE Types 117L/M7GT, 117N7GT & 117P7GT
This is a 10-valve amplifier for recording and play-back purposes for which we claim an overall distortion of only 0.01 per cent., as measured on a distortion factor meter at middle frequencies for a 10-watt output. The internal noise and amplitude distortion are thus negligible and the response is flat plus or minus nothing from 50 to 20,000 c/s and a maximum of .5 db down at 20 c/s.

A triple-screened input transformer for 7½ to 15 ohms is provided and the amplifier is push-pull throughout, terminating in cathode-follower triodes with additional feedback. The input needed for 15 watts output is only 0.7 millivolt on microphone and 7 millivolts on gramophone. The output transformer can be switched from 15 ohms to 2,000 ohms, for recording purposes, the measured damping factor being 40 times in each case.

Built-in switched record compensation networks are provided for each listening level on the front panel, together with overload indicator switch, scratch compensation control and fuse. All inputs and outputs are at the rear of the chassis.

Send for full details of Amplifier type AD/47

C.P.20A. 15 WATT AMPLIFIER

for 12 volt battery and A.C. Mains operation. This improved version has switch change-over from A.C. to D.C. and "stand by" positions and only consumes 5½ amperes from 12 volt battery. Fitted mu-metal shielded microphone transformer for 15 ohm microphone, and provision for crystal or moving iron pick-up with tone control for bass and top and outputs for 7.5 and 15 ohms. Complete in steel case with valves.

As illustrated. Price £28 0 0

RECORD REPRODUCER

This is a development of the A.C.20 amplifier with special attention to low noise level, good response (30-18,000 cps.) and low harmonic distortion (1 per cent. at 10 watts). Suitable for any type of pick-up with switch for record compensation, double negative feedback circuit to minimise distortion generated by speaker. Has fitted plug to supply 6.3 v. 3 amp. L.T. and 300 v. 30 m/a H.T. to a mixer or feeder unit.

Television E.H.T. Supply

2.—Voltage Multipliers: New Low-voltage Input Circuit

By A. H. B. WALKER, B.Sc. (Hons.), A.M.I.E.E.
(Research Laboratory, Westinghouse Brake and Signal Company)

In the first article¹ the performance requirements of a good E.H.T. supply were considered and three alternative systems were discussed. These were (a) E.H.T. mains transformer and rectifier, (b) R.F. power oscillator and rectifier and (c) Pulse-driven voltage-multiplier fed from the line output transformer. In addition to the last two methods of dispensing with the E.H.T. mains transformer, the writer has recently proposed a multiplier-circuit which achieves the same object by producing E.H.T. from the normal centre-tapped H.T. transformer without using an excessive number of multiplying stages.

Almost all present-day television receivers include a mains transformer having a centre-tapped H.T. winding for the provision of the anode supply to the receiver and time-base valves. This transformer is usually wound for 350-0-350 volts. Consequently...

---

¹ Wireless World, April 1948.

---

Fig. 6. Principle of operation of the Cockcroft-Walton voltage multiplier.
Television E.H.T. Supply—

ly most sets have available a 700-volt A.C. supply with an earthed centre tap, and it would be very useful if this could be used to produce an E.H.T. supply by some form of voltage multiplier. This cannot be achieved economically with conventional multiplier circuits, but in order to follow the development of the proposed system it is useful first to consider a normal Cockroft multiplier and to analyse its operation.

Cockroft Multiplier. A single half-wave section is shown in Fig. 6 (a), and in (b) the various potentials with respect to earth are illustrated as waveforms. The voltage to earth at point A is the transformer voltage as shown in Fig. 6 (b), but since capacitor C₁ soon becomes charged to the peak of the supply voltage, the voltage to earth at B is the same input voltage as at A, but with the addition of the steady charge on C₁, so that the positive peak reached at B is the original peak at A (= \( \sqrt{2} \) V) plus the charge on C₁; that is, a total of \( 2\sqrt{2} \) V. This peak voltage at B can easily be reached and stored by adding a further rectifier and capacitor as shown in Fig. 6 (c). At each cycle when point B reaches the peak, a current will flow into C₂ through MR₂ as shown, and will soon charge C₂ up to the peak voltage reached by point B (i.e., \( 2\sqrt{2} \) V). There will then be this steady voltage available at C without any superimposed alternating voltage [Fig. 6 (d)]. Thus far it has been easy going, but it is usually found more difficult to visualize the operation of the later stages. However, looking again at (d), it can be seen that, while point C remains at a steady positive potential, point B reaches earth potential once every cycle. Now, forgetting absolute voltages to earth for a moment, and thinking only of relative voltages, this means that once in every cycle, C becomes positive with respect to B to the extent of the full double-peak voltage of the input wave. When this happens there is no reason why a half-wave rectifier and capacitor should not be joined between C and B to take advantage of this fact, as it is a purely "local" matter concerning only the points B and C, and the relative potential between them. This has been done in Fig. 6 (e) with MR₃ and C₃, and just as in a normal half-wave circuit, forward current will flow through MR₃ as indicated, and C₃ will charge up to the peak of the voltage between C and B. The result is that the point D will remain permanently above point B at the maximum B, but that B sinks below C. We have now a steady charge in C₄ equal to \( 2\sqrt{2} \) V, and therefore the potential to earth of point D is easily obtained by adding this to the potential of point B. This is seen in Fig. 6 (f), and clearly, a peak of \( 4\sqrt{2} \) V to earth is reached by D every cycle. This peak voltage to earth can be rectified and stored by MR₄ and C₄ (just as the high peak voltage to earth of point B was rectified and stored by MR₂ and C₂), so that point E remains permanently at the peak reached by D once per cycle; i.e., \( 4\sqrt{2} \) V.

To recapitulate briefly, when the earthed end of the transformer is positive with respect to A, MR₁ charges C₁ to the relative peak between A and earth, and MR₃ charges C₃ to the relative peak between C and B; in the next half-cycle, when A is positive with respect to earth, MR₃ charges C₃ to the peak voltage reached by B, and MR₄ charges C₄ to the peak voltage reached by D. Naturally, any number of stages can be added, the only limitation being the voltage drop in the feed capacitors along the chain.

Series or Parallel Feed. Since in Fig. 6 (e) the alternating feed current to all the rectifiers has to be conveyed along the chain of series-connected capacitors, this current is greatest near the transformer, and decreases along
the cascade. It is, therefore, clearly desirable (particularly with a large number of stages) to use larger capacitors at the feed end, and to decrease the values progressively along the cascade.

This arrangement is known as a "series fed" multiplier, and although it ideally requires graded capacitance values, it has the advantage that all the capacitors (except \(C_1\)) can be rated for equal voltages. In Fig. 7 (a) this circuit is redrawn, but with the voltage and current distribution indicated, in order to bring out the points of difference from Fig. 7 (b) which shows the "parallel-fed" arrangement. In the parallel-fed circuit, all the feed capacitors are returned directly to the transformer, and have to carry equal currents (except the last); they can therefore be made equal in capacitance, but have to withstand progressively increasing voltages along the cascade as indicated in Fig. 7 (b).

Ripple and Regulation. From what has been said it will be apparent that the cascade multiplier is virtually a series of half-wave rectifier circuits, so contrived that each succeeding section rectifies and stores the peak-inverse voltage developed across the rectifier of the previous section. In a simple half-wave circuit the forward pulse of current through the rectifier which occurs once in each cycle, has to replace the charge given up by the capacitor to the load during the remainder of the cycle. The ripple voltage is, of course, due to the fact that the capacitor voltage must drop while it is being discharged, and must rise again during the recharging period. The extent of this voltage drop depends on the discharge current \(I\), the time of discharge \(t\), and the capacitance \(C\). If \(V_R\) is the ripple voltage, \(Q\) is the capacitor charge in coulombs and \(q\) is the change in charge, then

\[
q = It
\]

\[
Q = CV
\]

\[
V_R = \frac{q}{C} = \frac{It}{C}
\]

If \(f\) is the operating frequency, we may write \(t = 1/f\) hence

\[
V_R = \frac{I}{fC}
\]

Now, in the series-fed multiplier of Fig 6 (e), the total ripple voltage is the sum of the individual ripple voltages on \(C_2\) and \(C_3\), so that

\[
V_R = \frac{I}{fC_2} + \frac{I}{C_3} + \ldots + \frac{I}{C_n}
\]

and it can be shown that for a ripple voltage is roughly equal to the regulation voltage drop divided by the number of full stages \(n\).

E.H.T. from the Normal H.T. Transformer. When applying a multiplier to a normal 350-0-350 volt transformer, the first natural step is to connect the series-fed multiplier of Fig. 7 (a) to one-half of the normal transformer, as shown in Fig. 8, so that the earth side of the multiplier is joined to the transformer centre tap. This will produce E.H.T., but since only half the transformer winding is used, the number of stages required is excessive. For example, if a 350-0-350 volt transformer is used, the theoretical output per stage on no-load will be only \(\sqrt{2} \times 350 = 500\) volts, while the average stage output when loaded will be about 20 per cent lower, so that 12 or 14 stages will have to be used. Apart from this complication, the performance will be very poor, since, as we have seen above, the regulation increases as the square of the number of stages, and it would be quite impracticable to achieve the figure of 10 per cent per 100 micro-amperes change which we have seen is the worst regulation which can be tolerated (see Part 1).

In an attempt to improve

\[ \text{total of } n \text{ full stages (i.e., } 2n \text{ capacitors and } 2n \text{ rectifiers) } \]

\[ V_R = \frac{1}{fC} \cdot n \left( \frac{n+1}{2} \right) \quad (1) \]

This relationship shows that the ripple voltage can be reduced by reducing the load current or decreasing the capacitance values, but that the ripple increases with an increasing number of stages.

By a similar analysis it can also be shown that the voltage regulation \(V_d\) (or steady voltage drop from the theoretical output voltage), assuming perfect rectifiers, approximates to

\[ V_d = \frac{1}{fC} \cdot \frac{2n^3}{3} \quad (2) \]

By comparing equations (1) and (2) it is interesting to note that the

\[ \text{5} \times 350 (A.C.) + \text{350V(D.C.)} \]

Fig. 9. A series-fed multiplier connected across the whole centre-tapped transformer winding is also unsuitable for television, as 350 volts A.C. is added to the E.H.T. generated by the multiplier.
Television E.H.T. Supply—
matters the multiplier might be
connected across the whole
transformer winding as in Fig. 9.
This immediately halves the
number of stages required, and
improves the regulation by a
factor of 4, but unfortunately
half the transformer voltage (350
volts A.C.) becomes added to the
steady voltage produced by the
multiplier, so that the E.H.T.
output is unusable for television
purposes.

These difficulties can be over-
come by the new circuit* shown
in Fig. 10. Here two half-voltage
rectifier sections MR₁ and MR₂
are used at either end of the
cascade, thus enabling A.C. sym-
metry to be preserved, and pre-
venting any alternating voltage
from being injected into the high-
voltage output. Moreover, the
unwanted alternating voltages at
both ends of the multiplier now
become rectified by MR₁ and
for simplicity, together with two
half sections, but since these half
sections contribute to the output,
the total E.H.T. voltage is exactly
the same as if four full sections had
been used; i.e., 4√2 V. This
circuit can be fed, as it stands,
from an existing centre-tapped
transformer which is already feed-
ing a conventional centre-tapped
rectifier for normal H.T. purposes.
Thus, both H.T. and E.H.T.
supplies can be satisfactorily de-
erived from the same winding,
and they will have a common
earthed negative pole, as shown
in Fig. 11.

However, there is a further
modification which can be made
to the basic circuit of Fig. 10
which will enable a somewhat
higher output voltage to be ob-
tained without using any more
multiplier sections, and this is
shown in Fig. 12. Here the
feed-end half-section rectifier,
MR₁ (which, in Figs. 10 and 17,
was returned to earth) has been
connected to the rectifier valve
cathode. Owing to the presence
of the large reservoir capacitor
C₁, this point is virtually at earth
potential so far as alternating
voltages are concerned, so that
the operation of the multiplier
is not affected. The mean poten-
tial of the cathode, however, is
about 400 volts positive to earth,
so that this additional voltage
will be passed along the rectifier
cascade and will increase the
E.H.T. output voltage by the
same amount. It almost appears
that this advantage has been
obtained without any corresponding
cost, and this is almost true, but
in fact the voltages on C₁ and C₂
are both increased, as well as the
desired increase in voltage on
C₁. In general, if the total
transformer voltage is \( V_{\text{RMS}} \)
and the number of full section
rectifiers is \( 2n \), as before, the
theoretical open-circuit output
voltage will be \( \sqrt{2V (2n + 1.5)} \),
and the earlier calculations on
ripple voltage and regulation will
still apply to a first approximation.

Capacitor voltage ratings should
be as follows,
\[
C₁, \sqrt{2V}; \quad C₂, \sqrt{2V (2n + 1.5)}; \quad \text{all others} \ 2\sqrt{2V}.
\]

For the arrangement of Fig. 12, therefore, and
assuming a 350-0-350 volt sinusoidal input, the theoretical maximum
output would be 6.5 kV. C₁ would be rated at 1 kV and all
other capacitors at 2kV. These
voltages, however, are open circuit
figures, and assume no leakage

* Patents pending.
unit, which incorporates this circuit, has been designed with this in view. The complete circuit is shown in Fig. 13, together with the approximate distribution of potentials up the cascade when operating under load, and fed from a 350-0-350 volt transformer. In its mechanical form the rectifiers are mounted horizontally on one side of an insulating panel, while the feed capacitors are arranged vertically on the opposite side.

To protect the components from damage, and from electrostatically attracted dust, and also to reduce the risk of shock, the assembly is normally mounted in a housing consisting of a vertical tube of insulating material to which the moulded end plates are cemented, the E.H.T. terminal being brought out at the top. The base is designed for single hole fixing to the chassis, and three clearance holes are also required to accept the projecting bosses which carry the colour-coded input tags through the chassis. The chassis area required is less than that which would be occupied by an E.H.T. transformer with its associated rectifier, while advantage has been taken of the great headroom which is normally available in a television receiver on account of the large cathode-ray tube. The total weight is much less than the weight of an E.H.T. transformer, and apart from any other advantages, it is worth noting that no scarce materials, such as silicon steel or fine-gauge copper wire, are needed.

The regulation is shown in Fig. 14 and it can be seen that it is only approximately 7 per cent by our earlier definition, and this is well within the allowable limit of 10 per cent. The output ripple is very small, since rectification is full-wave instead of the usual half-wave, and no smoothing is necessary beyond the single reservoir capacitor, which should be 0.05 to 0.1 µF; no series smoothing resistor is needed. In fact, since the reservoir capacitor also acts as the feed capacitor to the final half-section rectifier, it is important to note that no resistor should be connected between it and the output terminal of the Westeht, or the E.H.T. voltage will be reduced, and the regulation will be impaired. Some reduction of output voltage is possible without affecting the regulation or reducing the input voltage by connecting the lead marked "yellow" in Fig. 13 to earth instead of to the rectifier-valve cathode; the circuit then becomes that of Fig. 11, and the E.H.T. voltage will be reduced by about 400 volts.

Summary — Future Trends. — Although it is perhaps unwise to attempt to forecast future developments in such a rapidly advancing subject, it is probably true to say that the recent development of miniature high-voltage metal rectifiers will result in the wider use of multiplier circuits in many varied forms. For low-priced receivers which do not include a mains transformer, the pulse multiplier operating from the line fly-back (Part 1) now appears very attractive; while for medium-priced receivers, and for the rapid servicing of sets with faulty E.H.T. transformers, the...

![Fig. 13. Complete Westeht (Model 1) circuit showing how the unit is fed from a conventional centre-tapped transformer and rectifier. The approximate distribution of potential on load is shown.](image)

"Westeht" unit offers advantages. For future requirements of 25 to 50 kV in projection receivers, the E.H.T. mains transformer and valve rectifier system becomes very bulky and heavy if adequately insulated, and it now seems very probable that it will be replaced by multiplier circuits using high-voltage metal rectifiers, or by specially developed high-frequency E.H.T. power packs.

![Fig. 14. Output voltage curves of typical Westeht unit for various input voltages.](image)
Physical Society's Exhibition

New Testing and Measuring Equipment

At the third post-war Exhibition of the Physical Society, held in London from 6th-9th April, the application of radio technique to non-communication purposes was prominent, as was the use of radar methods in other branches of physics. Generally, there was more emphasis on research and development than on production techniques.

Research Section

Examples of the travelling wave tube, which provides a new method of obtaining high amplification over a wide band at extra-high frequencies, were shown by G.E.C. and Standard Telephones. The S.T.C. tube was demonstrated under working conditions giving a 20 db gain at centimetre wavelengths.

Component parts of a miniature magnetron for the so-called Q band were displayed by Admiralty Experimental Establishments. With an external diameter of the same order as a standard receiving valve, this magnetron has a peak power output of 15 kW at a wavelength of 8 mm. An interesting demonstration of the optical properties of millimetre waves was given, using a detecting screen a copper plate with a pattern of \( \frac{1}{4} \lambda \) slots in an atmosphere of neon at 150 mm/Hg. Energy falling on the plate causes the slots to fill with the characteristic neon glow in the region of excitation. The demonstration included diffraction, change of polarization at reflection and focusing by metal lenses.

A sensitive D.C. amplifier making use of a magnetic transductor to modulate an A.C. source was shown by Ferranti. The sensitivity is greater than that obtainable from a moving-coil galvanometer and the instrument can be used under conditions of vibration which would rule out the use of a galvanometer. The principle can also be used for power control and examples of its application in this connection, with the gain increased by positive feedback, were demonstrated by Elliott Bros.

Methods of measurement formed a large proportion of the exhibits in the research section. The N.P.L. demonstrated the measurement of the velocity of propagation of electromagnetic waves by the frequency of resonance in a cylindrical cavity, and B.T.-H were showing a resonant cavity method of determining dielectric loss and permittivity. Ferranti magnetic amplifier.

A disc specimen of material under test is placed on the tuning piston of the cavity. The permittivity is obtained in terms of the change of resonant length of the cavity and the dielectric loss by the change in \( Q \) at resonance.

A simple method of impedance measurement giving results better than \( \pm 5 \) per cent in the frequency range 30-500 Mc/s was demonstrated by G.E.C. Research Laboratories. By using exponential capacitances in the ratio arms of the bridge a range of 1 to 100,000 ohms can be covered by a single scale. The impedance is compared with a standard 100-ohm resistor and a tuning head is provided so that the susceptance of the impedance to be measured can be tuned out, if desired.

The Post Office Engineering Dept. exhibited a speech transmission system used in determining the optimum characteristics of hearing aids, and also a probe microphone for use in conjunction with an artificial ear. They were also showing a speech spectrum integrator for measuring the total energy in a series of half-octave bands over a timed period. The method is used to determine the characteristics of...
microphones when held close to the mouth.

Apparatus for the investigation of architectural acoustics by the analysis of C.R.-tube traces of reflected sound pulses was demonstrated by Standard Telephone and Cables.

Marconi's W.T. Co. were showing equipment demonstrating a method of frequency-modulating a quartz crystal. The crystal itself is of special type and consists of a rectangular plate which is much larger than the electrodes and which is supported around its edges in a manner imposing a damping load. The active part of the crystal corresponds to the area covered by the electrodes and the surround bare quartz acts as a filter. By using the crystal in a special circuit a deviation of 1 part in 1,000 is possible.

Two pieces of apparatus designed to reduce the labour of routine measurements and applied to widely different subjects were noted. One was the polar diagram equipment for measuring centimetre aerials shown by Cossor, and the other a B/H curve tracer for magnetic materials by B.T.-H. Both depend upon the application of servo mechanisms and produce large-scale pen tracings on paper.

Many adaptations of radio and radar methods to other branches of physical science were noted. G.E.C. in conjunction with the Radio Therapeutic Research Unit of the Medical Research Council had in operation a linear accelerator employing a pulsed magnetron in conjunction with a wave guide and iris-loaded cylindrical resonator. The latter is virtually a succession of resonant cavities in which adjacent cells are designed to oscillate with a 180° phase difference when excited at the correct frequency. Electrons injected at one end of the resonator at a critical velocity are further accelerated to speeds approaching the velocity of light and energies of the order of 5 to 20 Mev. The difficulty of obtaining stable operation of the magnetron under the varying load (during the build-up period of the pulse) presented by the high Q of the resonator elements has been solved by careful design of the wave guide coupling system, which includes a stabilizing water load.

Radar technique has been applied by the Post Office to the location of faults in overhead lines by the examination of pulse reflections displayed on a C.R. tube. The equipment was shown in operation on an artificial line and photographs of characteristic responses demonstrated the effect of various faults.

B.T.-H demonstrated a relative velocity indicator operating on the radio Doppler principle which was employed in the proximity fuse. Indication was given on a meter calibrated directly in m.p.h.

Electronic counting methods have come into prominence recently in connection with nuclear research and an elaborate pulse amplitude analyser and counter for sorting the various responses of an ionisation chamber was shown in operation by the Atomic Energy Research Establishment Electronics Group.

**Trade Section**

**Valve-Voltmeters.** — The valve-voltmeter originally designed for A.F. and R.F. measurements is now being used as the nucleus of multi-range measuring instruments and other comprehensive test sets. Its high input impedance is particularly valuable for many D.C. voltage measurements for often a fraction of a milliamp load will lead to an ambiguous voltage reading.

Avo use a valve-millivoltmeter as the basis for their multi-range Electronic Tester and by so doing achieve a D.C. voltmeter resistance of 11 MΩ on all ranges up to 1,000 volts. A multiplier raises this to 110 MΩ and increases all ranges ten times. This instrument provides no fewer than 49 ranges of volts, current, power, resistance, capacitance, and R.F. voltage up to 200 Mc/s.

A valve-voltmeter is again the nucleus of the Micovac multi-range tester made by Electronic Instruments. As a D.C. or A.C. voltmeter the resistance is 1 MΩ per volt. This meter embodies a V.H.F. probe and R.F. voltage measurements can be made up to 200 Mc/s.

Metropolitan-Vickers adopt a similar principle in their multi-range test set, the valve-voltmeter being usable for R.F. measurements, while on the A.C. and D.C.
Physical Society's Exhibition—ranges the resistance is 4 kΩ per volt. A wide-range volt-ohmmeter of the same basic style having an A.F.-R.F. range of 50 c/s to 50 Mc/s, and using a detachable probe unit, was shown by Sifam.

A valve kilo-voltmeter has been designed by Rediffusion for use in research and development laboratories and for R.F. measurements on industrial electronic apparatus. By means of three auxiliary units, each covering two voltage ranges, provision is made for R.F. voltage measurements up to 15 kV and to 30 Mc/s.

A departure from customary practice was noticed in the Marconi Instruments Type TF899 valve milli-voltmeter, where a triode mounted in a probe is used in place of the more usual diode. It is usable up to 200 mV and in three ranges gives R.F. voltage measurements up to 200 mV.

Signal Generators.—The familiar standard signal generator, which at one time occupied a very prominent place among test equipment, appears to have retreated into the background this year and to have given way for more specialized types of R.F. and A.F. generators.

`surnal Laboratory showed a portable frequency standard using quartz crystal oscillator on 1 Mc/s with which is synchronized a series of multi-vibrators giving outputs of 1 kc/s, 10 kc/s and 100 kc/s respectively. All these generators are very rich in harmonics and together provide a wide range of check frequencies of high accuracy extending up to and beyond 50 Mc/s.

Several interesting A.F. generators have made their appearance, one by Elliott Bros. being a high-power precision generator covering a range of 40 to 2,500 c/s with a short-period stability of one part in 20,000. A voltage or current output up to a maximum of 75 VA is available, according to the nature of the test work to be undertaken.

For general A.F. testing Dawe Instruments have developed a range of resistance-tuned oscillators covering 0.1 c/s to 5 Mc/s. The lowest range is covered by the Type 400c which extends from 0.1 c/s to 1,000 c/s in four bands. It gives 100 mW output into 10,000 ohms, or 50 mW into 5,000 ohms and is balanced to earth.

An A.F. oscillator, described as Type F, for modulating R.F. signal generators was shown by Advance Components. It covers 5 to 10,000 c/s and gives 1 watt output which is maintained at ±2 db. The total harmonic and noise content is less than 3 per cent of the full output when measured at 1,000 c/s.

Another variable frequency generator, in this case covering 25 c/s to 100 kc/s and using an R-C oscillator circuit, was shown by Pye. The output can be monitored and it provides 20 volts into a 6,000 ohms line or 1.0 volt into 600 ohms as required. The total harmonic content is less than 1 per cent of the maximum output. All these oscillators are mains operated and the majority are self-contained, being reasonably compact and portable.

Bridges.—A compact and portable bridge for carrying out a wide range of measurements on components of various kinds was shown by Wayne-Kerr. Described as the Model BR1 Components Bridges it has the advantage that in most cases components can be measured in situ. It covers resistance from 2 Ω to 500 MΩ, capacitance from 2 pF to 500 pF, inductance from 0.1 µH to 5,000 H, all with an accuracy of less than ±2 per cent. It also covers leakage measurements on electrolytics, power factor and Q values.

Another very versatile bridge for
measurements at radio frequency is the General Purpose Bridge, Type 940162, shown by Pye. Made in three complementary units it provides inductance measurements from 10 to 20,000 µH, capacitance from 10 to 950 pF and resistance from 10 to 20,000 Ω. Components can be measured whose reactance changes from capacitative to inductance reactance according to the applied frequency and the critical frequency determined if within the range of the bridge oscillator. This covers 100 kc/s to 5 Mc/s with an accuracy of ±1 per cent.

For laboratory use Sullivan were showing an improved version of their direct-reading Universal Precision Inductance Bridge having an overall accuracy better than ±0.1 per cent and covering capacitance from 1 µH to 100 H and with attachments provides for the measurement of capacitance and inductance with superimposed D.C. at the same high order of accuracy.

A new item of measuring equipment shown also by Sullivan was a bridge for resistance measurements in either absolute or international units.

There were several self-contained wheatstone bridges incorporating the galvo and the battery, Pye in particular showing this style of apparatus.

A tendency towards the production of special power sources for energizing bridges is exemplified by the Sullivan Fixed-Frequency Oscillator. With an output of 1 W at three different impedance values, it can be supplied for frequencies of 800, 1000, or 1600 c/s.

Miscellaneous Measuring Apparatus.—A heterodyne wavemeter covering 100 kc/s to 20 Mc/s in eight switched ranges was seen on the Pye General Purpose R.F. Bridge, including oscillator, bridge and detector units. Normally they would be assembled side-by-side.

Pye General Purpose R.F. Bridge, including oscillator, bridge and detector units. Normally they would be assembled side-by-side.

from the R.F. oscillator is substantially pure in order to avoid ambiguity. Measurements are made by injecting the signal into the wavemeter and setting the internal circuits to resonance by the zero-beat method using headphones. It is essentially a precision instrument and the accuracy is better than ±0.2 per cent throughout. A crystal-controlled oscillator giving an output at either 10 kc/s or 100 kc/s and rich in harmonics is included for checking the calibration. Further examples of laboratory-type heterodyne wavemeters were included in Sullivan’s exhibit.

Another new piece of apparatus introduced recently by Plessey is an Impedance Meter for measurements on A.F. transformers and chokes. It operates on the principle of equalizing the voltage drop across a known resistance and the unknown, both being supplied from a source of A.C. at 400 c/s. Apart from a phase angle control only one other control is used and this is attached to a scale giving direct readings of impedance in ohms. The impedance range is 2-124 kΩ.

Some H.F. and V.H.F. bridges designed especially for impedance measurements on lines and aerials were shown by Wayne-Kerr. The former covered a range of 15 kc/s to 5 Mc/s, while the latter extended from 1 Mc/s to 100 Mc/s.

The pointer-type instruments which form the basis of so much test gear follow established lines in the main. There is a tendency towards the adoption of hermetic sealing and Ferranti exhibited a number in operation while immersed in boiling water.

Sifam have a model with a nominally logarithmic scale obtained through the use of a non-linear shunt, which acts also as an overload protector. An unusual instrument was shown by Nalder-Lipman; this is a meter with a 220° pointer movement. It is available in various sizes from 24 in to 12 in.

Components.—The Berco range of vitreous resistors has been extended by the addition of the Z type. These are of 42–375 W at 380°C rating and are in values of 0.15–32.2 Ω; they consist of a corrugated resistance strip wound on a ceramic tube. The standard type is now made with a blade-type fitting and the resistors are all of the same diameter but vary in length according to the value.

A power variable resistor in values up to 15 kΩ is available in ratings of 25–300 W. It has a detachable 4-in shaft so that the units can readily be ganged.

Wire-wound attenuators with an L.F. accuracy of ±0.1 db were
Physical Society's Exhibition—
shown by Langham Thompson and carbon types accurate within ±0.25 db. At 15 Mc/s and 30 Mc/s, the changes of accuracy are respectively claimed to be 0.25 db and 0.2 db. Sullivan were also showing attenuators of the T and H types, while Ferranti had miniature enclosed wire-wound variable resistors of precision design.

Special high-value resistors were shown by the G.E.C. Research Laboratories. Using as a conducting medium a toluene/alcohol/picric acid mixture resistors of low-temperature coefficient and a value of 10^8-10^18 Ω have been developed.

Relatively few new capacitor types were on view, but T.C.C. had a range of large-capacitance models intended for photo-flash equipment. Values of 14 μF at 2.5 kV intermittent rating are typical. This firm had also a range of components with plastic film dielectric for which exceptionally low leakage is claimed as well as a stable capacitance with time, low-power factor and low-dielectric hysteresis.

An unusual variable capacitor was shown by Labgear. A range of 5-25 pF is obtained by varying the separation of two circular discs by means of a micrometer—the capacitance change being 1 pF per 30 graduations of the barrel.

A range of thermally compensated mutual-inductance standards covering 10 μH to 0.01 H was shown by Sullivan.

Relays were shown by many firms and miniature types included the Electro Methods Type MIN which measures only 3 in x 3 in x 7 in and weighs 1 oz. There are two coils for series-parallel connection, and two models are available having coils of 100 or 350 Ω. With the latter in series connection the operating current is only 75 μA.

A wide range of centimetre-wave-components was exhibited on the Plessey stand. They included piston attenuators and wavemeters for cm-wave operation as well as crystal units, adjustable probes and connectors.

Valves.—A number of special-purpose valves shown by Ediswan included the 6F32 and 6F33. They are screened pentodes with sharp cut-off suppressor-grid characteristics intended for use in modulator, reactance and timing circuits. Cut-off is at about -8 V for the suppressor grid. In the case of the 6F33 positive drive on the suppressor grid is permissible, since a built-in diode is tied to it to prevent the grid from locking positive.

For use in stabilizer circuits there are the 29C1, a diode with a directly-heated tungsten filament, and the 12E1. The latter is a tetrode for series or shunt control in stabilized power units. With a maximum rating of 35 W dissipation, the operating limits are 700 V anode potential or 300 mA cathode current, while it will withstand 300 V between heater and cathode.

A neon tube designed for use as a voltage reference-level tube was shown by Mullard. It is the 85At with a burning voltage of 85.5 V and a short-term stability of 0.2 per cent; the variation between tubes is limited to 0.5 V. The well-known EF30 range of valves was shown, as well as the sub-miniature hearing-aid types.

Standard Telephones exhibited a number of gas-filled voltage-regulator valves which included sub-miniature types. This firm had on view a new selenium metal rectifier which is designed for use at radio frequencies up to 5 Mc/s, as well as their well-known range of power frequency types. Westinghouse featured the 36EHT copper-oxide rectifiers for low-current high-voltage rectification.

The M.O. Valve Company was showing a large number of types of all-glass construction, among which the 101-series is interesting in having heaters consuming only 0.1 A. The range includes a triode-hexode, X101, which is claimed to be useful up to 100 Mc/s. Sub-miniature pentodes with 25-mA filaments for hearing aids were shown.

Ferranti showed miniature high-voltage rectifiers as well as cold-cathode tubes and electrometer valves.

Cathode-ray tubes for oscilloscope and radar applications were shown by Ediswan and Cinema Television. Among the former were flat-ended types and some specimens that had...
Microwave Equipment

New Plessey Multi-Channel System

Developed for use where land-lines are impracticable, the Plessey microwave multi-channel radio communication system provides eight duplex speech channels. The equipment operates on the same basic principles as the Army No. 10 set and similarly uses pulse-width modulation and a paraboloid mirror at a wavelength of some 6 cm. The circuits used, however, differ considerably and of particular interest is the adoption of a common aerial system for transmission and reception.

The paraboloid reflector is fed from the rear by a waveguide projecting through the centre of the mirror. A dished reflector-plate is mounted in front of the waveguide mouth with its convex side facing it. The wave emerging from the guide is reflected back to the mirror by this plate and is then again reflected forwards to form the main radiated beam of some 4° in width. On reception the reverse action takes place.

The radiating system is connected to the equipment properly through a circular waveguide which can be of the flexible type. Separation of the transmitted and received waves is effected at the waveguide termination.

The principle depends on the use of polarization at 90° for send and receive; thus, if one wave is vertically polarized the other is horizontal. The waveguide, which carries both waves, terminates in a Y-branch in the two arms of which are included polarization filters. Within narrow limits these pass only waves of particular polarization. Beyond the filters the guides are terminated in resonant sections and coupled by probes to short lengths of coaxial lines for the connections to the equipment.

Velocity-modulated valves are used both for the transmitter and the receiver oscillators. The former develops some 400 mW peak power and is pulse modulated. The latter is operating continuously and kept to its correct frequency by an A.F.C. system operating on the received signal. A crystal mixer is used with a 6-stage wideband I.F. amplifier.

The pulse system comprises an 0-kc/s oscillator arranged to produce an 8-phase output which, in turn, controls a set of eight multivibrator pulse generators.

At a recent trial the equipment was installed, one on the roof of the telephone exchange at Hainault, Essex, and the other on the top floor of the Grandstand, at Epsom, Surrey, the distance being 25 miles. Eight duplex speech channels of excellent quality were obtained and cross-talk appeared to be quite absent. Some background hiss was evident but not to a degree which, in any way, impaired the intelligibility of speech.

Each channel has a response up to 4,000 c/s and can be used with ordinary terminal equipment to carry several teleprinter channels if required. Ringing facilities are included. The system allows for intermediate relay stations.

---


---

Block diagram of the signal-frequency and aerial systems.
WORLD OF WIRELESS

P.T. Increases • Extending Television • B.S.R.A. Conference • "Gee" Mechanics Wanted

PURCHASE TAX

Changes in the purchase tax chargeable on radio equipment were announced by the Chancellor of the Exchequer in his budget speech.

Radio receivers—whether of the domestic type, or for use in cars—radio-gramophones, television sets, kits of parts and valves are now chargeable at 60% per cent on the wholesale price instead of 50 per cent. Batteries and accumulators, other than dry batteries of not more than 6 volts, are still chargeable at 331/3 per cent. Hearing-aid batteries are exempt.

Loudspeakers, cabinets, transformers, resistances, etc., "when not sold as part of a transaction involving a chargeable receiver," remain untaxed, as do amplifiers, transmitters and hearing-aid valves.

The proposed increases will be the second in a few months. In the 1947 Emergency Budget the tax was increased from 331/3 per cent to 50 per cent. The industry rightly complains that the increases will have an adverse effect on it, especially as radio is a rapidly developing industry in which, when once ground is lost it is difficult to regain. Moreover, success in the export market depends on an adequate home market from the point of view of both research and production.

MIDLAND TELEVISION

Work on the construction of the first Midland television station began recently at Sutton Coldfield, near Birmingham, but no date can yet be given as to when it will be brought into service, neither has it been decided on what frequencies the sound and vision transmitters will operate. The 35-kW vision transmitter is being manufactured by E.M.I. and the 12-kW sound transmitter by Marconi's.

The station will transmit the same programme as that radiated from Alexandra Palace and it is the responsibility of the G.P.O. to provide the link between the two stations. In order that both cable and radio can be used experimentally in the initial stages a coaxial cable has been laid and, as already announced, the G.E.C. is erecting radio relay stations.

The radio link includes four relay stations situated at Harrow Weald, Dunstable, Blackdown Hill near Charvelton, and Rowley Regis, and terminal stations at the Museum Telephone Exchange, London, W.1, and at Telephone House, Birmingham. The programmes will be piped between the terminal stations and the main transmitters.

AERIALS

The importance of an efficient aerial has often been stressed in Wireless World and it is gratifying to find that the industry is recognizing this. The Radio Component Manufacturers' Federation has formed a Panel to consider the classification of broadcast receiving aerials. It is not proposed to produce rigid specifications for standardization but merely a classification by types specifying technical requirements.

The results of tests undertaken by manufacturers in various parts of the country are being collated and will form the basis of a report to be circulated to the B.B.C., G.P.O., and the industry.

TELEVISION AT B.I.F.

Exhibitors of television sets at the British Industries Fair at Olympia, will be the first to use the special reception aerial which is being erected by the Radio Industry Council on the roof of the exhibition building.

Some sixty or seventy manufacturers of radio equipment and accessories are exhibiting in the radio and scientific sections of the Fair at Olympia. In addition a number have taken stands in the engineering section at Birmingham.

The B.I.F. will be held simultaneously in London and Birmingham from May 3rd to 14th. Admission is by Trade Buyers' badge obtainable at the entrance price 2s 6d. The public will be admitted to Olympia on May 5th, 8th and 12th only.

RECORDING CONFERENCE

Disc, film and magnetic-tape recording and reproducing will be discussed and demonstrated at a conference being organized by the British Sound Recording Association. The conference, which will be preceded by the annual general meeting, will be held at the St. Ermin's Hotel, Caxton Street, London, S.W.1, on May 29th and 30th.

The A.G.M. begins at 2.15, and the conference opens at 4.30 with a paper on disc recording and reproduction. The annual dinner will be held at 7.15. The conference will continue on the second day with sessions at 11.0 and 2.30 on magnetic recording and sound on film, respectively. Demonstrations will be given at each session and throughout the conference recording and reproducing equipment will be on show. Admission is by ticket only.

Particulars are available from the hon. secretary, R. W. Lowden, "Wayford," Napoleon Avenue, Farnborough, Hants.

"BUSINESS RADIO"

The fifteen frequencies in the band between 67 and 87 Mc/s which, as stated last month, were to be made available for the use of the Press in the G.P.O.'s "Business Radio" scheme, have now been allocated.

The allocations have been made by the Joint Telecommunications

"RICE-GRAIN" VALVES are being developed in the laboratory of the U.S. Bureau of Standards. One is shown here in comparison with a miniature valve, a hearing-aid valve and an earlier "sub-miniature" type.
Committee of the Newspaper Society and the Newspaper Proprietors' Association and it now remains for the individual publishers to apply to the P.M.G. for licences. The allocations cover eighty provincial papers, eight nationals and two news agencies.

Owing to the limited range of the equipment permitted to be employed it has been possible to allocate the same frequency for use in different parts of the country.

Test flights will be made by two R.A.F. aircraft in order to measure the strength of signals at various ranges and heights. Meteorological observations will also be made as a result of which it is hoped to ascertain the relationship between the meteorological and propagational properties.

PERSONALITIES

E. F. Guest, technical development officer of H. J. Entwathen and Sons, manufacturers of "Superspeed" boxer, has been appointed to represent the company on the Inter-Service Radio Components Standardization Committee of the Ministry of Supply.

E. L. A. Mathias, O.I.E.C., who has been chief engineer and general manager of the Marconi Radio Telegraph Company of Egypt since its formation twenty-one years ago, has been appointed managing director. Prior to going to Egypt he was with Marconi's at Chelmsford for fourteen years. He is succeeded as general manager by P. T. Simpson.

J. W. Ryde, a senior physicist at the G.E.C. Research Laboratories, Wembley, has been elected a Fellow of the Royal Society. He has been a member of the scientific staff of the Laboratories since their formation twenty-nine years ago. His researches during the recent war were concerned with the attenuation and scattering of centimetric radio waves in various meteorological conditions.

A. Shore, A.M.I.E.E., has retired from Marconi's after 36 years' service. He joined the company's test department in 1912, was at one time assistant to the principal of the Marconi School and has later been in charge of the section producing technical literature.

Dr. R. C. G. Williams, who was recently appointed chief engineer of Philips Electrical, has been elected a Fellow of the Royal Institution of Electrical Engineers. He was for two years executive engineer to the North American Philips Company.

OBITUARY

We regret to record the death of Frank E. Butler, the American radio pioneer and associate of Dr. Lee de Forest, who recently died at his home in Toledo, Ohio, at the age of 70.

Piotr Nikolayevich Rybkin, who was an assistant of Popov, the Russian radio scientist, died in Kronstadt in February this year. For his services to the U.S.S.R. he was awarded the Order of Lenin and the Order of the Red Star.

IN BRIEF

Receiving Licences.—The number of licences in force in Great Britain and Northern Ireland at the end of February was approximately 11,233,500, including 43,500 television licences.

Exporting Television.—The Radio Industry Council is taking active steps to promote the export of television equipment and to this end transmitting gear is being installed in Copenhagen in order to demonstrate receivers during the British Exhibition to be held there in September.

U.S. Television.—The F.C.C. announces that at the end of 1947 there were seventeen television stations operating in the United States. Permission had been granted for a further 55 to be constructed and applications for another 84 were pending. The industry produced 178,571 television receivers last year, which was about one per cent of its total output of sets.

F.M. in U.S.—According to figures recently published in the U.S.A. there were, at the end of the year, 356 F.M. stations in operation. The production of F.M. receivers last year accounted for seven per cent of the industry's set output. The figures were: A.M. sets, 16,342,002; F.M., 1,175,104; television, 17,571.

Teaching by Example.—All the vehicles used by our Publishers, the Associated Life Press, and our Printers, the Cornwall Press, which, with staff cars, number seventy, have been fitted with interference suppressors in conformity with the campaign launched by the Radio Industry Council to impress upon motor users the need for suppressing television interference.

German Amateurs.—Although German amateurs are not yet licensed to operate, the Deutscher Amateur Radio Club has restarted publishing its journal Q. The first number contains a message from R. G. Shears, organizing secretary of amateur radio in the British Zone. The secretary of D.A.R.C. is Hann Haber, Holbeinstrasse, 27, Munich.

J. W. Ryde, of G.E.C. Research Laboratories becomes a F.R.S.

Radio Courses.—Among the courses available at the Cardiff Wireless College (3, Park Grove, Cardiff) is one for the City and Guilds amateur transmitters' examination. In addition to this evening course the College conducts full-time and post-graduate courses for the P.31/G's certificates in wireless telegraphy, civil aircraft radio officers' certificate, radio servicing and City and Guilds examinations.

Aircraft Radio.—For the purpose of assisting aircraft owners, manufacturers and maintenance organizations in obtaining approval of radio installations the Ministry of Civil Aviation has appointed Aircraft Radio Surveyors at

PUT TO THE TEST.—A tropicalized loudspeaker was suspended in a tank of water during the recent Paris radio components exhibition.

MECHANICS WANTED

WITH the completion of the Scottish "Gee" chain, which is expected to come into operational use during this summer, the Ministry of Civil Aviation will require additional radio mechanics to maintain the equipment. The stations are being erected at Great Dun Fell, Lowther Hill, Craigowl Hill and Ru Stafnish.

Applications are invited from men who have had practical experience in the maintenance of radio and/or radar equipment. Successful applicants are given four weeks training at the M.C.A. Signals Training Establishment at Bletchley Bucks, and start as Radio Mechanics, Grade II, at £5 15s a week.

Radio Mechanics are also required for the maintenance of radio and radar equipment in other parts of the country.

INVESTIGATING PROPAGATION

ANOMALOUS propagation, or "super-refraction," of radio waves is being investigated by physicists from the Telecommunications Research Establishment, who have gone to Malta where the necessary atmospheric conditions exist from about May to September.
**World of Wireless**

Croydon, Liverpool (Speke) and Prestwick airports, and also in Cairo. Applications for approval should be sent to the Director of Telecommunications, T.E. 7, Cornwall House, Stamford Street, London, S.E.1.

**European Broadcasting Stations.** According to figures issued by the International Broadcasting Organization there were 344 medium- and long-wave broadcasting stations operating in Europe at the end of last year.

India's New Stations.—Four new broadcasting stations have been opened in India during the past few months, bringing the number of medium-wave stations operated by All-India Radio to nine. The new stations are: Jullunder (1,333 kc/s), Cuttack (1,355 kc/s), Patna (1,314 kc/s) and Amritsar (1,305 kc/s). There is also one medium-wave station in each of the following four Indian States: Baroda, Mysore, Travancore and Hyderabad.

**“Trader Year Book.”**—The 1948 edition of this year book for the radio and electrical trade includes approximately 10,000 entries in its three directory sections giving trade addresses of manufacturers, proprietary names of products and a buyers’ guide to makers of equipment grouped under some 200 headings. In addition, such information as the mains voltages throughout this country, ratings for many towns overseas, condensed specifications of receivers introduced for the 1947-48 season, and a directory of trade associations is given. The book is obtainable from the Trader Publishing Company, Dorset House, Stamford Street, London, S.E.l, price 10s 6d post free.

**Meteorology and Radio.** Under the title “Meteorological Factors in Radio-Wave Propagation,” the Physical Society has issued a report on the conference held by the Physical and the Royal Meteorological Societies in April, 1947. This report is obtainable from the Physical Society, Lowther Gardens, London, S.W.1, price 2s.

**British Standards.** A synopsis of the 1,400 British Standards now current is contained in the 1947 Year Book of the British Standards Institution which has just been published. The 324-page volume, which includes a subject index and lists of members of the councils and industrial committees, is obtainable from the B.S.I., 24, Victoria Street, London, S.W.1, price 3s 6d.

**A Guide to the New Electricity Organization has been produced by our Associated Technical Journal.** A directory of the British Electricity Authority gives brief biographies of the officials. "Electricity Supply," as it is called, is obtainable, price 2s 6d (postage 2d), from Electrical Review Ltd., Dorset House, Stamford Street, London, S.E.1.

**F.B.I. Register.** We are informed that further supplies of the F.B.I. Register of British Manufacturers, the first post-war edition of which was recently issued, are available for the home and overseas markets. It is published by the Federation of British Industries, by Kelly’s Directories and Iliffe and Sons, price 2 gns.

**OUR COVER**

The subject for this month’s cover illustration is the V.H.F. frequency-modulated communication equipment recently installed by G.E.C. for the Madras City Police. The transmitter has a power of 100 watts.

**INDUSTRIAL NEWS**

**Philips** sound-reproducing equipment is to be made available on a rental/lease agreement. This addition to the normal outright sale method. The distribution of the equipment will be undertaken by the Modern Telephone Co., of 120, Tottenham Court Road, London, W.1, through appointed S.R.E. (sound-reproducing equipment) dealers, who will receive a share of the rental and may assist in the installation and maintenance.

**Pye**—To mark the 50th anniversary of the founding of the Pye Company the directors are inaugurating this month worth of television receivers to its workers. Two television sets are also being presented to each of the colleges at Cambridge University.

**Taylor Electrical Instruments** announce that their test equipment will in future be sold under the trade name of W. F. Taylor in order to enable it to be exported to markets hitherto closed because of the name conflicting with that of the Taylor Instrument Company of America.

**Raw Materials.**—Details of all raw materials controlled by the Board of Trade and the Ministry of Supply, together with the types of control at present operating and the addresses at which enquiries may be made, are given in the revised edition of "Raw Materials Guide," published by H. M. Stationery Office.

**Marconi** V.H.F. radiotelephone equipment has been installed at Douglas, Isle of Man, and on Merseyside for use in conjunction with radar for the control of shipping.

**R.C.A. in Britain.**—Arrangements have been made for enquiries regarding the engineering activities and products of the Radio Corporation of America to be dealt with in Great Britain by the Engineering Division of R.C.A. Photophone, Ltd. The address is 43, Berkeley Square, London, W.1.

**E.M.A.**—The first of a series of dinner meetings arranged by the Electronic Manufacturers’ Association was held on April 20th. The address of E.M.A. is now 53, Pall Mall, London, S.W.1.

**Partridge Transformers, Ltd.,** of 76-78, Petty France, London, S.W.1, has moved to Peckford Place, Brixton Road, London, S.W.9. (Tel.: Brixton 6960.)

United Insulator Company no longer has a factory at Leystall Street, London, E.C.I. All communications should be directed to Oakcroft Road, Tolywood, Surbiton, Surrey. (Tel.: Elmbridge 5241.)

**British Electronic Products.** The development and engineering sections of British Electronic Products, Ltd., of Moxley Road, Bilston, Staffs, have been transferred to Elstow Road, Rugeley, Staffs. (Tel.: Rugeley 130.)

**MEETINGS**


Cambridge Radio Group.—"Trophone Propagation," by H. G. Booker, M.A., Ph.D., on April 27th, at the Cavendish Laboratory, at 8.15.


**British Control on Birthday Lecture on "Electricity and Everyday." by P. Dunseath, C.B.E., M.A., D.Sc. (Eng.), on May 21st, at the Training College, Park Place, Dunce.

**British Institution of Radio Engineers London Section.**—"The Calculation of Electrode Temperatures in the Radio Valve," by I. A. Harris, on May 13th, at the London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1, at 6.


North-Western Section.—"The Wave Analysis of the Low Frequency Potentials of the Human Body," by W. E. Boyd, M.A., M.D., on May 13th, at the College of Technology (Reynolds Hall), Sackville Street, Manchester, at 6.45.


North-Eastern Section.—"Supervisory Control," by L. G. Brough, on May 12th, at the Neville Hall, Westgate Road, Newcastle-on-Tyne, at 6.

**Institution of Electronics North-West Section.**—"The Application of Electronics to Vibration Research," by D. M. Corke, on April 30th, at the Reynolds Hall, College of Technology, Manchester, at 6.30.


**CLUB NEWS** Unavoidably held over.
A SYSTEM of rather different character from the phase-splitters and phase-reversers must now be discussed. Two valves are used instead of one, but the pair does provide amplification. One valve is rather like a cathode-follower phase splitter. The input is applied to its grid and one output of opposite phase is taken from its anode. The cathode circuit provides a voltage of the same phase as the input which is used, not to provide the second output directly, but to drive a cathode-input amplifier stage. This cathode-input stage provides at its anode the second output in the same phase as its input. The basic circuit is shown in Fig. 23, which is complete except for grid bias arrangements. The mode of operation is quite simple and is most easily understood by considering a steady change of input voltage. Let terminal A become more positive than terminal B. The anode current of \( V_1 \) increases and so the voltage drops across \( R_1 \) and \( R_{a1} \) increase. Because of the latter the anode potential of \( V_1 \) becomes less positive and there is a negative-going output at the anode of \( V_2 \). The increased drop across \( R_2 \) makes the cathode potential become more positive than before. As the cathodes of both valves are joined together the cathode of \( V_2 \) also becomes more positive. Now the grid of \( V_2 \) is returned to the earth line, so that making its cathode potential change positively is the same thing as making its grid change negatively. Consequently the anode current of \( V_2 \) falls and its anode potential rises to provide the second output in the same phase as the input to \( V_1 \) and in opposite phase to the output of \( V_1 \). The alternating current through \( R_e \) is the difference between the two alternating anode currents of the two valves. If there is to be a voltage drop across \( R_e \) to provide an input to \( V_2 \), therefore, the currents cannot be equal. Consequently, if \( R_{a1} = R_{a2} \) and \( R_1 = R_2 \), the outputs \( E_{12} \) and \( E_{23} \) cannot be equal in magnitude. Equal output voltages demand unequal values of \( R_{a1} \) and \( R_{a2} \). If \( R_{a1} \) and \( R_{a2} \) are nearly equal, and the currents are nearly equal also, their difference is small. Consequently the value of \( R_e \) must be large. When the currents are nearly equal the grid-cathode voltages of the two valves will be nearly equal also, assuming similar valves. Therefore, the cathode-earth voltage will be nearly the same as the grid-cathode voltage of \( V_1 \) and each will be nearly one-half of the input voltage \( E_{AB} \). Now it will be clear that although the alternating anode currents are in opposite phase in \( R_e \), the direct anode currents are additive. The first necessitates a high value for \( R_e \) and the second means that this high value results in a large mean cathode potential relative to earth. If the heaters are earthed, and it is usually necessary to earth them to avoid hum, there is a large voltage (100-200 V) between the heater and cathode. It is necessary, therefore, to choose valves which will safely withstand it.

Because of this drawback, and because the amplification obtainable is about one-half of that given by other arrangements the circuit is not much used in A.F. amplifiers. All other forms of push-pull input circuit, except some of the simplest types described in Part I and of very limited application, demand the use of A.C. couplings; that is, either a transformer or coupling capacitors are needed to remove unequal steady potentials produced by the H.T. supply.

These A.C. couplings, and also decoupling circuits, make it difficult to secure balance at very low frequencies. However, conditions, are such that it is not difficult to secure adequate balance down to the lowest frequencies needed for the reproduction of music. Much lower frequencies are sometimes involved in the case of an amplifier for an oscilloscope, however, and it is here that the cathode-coupled circuit offers definite advantages. Coupling capacitors are not essential and,

---

Push-pull Input Circuits—
as a result, the response and balance can be maintained down
to zero frequency.

The circuit is shown in Fig. 24 devoid of coupling capacitors
and in Fig. 25 split into its
component parts. In Fig. 25 (a)
$V_I$ is shown and is evidently
a similar stage to a cathode-follower
phase splitter, the cathode load
comprising $R_c$ in shunt with the
input impedance of $V_2$. Fig. 25 (c)
shows the $V_2$ stage and is a simple
cathode-input amplifier (grounded-
grid stage). Figs. 25 (b) and (d)
show the equivalent circuits.

The circuit is analysed in
Appendix V. The input impedance
of $V_2$ [Equ. (3)] is very low and
in the limit tends to a minimum
value of $1/\beta_m^2$. The unbalance
is given by Equ. (10) and the
condition for zero unbalance by
(11). It is expressed in different
and more useful form in (13) and
this simple equation will repay some study. The term $x$
($= R_{a2}/R_{a1}$) represents the ratio of the coupling resistance to the
anode A.C. resistance of $V_2$, and
$y$ ($= R_c/R_{a2}$) represents the ratio
of the cathode-coupling resistance
to the anode A.C. resistance.

With triode valves the value of $x$ is usually around 2 to 3, but
with pentodes it will usually be
much less than 1. Again with
triodes $\mu_2$ will generally be about
$\beta_m^2 R_c = 99$. If $\beta_m^2 = 1 \text{mA/V}$,
$R_c$ must be $100 \text{k}\Omega$ and the mean
anode current will be about $1 \text{mA}$
per valve, so that the cathodes
will be $200 \text{V}$
above earth. If $\beta_m^2 = 6 \text{mA/V}$, $R_c$
need not be more
than $16 \text{k}\Omega$ or so,
but the current
per valve is not likely to be

![Fig. 26. This curve shows the relation between unbalance for equal values of of $R_{a1}$ and $R_{a2}$ or the fraction by which $R_{a1}$ must be less than $R_{a2}$ for balance as a function of $y = R_c/R_{a2}$ for the condition $\mu_2 = 29$ and $R_{a1}/R_{a2} = 2$.](image)

$20-40$, but with pentodes it will be
very large compared with $x$. With
the latter valves, therefore, Equ.
(13) can be reduced to
$\Delta R/R_{a2} = 1/(1 + R_{a2})$

If $R_{a1} = R_{a2}$ (i.e., $\Delta R = 0$),
the unbalance from Equ. (10)
becomes $1 - 1/(1 + R_{a2})$. For
$1$ per cent unbalance we get
than $7 \text{mA}$, so that the cathodes
will still be over $200 \text{V}$
above earth.

It is possible to reduce this
cathode-earth voltage by replacing
$R_c$ by a pentode valve. The A.C.
resistance of such a valve is much
higher than its D.C. resistance,
and the mean cathode potential
can then be kept down to some
$50-100 \text{V}$, while the effective
value of $R_c$ can be kept as high as
$0.1-1 \text{M}\Omega$.

Pentodes, however, are less
generally desirable than triodes at
low frequencies because of their
need for a screen supply of con-
stant voltage relative to cathode.
With triodes it is clearly desirable
to make $y(1 + \mu_2)/(1 + x)$ as
large as possible, and this means
$y$ and $\mu_2$ should be large and $x$
small.

In order to secure good linearity
$R_{a2}$ should normally be several
times $R_{a1}$, and the practical mini-
mum for $x = R_{a2}/R_{a1}$ is about 2.
If the frequency response must be
well maintained at high fre-
frequencies a large value of $r_{a2}$ is
undesirable when $R_{a2}$ is still larger.
A value of around $10-15 \text{k}\Omega$
is usually as high as is desirable.
With such a value $\mu_2$ will be
around $30$ in most cases. With
$x = 2$, and $\mu_2 = 29$, Equ. (13)

![Fig. 25. The first half of the circuit is shown at (a) with its equivalent at (b) while the second part, which has the form of a grounded-grid stage, appears at (c) with its equivalent at (d).](image)
becomes \( \Delta R/R_a = \frac{1}{1 + 10y} \) and \( \text{(10) becomes} \)

\[ U = 1 - \frac{R_{a1}}{R_{a2}} / [1 + 1/10y]. \]

If \( R_{a1} = R_{a2}, \) \( U = 1/[1 + 10y]. \)

The fractional change of resistance for balance and the unbalance for equal resistances are numerically the same. The curve of Fig. 26 shows how \( U \) and \( \Delta R/R_a \) vary with \( y = R_{a1}/R_{a2}. \) For 1 per cent unbalance it is necessary to have \( y = 0.9, \) and this usually means \( R_a \) is of the order of 100–150 k\( \Omega. \)

The voltage drop with this is excessive in most cases, and it is more usual to choose \( y \) around unity. The unbalance for equal values of \( R_{a1} \) and \( R_{a2} \) is then 12.5 per cent. This is large for A.F. amplifier applications, but may not be too great for an oscilloscope amplifier. Push-pull is here adopted more to avoid trapezium distortion than to obtain maximum undistorted output from the valves, although the increased output is naturally welcome.

With \( y = 1, \) \( R_a \) is some 10–15 k\( \Omega \) in most cases, and the mean voltage drop across it can often be kept down to 100 V or so. It is important to keep the voltage drop across \( R_a \) small, even apart from heater-cathode insulation difficulties, because it is subtracted from the H.T. supply, and when this is fixed it reduces the undistorted output.

The problem of grid bias must now be considered. A suitable arrangement for D.C. conditions is shown in Fig. 27. The grids are returned to a voltage-divider \( R_1, \) \( R_2 \) across the H.T. supply, the values being so chosen that the voltage drop across \( R_2 \) is less than that across \( R_1 \) by the amount of the bias needed. The earth-input terminal B is no longer H.T., but the junction of \( R_1 \) and \( R_2. \)

When the amplifier has to deal only with alternating voltages a capacitance can be included between \( A \) and the grid of \( V_1 \) with a grid leak from the grid to the junction of \( R_1 \) and \( R_2. \) The input can then be terminals \( A \) and \( 2. \) It is usual to shunt \( R_2 \) by a large capacitance to prevent any hum on the H.T. line from being applied to the grids.

An alternative bias circuit is shown in Fig. 28. Here grid leaks are returned to a tapping on the cathode resistor and the bias is the voltage drop across \( R_2. \) As long as \( C_g \) is large enough in relation to \( R_2 \) at the frequency concerned the effective value of \( R_e \) is \( R_3 + \frac{R_4 R_4}{R_2 + R_4}. \) However, if the frequency is low enough \( C_g \) introduces phase unbalance for, in effect, the grid of \( V_4 \) is returned, not to earth, but to the tapping on the potential divider formed by \( R_2 \) and \( C_g \) across \( R_4. \)

There is additional unbalance at all frequencies brought about by the presence of \( R_4 \) and it is similar to that found with the cathode-follower phase splitter (Part 2). If \( R_4 \) is kept large, however, it is unlikely to be serious.

At high frequencies stray capacitances greatly complicate the action of the circuit. The valve capacitances are shown in Fig. 29. Currents from the input flow through \( C_{g1} \) and \( C_{g2}. \) The former tends to reduce the output \( E_{12} \) and cause a phase error. The latter flows through \( R_e \) and tends to increase the cathode-earth voltage but again causes a phase error. The effective input capacitance resulting from these currents is \( C_{g3} \) and composed of two parts. Since the cathode-earth voltage is nearly equal to \( E_{AB}/2 \) the component due to \( C_{g2} \) is nearly \( C_{g1}/2. \) The component due to \( C_{g1} \) is nearly \( C_{g2}/2. \)

This diagram shows the various inter-electrode capacitances of the valves, which influence the performance at high frequencies.
Push-pull Input Circuits—parallel with \( R_{q1} \) and \( R_{q2} \) are likely to be nearly equal and so to have little effect on the balance.

In view of the fact that \( R_2 \) is shunted by the input impedance \( Z_{in2} \) of \( V_2 \), which is small, small values of \( C_e \) are unlikely to cause serious unbalance. It can be estimated from Eqn. (10) by writing \( R_e/(1 + j\omega C_e R_e) \) in place of \( R_e \).

Working out the phase unbalance on the lines of the preceding articles we find it is, approximately

\[
\omega C_e R_e \left[ \frac{1}{1 + \frac{j\omega C_e R_e}{1 + x}} \right]
\]

Taking \( y = 1, \ x = 2, \ \mu_2 = 29 \), the unbalance is \( \omega C_e R_e/11 \). If \( R_e = 10 \ \Omega \), \( C_e = 50 \ \mu\text{F} \) and \( f = 10 \ \text{kc/s} \), the unbalance is

\[
6.28 \times 10^4 \times 5 \times 10^{-11} \times 10^4/11 = 0.00285
\]

and is negligibly small.

APPENDIX V

Referring to Fig. (b) the second valve can be regarded as a cathode-input stage in which

\[ e_{ce} = e_{ce} = e_{ce} \]

Therefore,

\[
\begin{align*}
\mu_1 e_{ce} &= e_{ce}(1 + \mu_2) \quad \ldots (1) \\
E_{ce} &= \frac{e_{ce}}{(1 + \mu_2)} \quad \ldots (2)
\end{align*}
\]

\[
Z_{in2} = \frac{Z_c + R_{a2}}{R_e + Z_{in2}} \quad \ldots (4)
\]

and \( E_{ab} = e_{ce} + i_1 \equiv c_e \)

\[
\begin{align*}
\mu_1 e_{ce} &= i_2 (r_{a1} + R_{a1}) \quad \ldots (5) \\
E_{ab} &= \frac{e_{ce}}{(1 + \mu_2)} \quad \ldots (6)
\end{align*}
\]

\[
\begin{align*}
Z_c &= \frac{r_{a1} + R_{a1} + Z_c(1 + \mu_1)}{1 + \mu_1} \quad \ldots (7)
\end{align*}
\]

\[
E_{ce} = \frac{r_{a1} + R_{a1} + Z_c(1 + \mu_1)}{1 + \mu_1} \quad \ldots (8)
\]

The unbalance is

\[
U = 1 + \frac{E_{ce}}{E_{ce}} = 1 - \frac{R_{a1} + R_{a2} + Z_c(1 + \mu_1)}{R_{a1} + R_{a2}} \quad \ldots (9)
\]

For \( U = 0 \)

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_{a1} + R_{a2}}} \quad \ldots (10)
\]

If \( R_{a2} = x \) and \( R_c = y \), this can be written

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_c(1 + \mu_2)}}
\]

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_c(1 + \mu_2)}} \quad \ldots (11)
\]

Equation (11) becomes

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_c(1 + \mu_2)}}
\]

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_c(1 + \mu_2)}} \quad \ldots (12)
\]

Writing \( R_{a1} = R_{a2} - \Delta R, \) we get

\[
R_{a1} = \frac{R_{a2}}{1 + \frac{R_{a2}}{R_c(1 + \mu_2)}} \quad \ldots (13)
\]

Monitoring Loudspeakers

An interesting discussion of this subject, at a joint meeting of the French Sound Recording Association and the Acoustics Group of the Physical Society at the Royal Society of Arts, on March 11th, was opened by D. E. L. Shorter of the E.B.C. Research Dept. Mr. Shorter reviewed the methods by which the merit of a loudspeaker might be assessed. Measurements of loudspeaker response were easy to make, but difficult to interpret. What was needed was an instrument which would do the interpretation. Meanwhile, subjective listening tests, although not very scientific, provided the most reliable guide. For judging the highest quality of reproduction direct comparison with the original sound over a long period was necessary, but for somewhat lower standards a reduction in listening time could be effected by the use of successive recordings, and also by the use of a source of random noise. By re-recording a piece five or six times through the medium of a mediocre loudspeaker, its salient errors could be readily distinguished. Similarly, with the random noise source, the characteristic which would be coloured by what might be termed the formants of the loudspeaker tone.

Mr. Shorter did not subscribe to the "complacent mysticism" which surrounded the ear as a unique arbiter of quality of reproduction.

Requirements for Balance and Quality Control in Broadcasting and Recording Studios

One speaker drew attention to the possibility of intermodulation effects due to vibration in the fabric grille coverings which were commonly used; he favoured a rigid metal grille when some form of covering was desirable.

The possibility of using radically different physical effects, e.g., phonic arc flames, for electro-acoustic energy conversion was discussed, but it was thought that there was little prospect of the conventional forms of loudspeaker being superseded. No single source of sound could be small enough to avoid interference effects at high frequencies, and at the same time produce comparable sound intensities at low frequencies without creating pressures which would give rise to distortion in the transition from adiabatic to isothermal conditions.

Wireless World May, 1948

www.americanradiohistory.com
British made to an exacting tropical specification. Most standard items available from stock. Enquiries invited from Dealers and Wholesalers. If you need sound equipment, write or phone the Amplifier Sales Manager,
GOVERNMENT SURPLUS

TEST UNIT TYPE 78 consists of a special purpose Oscilloscope that requires only writing and the addition of a few condensers and resistors to convert into a standard Oscilloscope. Input 220 v. 50 e. A 1/16 c, B.I.M. tube and 1 X 2250, A, 1 X 334, 1 X 695, 3 X 841, 5 X 954, are included. Controls are "Brightness," "Velocity," X Shift," Y Shift," Focus Amplifier, "Invert," "Phase Shift," and "Gain." Carrying case, and packing 20.£.

METERS, are the best makers and are contained in balistc cases. Prices are about one-quarter the original cost.

ALL-WAVE SUPERHET KIT. A kit of parts to build a 6-valve (plus rectifier) receiver, covering 16-500 metres, medium and long waves. Valves comprising: 6L6, 6N7, 6H7, 6N7, two 264 and push-pull. Metal Rectifiers are incorporated for H.T. supply. Output impedance is for 3 and 15 ohms. The latest Weirey Coll Pack incorporating "Womb Unit Cells is used, making construction and alignment extremely simple. A pick-up plug on the wave switch with the kit is provided. A complete kit including valves but without speaker or loudspeaker. Price £11 16s.6d. overall height, 9 in. Price £11 16s.6d. inclusive. Is good.
THIS is a term I have more than once been asked to clarify, on the ground that beginners find it confusing. It is not at all surprising if they do, seeing that the highest authorities give quite a variety of different meanings to the word. The famous Dutch professor, Van der Pol, called attention to this in a lecture he gave before the I.E.E. After quoting a selection of the meanings which he had culled from about fifty books, he defined his own choice. As it is in mathematical form I will keep it till later, and start off with the British Standard definition, 2 which is quite consistent with it, but expressed in words, and rather more general in its scope.

The root of most difficulties with phase, I think, is vagueness about what it consists of. Is it time? Or is it an angle? Or is it something else? The British Standard has two alternative definitions of phase, as it exists "in an operation which recurs periodically." The first is very broad—"The stage or state to which the operation has proceeded." The second is rather more scientific—"The fraction of the whole period which has elapsed, measured from some fixed origin."

Let us consider the first. The "operation" might be the mass production of a radio receiver. Any particular "stage or state" could be named; say, the soldering of the output valveholder cathode contact. If all the sets were manufactured at exactly the same speed at every stage, then any phase in the whole operation could be specified by the time in hours and minutes from the start. In practice, however, the wiring operative's dinner hour might have upset the timing, so that at the same time after starting the next set she might be connecting the first I.F. transformer, which would obviously be a different stage or state. So although time definitions such as this by drawing graphs connecting voltage, current, power output, or what you will, with time. Fig. 1(a) is such a graph for the radar output. Any point on the graph marks a stage (and hence a phase) in the operation of radiating a pulse. Take A, for example. The same phase in the next pulse would readily be identified as point B. This is a better and clearer way of indicating phase than trying to describe it in words as "the stage at which the peak power of the pulse has decreased by nearly half," or some such story.

Now suppose there is another radar transmitter, identical with the first except for a higher pulse recurrence frequency, as shown by its graph, Fig. 1(b). The first pulses shown for both transmitters coincide in time, so it seems reasonable enough to choose point C to mark the same phase as A. Measuring off from C a time interval equal to AB gives point D. There is no doubt about this being an entirely different phase. The point corresponding to B on the second pulse is E, surely. Again time enters into the matter, but phase is not just time, nor even directly proportional to time.

So far, the first B.S. definition seems to have been quite clear, enabling anyone to identify similar phases. But the second one puts it a little more specifically: "The fraction of the whole period which has elapsed, measured from some fixed origin." A period is, normally, a time. Scientificaly, it is the time of one complete operation in a recurring series. It is marked "T" in Fig. 1(a) and (b). Phase being defined as a fraction of the whole period certainly rules out any such silly mistake as D in Fig. 1(b). Evidently one starts reckoning phase afresh from the beginning of each period. A convenient "fixed origin" from which to start is the point O at

---

2 B.S. 205: Part I: 1943, definition 1511.

---

Fig. 1. What phase is and what it is not are discussed with the aid of these pulse waveforms.
Phase—

which the pulse commences.

At this juncture one might hastily suppose that a phase, being defined as a fraction of a time period, is itself a time. A little thought will show that this is not so. The fraction of a period, measured from its start, is

**Time between start of period and selected phase**

Time divided by time is just a number, a ratio. Phase A, for example, could be precisely specified as 0.1; that is to say, if the whole period T were divided into 10 units, it would occur after 1 of these units had elapsed, starting from 0.

Applying this to Fig. 1(b) we immediately get into difficulties. T is a shorter period here, so phase 0.1 would be nearer 0 than A and C are. It would be a little higher up the pulse. To take a more extreme case, consider Fig. 1(c). Here the period is the same as in (a) but the pulse is fatter. Phase 0.1 brings us to F, which no one would recognize as the same stage or state of operation as A. Apparently the two definitions disagree. F is the same “fraction of the whole period,” but certainly not the same state.

Where we have gone wrong is in trying to identify the same phase in two different operations. After all, the definition referred to an operation, not to two or more sets of different operations. It would be difficult to identify the stage of wiring the first I.F. transformer in the manufacture of a T.R.F. set! So long as we stick to Fig. 1(a), or (b), or (c), then the phase reckoned according to the second definition agrees with the first definition. Measuring 10 per cent of T from the start of the second pulse in Fig. 1(a) brings us to point B, which is the same state as A in the first pulse. And so on.

Comparing phases in two or more sets of operations need not be forbidden in every case; it is allowable so long as they are identical operations. That is obvious, of course. What is not so obvious—in fact some people would disagree with it, though it does satisfy both B.S. definitions—is that corresponding phases can be picked out in operations having different periods and amplitudes, so long as the shapes of the graphs are the same, and only the scales are changed. For instance, in Fig. 1(d) the recurrence frequency is higher than in Fig. 1(a), so that the period is shorter; also the peak output is greater. But if 1 (d) were replotted to suitably altered time and power scales it could be made to coincide exactly with 1(a). This being so, 0.1 of T brings us to G, which will generally be agreed to be the same phase as A in 1 (a).

So far so good. Accepting the B.S. two-fold definition, we have a method of specifying any particular point in a recurring waveform (or other operation or phenomenon) by means of a fractional number. It is not a time or a distance or any other physical dimension, although in most of the cases in which we are likely to be interested it is related to time and can be represented (on a graph) as a distance.

The chief usefulness of the phase idea, however, is not just in marking or identifying stages or states or points. Nearly always it is a phase difference that is involved, even when the word “difference” is left out. That is why it is important to be quite clear about what sorts of different waveforms, etc., can be compared as regards phase. The B.S. definition of phase difference is not really a definition, for it starts off by saying it is “The difference of phase ...”. What it does do is to lay down certain limitations—of phase that it does enable one to speak of a phase difference between oscillations of different frequencies.

To avoid any abrupt break in the line of thought, let us postpone for a few minutes all these new complications, and go on calmly with our radar pulses. Fig. 2 (a) is just a repetition of the Fig. 1 (a) waveform, but we are going to use it for considering phase difference. Fig. 2 (b) is yet another repetition of the same graph, but it is to be supposed to relate to another radar transmitter. No one is likely to dispute the statement that the two transmitters are pulsing “in phase.” That is to say, at every instant their phases are the same; in other words, the phase difference is nil.

Fig. 2 (c) is the graph of a third...
transmitter, still with the same recurrence frequency. Consider the phase at the starting line. Taking the commencement of the pulse as the fixed origin in all cases, the phase of the first two is zero, while that of the second is, at a guess, +½ or -½, depending on whether one reckons from the last prehistoric pulse or the first one to be recorded here. The phase difference of (c) relative to (a) and (b) is +½ or -½, or in other words (c) leads (a) and (b) by ½ of a period, or lags by ½. That is because a (c) pulse started ½ of a period before the start of a pulse in (a) and (b), and another pulse is going to start ½ of a period later. If, instead, you take (c) as the standard, and note the phase difference of (a) and (b) relative to it, you will find that the signs are reversed; the phase difference is -½ or +½. Make quite sure of this before passing on! The same phase difference can be either positive or negative, just as the potential difference between two terminals of a battery is either positive or negative according to which terminal is taken as zero.

You may say there are more than two alternative phase differences; the (c) pulse can be said to be ½ or 2½ or even 3½ periods behind (a). True, but seeing that phase has been defined as a fraction of a period, it is surely just being awkward to bring in an indefinite number of other values containing whole numbers. The only justification might be if particular cycles in one of the sets of waves were connected in some way with particular cycles in the other set. Suppose that Fig. 1 (c), instead of representing transmitter pulses, represented the received echoes (not to the same power scale!). Then it would seem rather absurd to say (c) led (a) in phase; it would suggest that an echo arrived before the pulse which caused it to be radiated! If echo A were caused by pulse A, the natural thing would be to say that its phase difference was -½. But if pulse A produced echo B, this fact could be brought out by saying the lag was not ½ but ¼.

It is necessary to be rather careful about this, though. It is likely to lead to entirely wrong ideas—about that. The lag between radar pulses and echoes is really and truly a time lag. It is not, in its nature, a phase lag at all. A single pulse with its single echo would display the same time lag, but as it wouldn’t be a periodical operation, phase wouldn’t exist at all. To avoid confusion it is better to call a time lag a time lag, and if for any reason it may be possible and desirable to treat it as a phase-difference, never to forget that it is only indirectly so, and that the agreement would be upset, for example, by a change in frequency.

Current "Leading" Voltage

Another example of the confusion of thought caused by thinking of phase as time is probably more familiar to most readers. When we study simple A.C. circuits we learn that the current in a purely capacitive circuit leads the voltage by a quarter of a cycle (or period). Since there is no doubt that the current is a result of the voltage, it seems queer, to say the least, that the result should come before the cause! As this is a common stumbling-block we might digress from pulses to consider it. The fallacy, of course, is in assuming that each voltage peak from the supply is the cause of a current peak. That is so in a resistive circuit, but not in a reactive one. You can have as many volts as you like across a condenser, but so long as the voltage is steady there will be no current (if it is a good condenser). When current flows in or out of a condenser, it charges or discharges it; that is to say, the voltage across the condenser rises or falls. Conversely, if the voltage across it is made to rise or fall, current flows in or out. The more rapidly the voltage changes the greater the current. If the supply voltage is sinusoidal, its most rapid increase is when it is zero, at point 0 in Fig. 3. So it is that zero (but rapidly increasing) voltage which causes the peak current. At point 1 the voltage is momentarily not changing at all, so the current must be zero. At point 2 the voltage is decreasing at its fastest, so the current is at its negative peak. And so on. The cause of the peak current at the start of Fig. 3 is the rapid increase of voltage at 0, not the voltage peak at 1.
Phase—
Still another wrong idea of phase sometimes mystifies students of wave guides who have previously learned that nothing can travel faster than light. The mystification occurs when they are told that 'phase velocity' in wave guides is always faster than light. It is true that no material or energy or radiation or signal of any kind can travel faster than light, but phase is none of these things; in a wave guide it is a mere pattern formed by relatively slowly moving fields. It is like the cutting intersection of the blades of a pair of scissors. The intersection is just a point in a geometrical pattern, like phase, so has no restriction on its velocity.

Now let us get back to our pulses. One thing I omitted to point out about Fig. 2(a) and (c) is that the phase difference which we observed on the starting line is the same everywhere else. If that is not obvious you had better try a few places to see; for example, the second dotted line marked X. Here the phase of (a) is +1/2, and of (c) +1/4. Subtracting 1/2 from 1/4 to get the difference, we have -1/4 as before.

But now consider Fig. 2(d), which has a lower frequency. As the start it is in phase with (a). But as time rolls on, (d) lags behind. At line X it is half a period behind. At the fourth pulse in the (a) series it is a whole period behind. Or in phase, if your prefer it. The phase difference varies with time. That is a feature of the phase difference between wave trains of unequal frequency.

This process can be seen more clearly by drawing a phase/time graph, as in Fig. 4(a). Adhering to the strictly fractional idea of phase, which is what the British Standard seems to have had in mind, the phase jumps back to zero at the completion of each cycle, as shown. The phase difference is represented by the vertical distance between the two graphs. As you see, (a) gains a steadily increasing lead up to the end of its first period; then after its jump back it finds itself lagging, but it gradually reduces this lag, until (d) jumps back and gives it a big lead. Finally the two come momentarily into phase again, after three (a) periods, which is the same time as two (d) periods.

If, on the other hand, you prefer to let your phase accumulate, as I understand Van der Pol and others do, the diagram is as in Fig. 4(b), in which the (a) series gains an ever-increasing lead at a steady rate. The difference between these two diagrams shows one of the differences in the minds of the authorities, which one has to know if not to be caught. Of course the British Standard wouldn't own Fig. 4(a), because the B.S. rules out phase differences between quantities of unequal frequency. Don't ask me why; we seem to have been getting along quite happily with different frequencies on the basis of the British Standards definition of phase.

Obtainable from all leading booksellers or from ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.I.

(To be concluded.)
Short-wave Conditions

March in Retrospect: Forecast for May

By T. W. Bennington and L. J. Prechner (Engineering Division, B.B.C.)

During March the average maximum usable frequencies for these latitudes decreased during the day and increased considerably during the night. Communications on frequencies higher than 35 Mc/s were very infrequent. There was in March more ionosphere storminess than in February, much of it very probably connected with two large sunspot groups, one of which crossed the central meridian of the sun on March 3rd and the other on March 14th. Ionosphere storms occurred on 2nd, 13th-16th and 21st, the conditions on 15th being particularly disturbed.

Of the several "Dellinger" fade-outs which occurred, that at 1240 G.M.T. on the 20th appears to have been most severe.

Forecast.—It is expected that during May daytime M.U.F.'s in the Northern Hemisphere will undergo a considerable decrease, though, because of the long duration of daylight at this time of the year, moderately high frequencies will remain of use for longer periods than during April. Night-time M.U.F.'s should continue to increase and thus, during May, there will be less change in working frequencies from day to night than during the previous months.

Daytime communication on very high frequencies (like the 28-Mc/s band) should be relatively infrequent except on soundlessly transmitted paths, but over many circuits frequencies as high as 15 Mc/s will remain usable till well after midnight. During the night frequencies lower than 11 Mc/s should not really be necessary at any time.

For distances up to about 1,800 miles transmission will be controlled largely by the E and F layers, and for these distances both daytime and nighttime working frequencies should be higher than in April.

Sporadic E usually increases sharply in its rate of incidence during May. Medium-distance communication (up to 1,400 miles) by way of the Sporadic E layer may be possible for about 15 per cent to 25 per cent of the time on frequencies exceeding 21 Mc/s. Frequencies as high as 50 to 60 Mc/s may be occasionally reached for a very short time.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during May for four long-distance circuits running in different directions from this country. 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. Times in G.M.T.

Montreal: 0200 13 Mc/s (20 Mc/s)
0900 11 Mc/s (17)
1600 15 Mc/s (21)
2300 15 Mc/s (23)

Buenos Aires: 0200 17 Mc/s (23 Mc/s)
0900 15 (21)
1600 15 (21)
2300 15 (23)

Cape Town: 0200 17 Mc/s (24 Mc/s)
0900 21 Mc/s (30)
1600 26 Mc/s (37)
2300 26 Mc/s (38)

Chungking: 0200 17 Mc/s (24 Mc/s)
0900 21 Mc/s (30)
1600 26 Mc/s (37)
2300 26 Mc/s (38)

During May ionosphere storms are not as a rule very prevalent, nor are the effects of those which do occur usually particularly disastrous to radio communication. At the time of writing it would appear that storms are more likely to occur during the periods 5th-10th, 15th and 22nd-24th than on the other days of the month.

SOUND REPRODUCTION MANUAL

The new "Partridge Manual" replaces "The P.A. Manual" and "The Partridge Amplifier Circuits" previously issued by Partridge Transformers, 76-78, Petty France, London, S.W.1. It deals broadly with sound reproduction and in addition to practical data on amplifier design contains useful information on sound and hearing, and acoustical problems such as the location of microphones and loudspeakers.

The manual which costs 5s runs to 60 pages and contains about 30 figures and charts.

Bi-colour Wire

Two-colour P.V.C.-insulated connecting wire is now being produced by a new process by Associated Technical Manufacturers, Vincent Works, New Islington, Manchester, 4. It is especially intended for use in elaborate colour-coding schemes.

And now the STANDARD RACK

Latest edition to the Imhof range of cases is the new Standard Rack and Panel assembly. Of heavy gauge mild steel angle, it is strongly constructed with welded corners, and finished in grey stove enamel. Standard 19" Rack panels of 1/2" thick mild steel plate are available in four sizes: 12", 17", 22" and 29" deep finished in grey stove enamel.

Bi-colour Wire

Two-colour P.V.C.-insulated connecting wire is now being produced by a new process by Associated Technical Manufacturers, Vincent Works, New Islington, Manchester, 4. It is especially intended for use in elaborate colour-coding schemes.
Unbiased

Ten Per Cent More

THOSE of us who are striving with might and main to achieve the extra ten per cent for which the Prime Minister has appealed cannot help feeling sorry that more scientific and subtle methods are not used to achieve this desirable target. The sandwiching of these calls on our patriotism between the more alluring appeals made by the seductive sirens of WarLOUR Street is of little value.

The gist of the whole problem so far as I can see is that we should all put in longer hours of work and so increase production. I cannot help feeling that however willing we may be, the flesh is weak and to some of us, myself included, these appeals to our better nature have about as much effect as the leaflets, which we dropped from the skies, did on the Germans. Experience taught us then that sterner and more scientific measures were necessary and such I feel will be necessary now to extract the extra hour out of us painlessly and without protest.

The method of doing it must be fairly plain to all of you who live in districts served by A.C. mains. It will be recalled that in the days immediately preceding the great freeze-up in February, 1947, when there were frequent and, at times, lengthy periods of frequency "slow down," the B.B.C. used to bid us to us and slow it down during the daytime so that we did an hour's extra work, also unbeknown.

There are, of course, several practical difficulties in the way which might be likened to the nasty little fact which sometimes destroys a beautiful theory. But all these difficulties can be overcome with a little ingenuity. The gist of these is, of course, that some people are served by D.C., while others have no mains at all. This can easily be remedied by quickly supplying A.C. to everybody. Labour and materials thus expended would be recouped a thousandfold when once the scheme got going. After that it would, of course, have to be made a penal offence to use or own ordinary clocks, but this would be well within the scope of ministerial regulation. Watches would, of course, be a bit of a snag but I feel sure that everybody could be induced to surrender them for export to the Andaman islands or somewhere like that.

The real snag is, of course, the shift workers, but even here it must be remembered that most factories use individual master-and-slave clock systems which could easily be slowed down and speeded up at the master clock.

Babel Up to date

THE Oxford accent, like Cambridge sausage, has no connection with the ancient seat of learning after which it appears to be named. Unfortunately, however, some people seem convinced that this ghastly sort of pseudo-English is both used and encouraged at Oxford, rather in the manner that some people imagine that people in Australia spend their time in throwing boomerangs and crying coo-ee. I'm sure I don't know where this particular accent is used. The B.B.C. announcers are not guilty.

Although they are not guilty of using this atrocious travesty of good English, the B.B.C. announcers are. I am sorry to say, very guilty of causing bewilderment and chaos among those of us who are not alumni of places where the niceties of English pronunciation are taught. I am no supporter of a dull, rigid and monotonous sort of standard English, and rejoice to hear the sing-song accents of the Rhondda Valley or the still surviving Cromwellian accent in Se1 Suffolk.

But from the lips of B.B.C. announcers when they read the news or bid us be ready to hear some sentimental slush from the lips of an inane crooner, I certainly think that we ought to hear some form of standard pronunciation as indeed I think we used to do at one time. To mention but two of the many words upon which the B.B.C. announcers do not seem to be agreed; when we talk of "finance" we must call it "fin-ants" or "fin-ants," and is it "civil-eyes-ation" or "civil-iz-ation"?

Perchance there is no hard and fast rule on this matter, and one method of pronunciation is as good as the other, but surely the announcers can all use the same pronunciation even if it is the wrong one. We have in this country no equivalent to the "Académie Fran-caise" to guide us in this matter, but surely the B.B.C. can find somebody as painstaking as the late Professor Lloyd James to guide them in this matter. Maybe I shall be told that there is an authority at the B.B.C. to see to these matters and probably the B.B.C. will send me some little "Announcers' Vade-mecum" which, like the Highway Code, is supposed to be studied by all and so seldom is—by pedestrians at any rate. Don't think that I am trying to set myself up as an authority on good English. I am not, for I am, relatively speaking, a newcomer, an alien whose ancestors came over from Normandy not yet 900 years ago. I make no pretence to be a real dyed-in-the-wool Englishman who came over with Hengist and Horsa some six hundred years earlier—449 was the year if my memory serves me right.
LETTERS TO THE EDITOR

Midget Valves • F.M. and Interference • No-A.F. Receiver • Contact Resistance

British Sub-miniature Valves

I was glad to see the article in the March, 1948, issue of your journal, and to learn that a serious attempt is being made by British manufacturers to supply these tiny valves, which have hitherto come principally from the United States.

I fear that some of your readers may be misled by the comparison made between the British valves and their American counterparts. The figures given for the English valves relate to a product which is not yet commercially available, whereas the figures for the American counterparts relate to valves which have been freely available for the past two years, and which are now obsolete.

Taking first the statement that "These (English) valves compare favourably in size with corresponding sub-miniature valves of American manufacture." While the English valves are 0.4in in diameter, the American valves approximate to a rectangular cross-section 0.35in by 0.285in. The significant factor here is the flatness of the American valve, of which full advantage is taken by some English and most American manufacturers of miniature hearing aids. British-made hearing aids are in production which are too slim to accommodate the new English valves. To increase the dimensions of these aids would be to put this country at a disadvantage in important export markets.

Again, while it is appreciated that the reduction of the total filament current of a three-valve hearing aid to 1.25V, 50mA represents a very considerable technical feat, the present American hearing aids have reduced the current drain to 40mA. The voltage amplifier valve used, Raytheon CK-512AX, has a filament rated at 0.625V, 20mA. The voltage gain obtainable is slightly above the figure quoted for the equivalent new English valve. These valves have been produced and are in use in very large quantities and have proved extremely reliable; indeed, the service obtained is better than that which we have come to expect from full-sized battery valves. The figure quoted in the article of 75mA filament current for a similar circuit employing valves of American manufacture is seriously out of line with current practice.

It seems appropriate to point out here that initial leadership in the design and manufacture of sub-miniature valves came from this country, and in the late 1930s such valves were exported to the United States. Immediately after the war, a satisfactory sub-miniature output valve with a filament current of 30mA was available in this country, and at that time was superior to equivalent American valves in that respect. Such valves have been used by the company with which the writer is associated for nearly two years with satisfactory results. It may be of general interest to readers to learn that a complete range of these sub-miniature valves comprising more than twenty different types, is now available in the United States, and that as well as valves specially designed for hearing aids, there are also types for portable radios, U.H.F. oscillators, gas triodes and electron meters.

I have every reason to believe that the new English developments will lead to the production of miniature valves of the highest performance and reliability, but it does seem important to take this opportunity of reviewing these developments in their correct perspective in order to avoid any suggestion of complacency.

J. P. ASSENHEIM,
Chief Research Engineer,
Amplivox, Ltd.,
London, W.I.

"F.M. Reception"

Referring to the description in your March issue of comparison tests on F.M. phase dis-

1 This presumably refers to Hivac valves—En.
Letters to the Editor—

Criminators and ratio detectors. I am not quite satisfied with the legitimacy of making the impulsive interference tests in the absence of a frequency modulated signal.

In the case of the phase discriminator this is probably justifiable, but in the ratio detector it would appear that when the impulsive interference has a peak value greater than twice the peak value of the signal, the capacitor C3 would charge up rapidly to almost the peak value of the interference, and not to the peak value of the signal.

The diodes will then be rendered non-conducting except during interference pulses, and the signal will either disappear or at least become seriously distorted.

I should be interested to know whether the authors have made any tests under these conditions, and whether they have any evidence of distortion occurring during impulsive interference.

J. E. PATEMAN.

Enfield, Middlesex.

[The authors of the original article comment as follows.—Ed.]

The biasing-back effect which Mr. Pateman suggests has not, in fact, been observed until the strength of the impulsive interference is so great that the programme is virtually drowned in it. In this case, it is hard to say whether the programme is being aurally masked by the interference or whether it is being electrically biased back by this. It would seem that the probable reason why this biasing-back effect is not serious is because the condenser C3 would not charge up rapidly to almost the peak value of the interference because the charge time of the network, including C3, is probably a little longer than the discharge time. This being the case, the voltage across C3 would tend to something a little lower than the mean value of the impulsive interference which, for normal repetition rates, would be far below the peak value and, therefore, probably insignificant.

We have made some tests in the conditions specified by Mr. Pateman and we have not noticed any evidence of distortion occurring during impulsive interference, at least, until it becomes so disturbing that the programme is drowned through it is not worth listening to at all.

**High-level Detection**

In the last two years you have published details of a number of high-quality amplifiers and receivers but all of them have had one or more A.F. stages before the output. There has been no mention of my own particular pet—the high-voltage diode feeding a push-pull output stage without any intermediate amplification. This strikes me as being capable of permitting the best quality reproduction on radio; you allowed me to describe it in *Wireless World* as long ago as November, 1934.

I contend that the diode provides the most linear detection when used as high on its slope as possible and that it permits the use of a most convenient method of paraphrasing. The use of only the one A.F. coupling has advantages in a decrease of phase-shift in stability and in diminution of hum.

It may interest you to know that, thanks to improvements in valves, my present set represents a further stage in my search for quality. The D63 diode I use is capable of handling up to 2mA per diode (mine are strapped in parallel) allowing a low D.C. load to be used and therefore a better relationship between the D.C. and A.C. loads, (vide Langford Smith's "Radio Designer's Handbook"). The D63 is capable of giving a sufficient reserve of output to permit a fair amount of negative feedback being employed in the PX25 output circuits, a further precaution which increases quality. I found little difficulty in feeding an adequate R.F. voltage to the diode, thanks to the use of an output tetrode in the third R.F. stage; nor had I much trouble with instability as the gain per stage is low and totally screened pre-set tuning as well as staggering of the tuning allowed me to get the three stations I require with the widest possible band of frequencies.

While such a set is admittedly extravagant, to me it represents the nearest approach to an ideal both regarding quality of reproduction and simplicity of design. It has two disadvantages, however; it cannot very well be used for gramophone reproduction, and, most serious, it shows up many of the B.B.C. transmissions, particularly recordings, long landline and short temporary landline transmissions. On the other hand it provides me with a supreme enjoyment of the really high quality transmissions and programmes that are frequently broadcast by the B.B.C. This alone makes the labour and expense well worth while.

W. MacLANACHAN.


"Cleaning Switch Contacts"

In his article in your February, 1948 issue J. J. Payne does not mention the more complex problems of contact non-linearity. These might not cause any great difficulties when dealing with circuits where small changes in contact resistance can be neglected. But such changes undoubtedly occur and Mr. Payne's statement that high spots 'will still make electrical contact' because 'the contact pressure will force the high spots through this layer' (of grease) must be read with caution. There is no reason to believe that there will not be a very fine layer of grease between the contacts even with comparatively high pressures. This layer will cause a small change of contact resistance. Also, this resistance is affected by the substance or gas with which the gaps between any two contacts are filled, whether air or grease or impurities or any combination of these. Thus, even if the area of direct contact is not altered, whether grease is applied or not, as Mr. Payne states, the contact resistance will be altered in cases where the gaps do not act as a perfect insulator, as they seldom do. Contact resistance problems will then become considerably more complex.

G. L. WALLACH.

London, S.W.15.

With reference to the interesting article in the February *Wireless World* I have found carbon tetrachloride in which a quantity of "Vaseline" has been dissolved—enough to give the
mixture a rich amber colour—to be very satisfactory. It would appear that this meets the require-
ments referred to in the article.

R. V. GOODE.
Totland Bay, I.o.W.

New Domestic Receivers

A table model battery receiver (Model A801) designed to run off a 1½-volt dry cell or 2-volt accumulator has been introduced by Allan-der Industries, Bridgeton, Glasgow.

Ekco “Princess” portable.

Loctal base valves are used in the four-valve circuit which covers short, medium and long waves. The price is £16 16s plus purchase tax. In the “Princess” portable, made by E. K. Cole, Southend-on-Sea, miniature valves are used in the 4-valve superhet circuit which operates on medium and long waves. The battery consumption is 0.25A at 1½V and 9mA and 65V. The dimensions are 9½in. x 7½in. x 2½in. and the weight approximately 4½lb. Provisionally the price has been fixed at £13 13s plus purchase tax.

A four-valve, four-waveband A.C. superhet (Model 31) has been added to the range of receivers made by Invicta Radio, Parkhurst Road, London, N.7. The price is £18 18s. plus purchase tax.

Those who saw the 128 series of export receivers made by Murphy Radio, Welwyn Garden City, Herts, at Radioliom for, will be interested to know that equivalent models for sale in this country are now available. In addition to the usual medium and long-wave ranges the sets cover 75-200 metres and have bandspread tuning on the 16, 19, 25, 31 and 41-49 metre bands. An SF41 R.F. amplifier is added to the 4-valve superhet circuit for the bandspread ranges. The price is £31 plus purchase tax and alternative models are available for A.C. or A.C./D.C. supplies.

Manufacturers’ Literature

Leaflet giving particulars of television aerial installation service from Wolsey Television, 87, Brixton Hill, London, S.W.2.

Leaflet describing the new “Acru 24” soldering iron from the Acru Electric Tool Manufacturing Co., 153, Hyde Road, Ardwick, Manchester, 12.


Catalogue of radio components, receiver kits, etc., from Coulphon Radio, 98, Derby Street, Ormskirk, Lancs.

Descriptive leaflet dealing with the “Aldryunit” battery eliminator from the Dulci Company, 95-99, Villiers Road, Willesden, London, N.W.2.


Illustrated folder describing 18in and 18in heavy-duty loudspeakers from Goodmans Industries, Lancerot Road, Wembley, Middlesex.


Booklet giving dimensions of transformer and choke laminations in Numetal, Radiometal and Rhometal from Telegraph Construction and Man-

Catalogue and price list of microphs, loudspeakers and accessories from Vitavox, Westmorland Road, London, N.W.9.

Illustrated folder on Carbon Pile Resistors from the Morgan Crucible Co., Battersea Church Road, London, S.W.11.


A.F. Measurement Service

A series of twenty-four tests of performance of audio-frequency amplifiers is undertaken by A. E. Cawkell, 7, Victoria Arcade, The Broadway, Southall. These include distortion, phase shift, etc., and trace photographs of oscillograms. The charge for the comprehensive tests is £6 gs and a selection of four “minimum essential” tests can be made for 2½ gs. It is hoped later to extend this service to microphones, loudspeakers and pickups.
Random Radiations
By "DIAList"

F.M. Receivers

Though V.H.F. F.M. transmissions have been made regularly by the B.B.C. for some time now, and though the corporation's policy is to develop this kind of high-fidelity broadcasting in addition to its medium-wave, medium-fidelity system, our radio manufacturers don't yet seem to be offering the man in the street apparatus that will receive the transmissions. I expect that they'll be doing so before the autumn. If they take the right steps to interest the public, they are sure to reap a rich reward. There must be a demand for high-fidelity reproduction, for the success of the Third Programme has proved the unexpectedly wide interest of listeners in good music—and good music cannot be reproduced properly but by other than high-fidelity apparatus. Not the least of the other advantages of F.M. are freedom from most forms of interference and the fact that there is no need for "contrast compression" to be anything like so severe as it must be in A.M. broadcasting.

New Primary Cells

Particulars of two new primary cells, both using magnesium instead of zinc for the negative electrode, have reached me from the United States. The possibilities of magnesium have been realized for sometime, but there were until recently difficulties about producing at the right price adequate supplies of a sufficient degree of purity. Unless the metal is well over 99% pure the shelf-life of cells is apt to be unsatisfactory. One type developed for special war purposes by the Burgess Battery Company has a spirally wound positive electrode of silver foil. The depolarizer of silver chloride is applied to the strip in the form of a paste. The electrolyte is simply—water! Such cells are capable of quite remarkable discharge rates at relatively high voltages. One battery, for example, which weighs 10 oz consists of two cells in series. It will supply a substantially constant current of 53.5 amperes at 2.8 volts for 6 minutes. A single cell of another type, cylindrical in shape and measuring 1\(\frac{2}{3}\)in x 2\(\frac{1}{2}\)in, gave under test 100 amps at 1.4 volts for 1½ minutes. The zinc-carbon dry cell averages 1.55 ampere-hours per pound of weight, the lead-acid accumulator 5.6 Ah, the nickel-iron accumulator 9.6 Ah and the magnesium-silver chloride cell 12.9 Ah. The magnesium cell also behaves well under small loads such as those imposed on the H.T. batteries of wireless receiving sets. In such cases the discharge curve, whether the load is continuous or intermittent, remains almost flat, the voltage being 1.55 V per cell until a short time before the battery is run down. At that point there is a sharp downward bend. The discharge curve is, in fact, shaped almost exactly like that of a secondary battery or cell. We seem at last to be progressing in the matter of primary cells. If only someone would invent that A.C. battery demanded years ago by "Free Grid"!

Television in America

According to the latest statistics prepared by the American Radio Manufacturers' Association 170,000 televisions (they spell it televisers) were sold in the States during 1947. The average price paid by viewers for their apparatus is rather surprising, working out as it does at $759, or £180 15s. I think I mentioned some time ago in these notes that American television receivers were a good deal more expensive than ours; but I hadn't realized that the difference was so great. The figures are official, so there's no mistake about them. It is a curious fact that though American manufacturers can and do beat us hollow in the matter of broadcast radio receiver prices (you can buy a valve plus rectifiers from $29, or 75 8c a piece, or even less), we are producing good and reliable television receivers at about one-third of the average price over there. Probably American television prices will come down with a run when production really gets into its stride. It seems to be doing so fairly rapidly. In January, 1947 (a month of five working weeks) 3,437 televisions were manufactured. In the five working weeks of October the total has risen to 23,693; and in the same number of weeks in December it reached 29,345. The industry's forecast of the number of vision receivers in use by the end of this year is a round million; you can see, then, that the new sets produced are going to average about 70,000 a month this year.

Transmissions in the States

At present the best-served cities in America, so far as television is concerned, are New York, Philadelphia, Chicago, Los Angeles, Washington, Detroit, Baltimore and St. Louis. The present scheme (already partly carried out) is for a chain of television transmitters down the east coast, a similar chain down the west coast and a connecting chain right across the country from New York to Los Angeles, with branches into the more thickly populated parts of the country such as Illinois and the Middle West in general. The links of the chain consist partly of runs of coaxial cable (some very long) and partly of radio relays. The system now in operation is extensive; it should cover a very considerable part of that large country within two or three years, at the present rate of progress.

Reflections from the Moon

A report in the March number of the O.I.R. Bulletin gives some interesting particulars of work done last year by the Australian Council for Scientific and Industrial Research on radio echoes from the moon. Transmissions were made, by means of a rhombic aerial system, from the short-wave station at Shepparton (about 100 miles almost due north of Melbourne) reception taking place at Hornsby, some 350 miles away in New South Wales. The frequencies employed were 17.84 and 21.54 Mc/s and the transmissions were in the form of pulses. On some occasions sets of three 0.2-second pulses were sent out; on others single 2.2-second pulses were used. As the aerial system was fixed, transmissions could be made only when the moon was in the right position. They were further limited to times when the F2 layer was in a suitable condition to allow the radiation to penetrate it. And overriding both these considerations was the fact that the Shepparton station was available for experimental purposes only at times when it was not required for broadcasting. All conditions, however, were ful-
filled on the nights of November 7th, 8th, 9th, 10th, when most successful results were obtained. The echoes were received with a delay of 2.66 seconds, which, taking the velocity of electromagentic waves in round figures at 186,200 miles a second, makes the distance of the moon from us at that time some 247,640 miles. One very interesting phenomenon was observed: the received signals were tuned in on a frequency about 50 c/s above that of the transmissions, due to the Doppler Effect.

**Television Test Pattern**

*The new television test pattern seems to me to be quite first rate from everyone's point of view except possibly that of the fellow who is trying to dispose of a disc televistor. It must be of great value to designers and back-room boys servicemen can spot a large variety of faults and wrong adjustments in the twinkling of an eye; the would-be televistor can check the performances of the set he thinks of buying. It says a great deal for the high standard of British television that our manufacturers should not only have co-operated with the B.B.C. in designing this very exacting test pattern, but should also be anxious to have it broadcast for anyone to receive. One effect rather unexpected in a modern televistor is shown up, by the way, in no uncertain manner if it is there. This is "pin-cushion" distortion (concavity of the edges of the raster) which leapt to the eye when a friend and I tried his home-made set, incorporating a "disposals" C.R.T., on the pattern a few mornings ago.*

**Sound Recording Manual**

**Hints and Tips for Beginners**

*NEWCOMERS* to the art of disc recording will find interest and instruction in a handbook "Recording by the Direct Disc Method," by D. O'C. Roe, issued by Birmingham Sound Reproducers, Clarence Street, Old Hill, Staffs. In addition to operating instructions for the B.S.R. Type DR33 recorder and AR15 amplifier there is much useful general information including hints and tips on recording practice, studio acoustics and the arrangement of performers and microphones and the addresses of societies concerned with questions of copyright.

The booklet is well printed and illustrated and costs 5s.

---

**Indicators - BULGIN**

**Signal Fittings**

**IN ALL COLOURS**

Universally used by reason of their complete reliability, these signal fittings are found on all types of electronic and domestic electrical apparatus. The types illustrated are for low-voltage use, and are designed for M.E.S.-cap and similar lamp bulbs. Models are available with one pole "live" to frame, or with frame "dead" (when max. [peak] wkg. V, to E. = 250, 500 V. peak test). Internal lamp-holding arrangements ensure permanent trouble-free contacting. Types also manufactured suitable for M.B.C. and S.E.S. lamps. Enquiries for direct—and indirect—export are particularly invited.

---

**BULGIN**

*The Choice of Critics*
CATHODE-RAY INDICATORS

When rectified, as distinct from alternating, voltages are applied to the deflecting plates of a cathode-ray tube, as, for instance, in automatic direction finding, the indicating spot is moved to some fixed point on the screen, and the direction is then given by the imaginary line joining the spot to its normal or zero position, which is often difficult to identify accurately.

According to the invention, the charging voltages are applied to each of the deflecting plates through equal resistances of high value, and the plates are coupled to a common earth- ing point through separate condensers which are periodically shorted, say, at 50 c/s, by electronic switching. The fixed-spot indication is thus converted into a permanently visible straight-line trace, the length and orientation of which is determined by the steady value of the original deflecting voltages.


RECORD REPRODUCTION

The movements of the stylus are applied to de-tune the circuits of a pair of diode rectifiers which are coupled to a radio-frequency oscillator. The arrangement develops an audio-frequency output voltage that is directly proportional to the mechanical drive; it also automatically suppresses any parasitic noises or disturbances that may arise in the R.F. circuits.

A crystal-controlled valve V supplies R.F. oscillations to the two input circuits of a pair of diodes D, D1, which are connected to a common load resistance R. Both circuits are tuned by a split condenser C. This has a flexible electrode which is directly driven or vibrated by the stylus S. The circuits are therefore simultaneously de-tuned, in push-pull fashion, and a corresponding summation voltage appears across the load resistance. and is fed to an audio-frequency amplifier (not shown). Any fluctuations originating on the R.F. side of the transformer T are opposed after rectification, and mutually cancel out.

Radio Corporation of America. Convention date (U.S.A.), March 29th, 1944. No. 589834.

WAVE GUIDE FILTERS

Electromagnetic energy can flow through a wave guide either as a TM wave having a transverse magnetic and a longitudinal electric field, or as a TE wave with a transverse electric and a longitudinal magnetic field the former induces longitudinal, and the latter transverse currents in the walls of the tube. Both types of wave are usually present initially in the guide, and the invention describes means for filtering out one from the other.

As shown, a series of radial quarter- wave slots S are cut in the thickness of the walls, extending for a full wavelength, so as to present a substantially infinite impedance to the flow of transverse current. This blocks the passage of the TE wave. In width, the slots are too narrow to have any noticeable effect on the flow of axial currents, so that the TM wave is not attenuated. The slots may be filled with powdered graphite to dissipate the energy of the standing wave.

A single circular slot, a quarter wave in depth, and carried peripherally around the guide, will pass the TE type.

Western Electric Co., Inc. Convention date (U.S.A.), April 28th, 1944. No. 590432.

PIEZO-ELECTRIC REACTANCES

A piezo-electric capacitor is held, by thermostatic control, at its critical or Curie-point temperature, where the dielectric is shown to find maximum change in capacitance for a given variation in the applied voltage. The arrangement can be used as a fast-acting reactance for frequency modulation, when shifted across the inner and outer conductors of a tuned coaxial-line element coupled to the output circuit of a U.H.F. triode oscillator.

A convenient dielectric is standard Rochelle salt, which has a Curie-point temperature of 24° C. Another alternative is the same salt crystallized from heavy water (deuterium oxide) this crystal has a critical temperature of 35° C., which can be held by a very simple form of thermostatic control.

Western Electric Co., Inc. Convention date (U.S.A.) October 21st, 1943. No. 596399.

LARGE-SCALE TELEVISION

The screen of a cathode-ray tube is coated with caesium, which is maintained at such a temperature that the extra heat produced by the impact of the scanning beam is sufficient to produce a momentary evaporation of the metal from point to point along the line of scan. The extent of evaporation increases with the power of the beam as modulated by the received signals, thus varying the transparency of the screen to an external source of light and allowing the picture to be projected outside the bulb of the cathode-ray tube, where it is not restricted in size.

Local cooling is applied to ensure that the volatile metal is deposited back on the screen, in the rear of the scanning beam. In addition, the whole of the cathode-ray tube, except the screen, is enclosed in an electric oven, which is maintained at a sufficiently high temperature to prevent undesirable condensation.

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 -50V., 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 megohms, 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 8404-9
"Advance" Signal Generator type D.1.

This "ADVANCE" Signal Generator is of entirely new design and embodies many novel constructional features. It is compact in size, light in weight, and can be operated either from A.C. Power Supply or low-voltage high-frequency supplies.

An RL18 valve is employed as a colpitts oscillator, which may be Plate modulated by a 1,000-cycle sine wave oscillator, or grid modulated by a 50/50 square wave. Both types of modulation are internal, and selected by a switch. The oscillator section is triple shielded and external stray magnetic and electrostatic fields are negligible. Six coils are used to cover the range, and they are mounted in a coil turret of special design. The output from the R.F. oscillator is fed to an inductive slide wire, where it is monitored by an EA50 diode. The slide wire feeds a 75-ohm 5-step decade attenuator of new design. The output voltage is taken from the end of a 75-ohm matched transmission line.

The instrument is totally enclosed in a grey enamelled steel case with a detachable hinged lid for use during transport.

Price £80
Delivery ex Stock.

Write for descriptive Leaflet.

**Marconi**

Marconi Quartz Crystals are made to satisfy the highest possible standards because nothing but the highest standards satisfy the designers of Marconi equipment.

Mounted in an evacuated glass envelope, with a Type B7G base, Marconi Crystals can now be supplied to all Manufacturers in the following ranges:

- 75-150 kc/s
- 200-500 kc/s
- 2-15 Mc/s
- 12-35 Mc/s (overtone plates)

Frequency Tolerance...0.1% normal
-0.05% maximum

Temperature Coefficient...2 parts in $10^8$ per degree C.

Enquiries are also invited for other types to suit specific requirements.

Marconi's Wireless Telegraph Company Limited
(Dept. B), Marconi House, Chelmsford, Essex

---

Wireless World May, 1948

10 to 310 mcs.

Light Weight 36 lbs.
Negligible Stray Field.
Frequency Calibration 1%
Modulation 30%, sine wave 1,000 - and pulsed 50/50 square wave at 1,000 -
Attenuation Max. error at 300 mcs. ±2dB
Precision Slow-Motion Dial.
Wide Range, 10-310 mcs.
Compact 12 1/2in. x 13 1/4in. x 7 1/4in.

Dual-Power Supply
200-250v., 40-100
80-v., 40-2000
**MAZDA for Dependability**

**CHARACTERISTIC CURVES OF AVERAGE MAZDA VALVE TYPE SP61. CURVES TAKEN AT Va = 250.**

**SP.61**

**A.C. MAINS H.F. PENTODE**

**BASINGS**

- Pin No. 1. Heater.
- 2. Cathode.
- 3. Anode.
- 4. Screen.
- 5. Suppressor Grid.
- 7. Omitted.

Top Cap. Control Grid. Viewed from the free end of the base.

**RATING**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Voltage</td>
<td></td>
</tr>
<tr>
<td>Heater Current (Amps.)</td>
<td></td>
</tr>
<tr>
<td>Maximum Anode Voltage</td>
<td></td>
</tr>
<tr>
<td>Maximum Screen Voltage</td>
<td></td>
</tr>
<tr>
<td>*Mutual Conductance (mA/V)</td>
<td></td>
</tr>
</tbody>
</table>

* Taken at Va = 200v; Vg 2 = 200v; Vg 1 = -1.5

**TYPICAL OPERATION**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode Voltage</td>
<td>200</td>
</tr>
<tr>
<td>Screen Voltage</td>
<td>250†</td>
</tr>
<tr>
<td>Grid Voltage</td>
<td>1.0</td>
</tr>
<tr>
<td>Anode Current (mA)</td>
<td>2.2†</td>
</tr>
<tr>
<td>Screen Current (mA)</td>
<td>5.5†</td>
</tr>
<tr>
<td>Mutual Conductance (mA/V)</td>
<td>7.6</td>
</tr>
<tr>
<td>Input Capacity Working (µµF.)</td>
<td>15</td>
</tr>
<tr>
<td>Change in Input Capacity produced by biasing valve to cut-off ΔC (µµF.)</td>
<td>3.75 4.0</td>
</tr>
<tr>
<td>Self Bias Resistance (ohms)</td>
<td>37</td>
</tr>
<tr>
<td>Input Loss at 45 Mc. (ohms)</td>
<td>2,500</td>
</tr>
</tbody>
</table>

†Maximum permissible rating as Video Output valve; anode volts must not exceed 200 volts. Grid cathode circuit resistance should not appreciably exceed 5,000 ohms.

**INTER-ELECTRODE CAPACITIES**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 *Anode to Earth</td>
<td>5.25 µµF.</td>
</tr>
<tr>
<td>6 *Grid to Earth</td>
<td>10.75 µµF.</td>
</tr>
<tr>
<td>250 *Anode to Grid</td>
<td>0.005 µµF.</td>
</tr>
<tr>
<td>8.5 *“Earth” denotes the remaining earthly potential electrodes and metallising joined to cathode.</td>
<td></td>
</tr>
</tbody>
</table>

**Price:** 10/6 plus 3/5 purchase tax

**MAZDA**

**RADIO VALVES AND CATHODE RAY TUBES**

THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2

- May, 1948
- Wireless World
- Advertisements
Advertisements

Wireless World

May, 1948

Are we tackling 'LITTLE' RUBBER-METAL PROBLEMS?

Here's one answer of many!!

RUBBER BONDERS LIMITED
FLEXILANT WORKS - DUNSTABLE - BEDS
ENGINEERS IN RUBBER BONDED TO METAL
TELEPHONE: DUNSTABLE 805-4-3

E.M.I. TRAINING FOR CAREERS IN ELECTRONICS

An E.M.I. correspondence course, brings students into direct contact with scientists of Britain's Largest Electronic organisation.

BASIC RADIO or BASIC TELEVISION for City and Guilds Telecom. Finals.
(Ready this Autumn) A.M.Brit.I.R.E.
Intermediate Maths. for City and Guilds
Advanced Maths.
Industrial Electronics

Also FULL TIME COURSES

Whatever course is chosen, the E.M.I. staff give first hand up-to-the-minute knowledge of the application of electronics to industry. Write for full details to:-

The Principal: PROFESSOR H. F. TREWMAN, M.A. (Cantab)

E.M.I. INSTITUTES LTD
Dept. 16, 43, Grove Park Rd., London, W.4
E.58a

MODELS WX
AUTOMATIC COIL WINDING MACHINES
FOR PILE OR WEAVE WOUND COILS
Particulars of this new improved model and other machines on application.

ETA TOOL CO (LEICESTER) LTD.
161 METCALF STREET, LEICESTER.
Phone-5386.

E.58a
Condenser sealing —

a New technique

Pioneers of the familiar bakelite terminal method of sealing condensers, T.C.C. have now developed a new method of complete hermetic sealing by means of Neoprene bungs through which are brought soldering wires/tags or insulated flexible leads. Typical types of condensers to which this construction is applicable are illustrated above. Obvious applications are paper condensers for telephones, fluorescent lighting, ignition, interference suppression, flash photography, etc., etc. Considerable economies are made possible by the use of this technique, and we shall be pleased to put forward designs and prices against enquiries where quantity production is warranted.

PATENTS AND REGISTERED DESIGNS PENDING

THE TELEGRAPH CONDENSER CO., LTD.

NORTH ACTON • LONDON • W. 3 Telephone, ACORN 0061
The Type 1684 series of Oscilloscopes is already well known. The new Model retains the desirable features of this series—d.c. shift controls, response flat to video frequencies, d.c. coupled symmetrical amplifiers on both axes, fully-automatic synchronisation of the time base, etc. but incorporates many new features of design, both electrical and mechanical. 1648 D has, in fact, been accorded an enthusiastic reception and despite steadily mounting orders, a three-fold increase in production is enabling reasonable deliveries to be maintained.

PRINCIPAL FEATURES

★ TUBE 3½ in. diam. Blue, green or delay screen.
★ AMPLIFIERS. D.C. to 3 Mc/s., 18 mV. r.m.s. per cm. or D.C. to 1 Mc/s., 6 mV per cm. Symmetrical or assymmetrical input, X and Y amplifiers are similar.
★ TIME BASE. 0.2 c/s to 150 kc/s. Variable through X amplifier 0.2 to 5 screen diameters.
★ ACCESSORIES. Camera, telescopic light shield, ruled graticule.

NOTE THESE CHARACTERISTICS:
D.C. RESISTANCE, 47 Ohms.
IMPEDEANCE, 52 Ohms at 1,000 c.p.s.
SENSITIVITY, $1.2 \times 10^{-11}$ Watts at 1 kc. = 0.0002 Dyne/cm².

Descriptive literature on request.

PRICE £5.5.0 PER PAIR.
Supplies now available.
Order from your Local Dealer.

HEADPHONES WHICH UPHOLD BRITISH PRESTIGE.

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.

NOTE THESE CHARACTERISTICS:
D.C. RESISTANCE, 47 Ohms.
IMPEDEANCE, 52 Ohms at 1,000 c.p.s.
SENSITIVITY, $1.2 \times 10^{-11}$ Watts at 1 kc. = 0.0002 Dyne/cm².

Descriptive literature on request.

PRICE £5.5.0 PER PAIR.
Supplies now available.
Order from your Local Dealer.

HEADPHONES WHICH UPHOLD BRITISH PRESTIGE.

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

For details of other S.G. Brown Headphones (prices from 30/- to 63/-) ask for illustrated Brochure "W.W."

For detailed information on Raytheon Deaf Aid Valves write to Submarine Signal Company (London) Ltd., Artillery House, Artillery Row, London, S.W.1, England, or to:

RAYTHEON MANUFACTURING COMPANY
INTERNATIONAL DIVISION
60 EAST 42nd STREET
NEW YORK 17, N.Y., U.S.A.

Here is the Raytheon valve that is the heart of almost every Deaf Aid in use today. . . . In spite of the complex construction within this tiny tube, Raytheon's unique precision-electronic assembly methods have resulted in valves so uniform and dependable that the Deaf Aid user no longer gives them a thought . . . Is it any wonder that Deaf Aid makers and users rely so universally on valves bearing the name RAYTHEON?

For detailed information on Raytheon Deaf Aid Valves write to Submarine Signal Company (London) Ltd., Artillery House, Artillery Row, London, S.W.1, England, or to:

RAYTHEON MANUFACTURING COMPANY
INTERNATIONAL DIVISION
60 EAST 42nd STREET
NEW YORK 17, N.Y., U.S.A.

www.americanradiohistory.com
"Monobolt" speakers, the first of the new Truvox radio range, are now available from all radio dealers. Quality enthusiasts, and all those who want "the best," will welcome this news. If you require fuller details than are given below—a postcard will bring them.

| Model BX 50 | 5in. | 8,500 lines | £1 1 0 |
| Model BX 52 | 5in. | 10,000 lines | £1 4 6 |
| Model BX 60 | 6½in. | 8,500 lines | £1 2 6 |
| Model BX 62 | 6½in. | 10,000 lines | £1 6 0 |
| Model BX 80 | 8in. | 8,000 lines | £1 4 0 |
| Model BX 82 | 8in. | 10,500 lines | £1 10 0 |
| Model BX 100 | 10in. | 8,000 lines | £1 10 0 |
| Model BX 102 | 10in. | 10,500 lines | £1 17 6 |

New products, as illustrated above, are well under way. Full details will be announced as they become available.
**SOUND SERVICE**

**THE COMPLETE SERVICE FOR SOUND RECORDING AND REPRODUCTION**

- Mobile, static and specialised recording units.
- Complete Wire Recorders, Recording and Wipe-Off Units.
- Recording Amplifiers.
- Moving Coil and Crystal Microphones.
- Sapphire cutting and reproducing stylii.
- Blank recording discs from 3in. to 17in., Single or Double sided.
- Lightweight, moving iron, permanent sapphire and moving coil pick-ups.
- A comprehensive range of accessories to meet every requirement of the sound recording engineer.
- And our latest development (of special interest to users of sapphire and delicate pick-ups)—THE SIMTROL. This is a controlled micro-movement easily fitted for use with any type of pick-up.

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

**SIMON SOUND SERVICE, Recorder House, 48/50, George St., Portman Square, London, W.1.**

**CABLES: Simsole, London.**

**TELEGrams: Simsole, Wesde, London.**

**TELEPHONE: Welbeck 2371/2.**

---

**M. R. SUPPLIES Ltd.**

offer only selected and brand new materials which are sure to give complete satisfaction. All orders handled with the utmost diligence and dispatch. All prices nett. **ROTHERUREL AMPLIFIERS.** Very special exclusive offer of two currently listed models at attractive prices. Operation 250/250 v. A.C. Model 98DR, output 5 watts (two 45 valves in p.p.) Input for crystal mic. and any pickup, with switch-over. Output matched to 50 or 500 ohms. Open chassis style, size 12in. by 5in. by 8in. Complete with 2 valves, ready for use. (Last 220, limited number at £12/15/- dispatch 9/6.) Also Model HOI90, output 9 watts (two 812A in push-pull). Inputs for crystal mic. and any pickup with electronically mixing and tone controls. Output matched to 2, 4. A.C. 15 and 500 ohms. Overall gain 15 0 db. Response within ±2 db from 50 to 15,000 cps. In crystal-filled steel cabinet 11in. by 7in. by 6in. Complete with 2 valves, ready for use. (Last 220, limited number at £22/6. 5/- D.C./A.C. CONVERTERS, the new efficient Vibrator type, fully smoothed and filtered for all wave-lengths. 500/500 v. D.C. to 500/500 v. A.C. 50 c., 100 watts, 95 (dees. 5/-) 550 watts, £14 (dees. p. train 3/-) NOTE.—For television we recommend the 590 watt 75 cycle model at £15, already in use. ROTARY CONVERTERS (ex. Amstrad.) Input 100/100 v. D.C. Output 50/50 v. D.C. £25.00, raised at 200 watts but capable of 700 watt duty. Fully enclosed, 17x11 in. by 8in. Weight approx. 100 lbs. £15 over. ltd. ANODE CONVERTERS (Rotary Transformers). This is the really useful one. Input 50/50 v. D.C., output 500 v. 150 in. D.C. Ideal for mobile radio and small amplifiers. etc. In makers' cartons, £12/6. PIEZO-ELECTRIC HEADPHONES. (Rotherurel) Exceptional limited offer. With adjustable headbands. Response 60/10,000 cps. Weight 6 oz. Used in normal way, each provides a perfect piezoelectric microphone without alteration. (Last £3/15/-) A few brand new pairs at 35/-.

**BATTERY CHARGERS.** (Ex Air Ministry). Operation 250/250 v. A.C. Output 5 amps, at 12 v. D.C. Metal (STC) Rechargeable. Lead aiding resistance, 6/P. amplifier, fuse, lead, etc., ready for use. £25.00, raised at 250 watts but capable of 500 watt duty. Fully enclosed, 17x11 in. by 7in. Weight approx. 200 lbs. £25 over. ltd.

**UNIVERSAL IMPEDANCE BRIDGE MODEL UB 202**

This is a self contained universal bridge which measures resistance at DC, Capacity and Inductance at 1000 Cycles. The necessary bridge voltage and null detectors are incorporated in the instrument. Measurements in condensers can be carried out with applied polarising voltage and inductances can be measured with superimposed DC.

Resistance Range .01 ohm to 1 megohm
Capacity Range 10 pf. to 1000 mfd.
Inductance Range 10 µH. to 1000 Henries

For particulars of this and our full range of measuring instruments write to—

**BRITISH PHYSICAL LABORATORIES**

**HOUSEBOAT WORKS, RADLETT, HERTS.**

**Telephone: Radlett 5674-56**

---

**B. I. F.**

See our Stand H57 OLYMPIA

---

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

**Telephone: MUSW 2958**
NITROGOL Capacitors

THE STANDARD OF TECHNICAL EXCELLENCE, QUALITY AND RELIABILITY

The most modern development in Paper Dielectric Capacitors. Subjected to a new and highly specialised process, with extended foil construction and a mineral base impregnant, they have low power factor, low inductance, uniformity of dielectric and small temperature gradient.

They withstand diversity of temperature, humidity and vibration, making them suitable for use in the most arduous conditions.

Manufactured in rectangular metal containers for all normal purposes and in shallow containers for under-chassis mounting, they are fitted with ceramic terminals. Special cylindrical and rectangular designs are available for Television and other small-ripple high-tension applications.

MAKERS OF THE WORLD'S FINEST CAPACITORS

B.I.F. STAND No. H.45.

DUBILIER CONDENSER CO. (1925) LTD.

EMPIRE HALL, OLympia.

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

Phone : Acorn 2241.  
Grams : Hivoltcon, Phone, London.  
Marconi International Code.  
D6.

www.americanradiohistory.com
For every need of consistently accurate electrical measurement, there is a Pullin Instrument.

- Miniature
- Industrial
- Laboratory Pattern
- Portable
- Single or Multi-range

Send your instrumentation problems to us.

MEASURING INSTRUMENTS (PULLIN) LTD
Address all enquiries to Dept. J, Eleetrin Works,
Winchester Street, Acton, London, W.3. Telephone: Acorn 4651-4

Wharfedale W10/CS LOUDSPEAKER
An outstanding Speaker.
Level Response—Clotf Suspension—10" Die Cast Chassis
14,000 lines Magnet. Speech
3 or 15 ohms.
Each Speaker with Calibrated Resonance
PRICE £140-/

Made and Guaranteed by
WHARFEDALE WIRELESS WORKS
BRADFORD ROAD, IDLE, BRADFORD
Telephone: Idle 461 Telegrams: Wharfdel, Idle, Bradford
THIS LITTLE UNIT BEATS THEM ALL!

The Hadley MULTICOM for
COMPLETE INTERNAL COMMUNICATION

HADLEY engineers "scoop" the trade with this new intercom, the first of its kind to provide complete intercommunication between all points.

Secret is the new design auto-control unit, housed out of sight, which cuts the size of the desk unit down to a 6" x 4" cabinet—a marvel in miniature.

Every desk unit has direct contact with all other units while executives can have priority.

THE HADLEY INTERCOMMUNICATOR provides for two-way calling and communication between master unit and any or all of the sub-stations and also incorporates the novel feature of a desk radio which can be relayed to the sub-stations.

THE HADLEY INDUSTRIAL UNIT proved to be well in advance of any similar equipment. Provides all facilities for "Staff Location," "Music for the Workers," "Time Signals," etc.

All Hadley Equipments are available on Cash Purchase or Rental Maintenance terms.

Trade and overseas enquiries invited. Literature on request.

Phone: BEarwood 2575/6

BEARWOOD ROAD, SMETHWICK, STAFFS.
Stabilised Insulation
BY MODERN IMPREGNATION METHODS

HYMEG
HIGH-SPEED PRODUCTION

HYMEG Synthetic Insulating Varnishes are recognised and widely used for their mechanical rigidity, improvement of electrical properties of windings: heat, moisture, oil, acid and alkali resistance as well as for the considerably reduced stoving time necessary. Often faster than infra-red baking with none of the defects, reduced handling, absence of special jigs, with complete freedom from blistering, bubbling and porosity, are some of the advantages claimed and substantiated for HYMEG High Speed Production methods.

HYMEGLAS
GLASS FIBRE INSULATION SYSTEM

This integrated system of development is successful in enabling machines to be designed and operated without weak links in the chain of insulation below 200°C. Thus the fullest advantage is taken of modern glass fibre insulation by providing a degree of bonding and insulation at every point in which the uniting of Hymeg impregnation with the Hymeg as used for subsidiary insulations gives a solid homogeneous winding of equally efficient characteristics and heat resistance throughout. HYMEGLAS therefore virtually eliminates any risk of insulation failure and enables motors and the like to operate under abnormal conditions for long periods without risk of electrical breakdown.

After much research in our laboratories and in conjunction with many well-known specialists manufacturers, we have now evolved the HYMEGLAS System of Insulation which comprises modifications of Hymeg as used for coil impregnation to meet the varying conditions applying to each field of manufacture.

LEWIS BERGER & SONS LTD. (Est. 1760)
35, BERKELEY SQUARE, LONDON, W.1.
Telephone: MAYfair 9171.
MANUFACTURERS OF HIGH - PERFORMANCE INSULATING VARNISHES AND ENAMELS

New Types for Midget Receivers
Hearing AIDS
Meteorological Instruments

HIVAC LTD
Greenhill Crescent. Phone HARROW
Harrow on the Hill, Middx. 0895

Wireless World May, 1948

Radiomart 'Special Offers'

BRAND NEW HEAVY DUTY L.F. CHOKE.
Fully shrouded in cast aluminium rectangular "Pots."   PRICE

30 Hy. 100 m/A 150 ohms (wt. 14 lbs.)       ..     ..     ..     ..     20/-
30 Hy. 126 m/A 100 ohms (wt. 14 lbs.)       ..     ..     ..     ..     22/6
30 Hy. 50 m/A 150 ohms (wt. 18 lbs.)       ..     ..     ..     ..     23/6

(The rating on these can be increased 100 per cent. on "Ham" service.)

BRAND NEW H.V. TRANSFORMERS
Primary 115 volts, sec. 1250-0-1250 v. 200 m/A. Connect two of these in series with secondaries in parallel for 1250-0-1250 v. 400 m/A or secondaries in series for 2500-0-2500 v. 200 m/A in ... 30

(INCLUDE 5/- FOR CARRIAGE ON ORDERS FOR ALL THE ABOVE). H.F. CHOKE.
Pie wound. 250 m/A Tx. type, 1/9 each, 18/- dozen 100 m/A Rx., type 1/6 each, 15/- dozen.
Screened Valve Caps (English type), 6d. each, 4/6 dozen.
Yaxley Switches (small type), 2-pole 6-way, 2/6 each.

Tuning Condensers, small, 20 pl. double spaced, ceramic insulation, double end frames, 3/6 each.

CO-AX CABLE.
Genuine 72 ohms, now reduced to : 1/6. dia., 1/2 per yard; 1/2 dia., 9d. per yard.

CO-AX PLUGS for 1/6. dia. cable, 2/6 each. Sockets for 1/6. plugs, 1/6 each.

CO-AX PYE PLUGS for 1/6. dia. cable, 9d. each. Sockets for 1/6. Pye Plugs, 6d. each.

RADIATOR THERMOMETERS.
These make excellent backwards reading meters for "R" Meters connected in cathode or plate of I.F. Approx. 750 micro-amp movement. Price 3/- each, 30/- dozen.

Best quality Flexible Couplers, 1/4 in. dia. Price 3/- each. New G.P.O. type Relays, 500 ohm coil 4-pole make. Price 3/- each. 9-1 m/A Meters, 2/6 dia. flush mounting, in desk stand, 2/- each.

15 WATT MOBILE AMPLIFIERS. 6N7, 6N7, 2 6L6’s, with built-in rotary converter. For operation off 12 v. D.C. Price 6/2 Folded Horn Speakers for above ... 63

Carriage and packing on Amplifier or Speaker, 10/- each.

RADIOMART LTD
48, HOLLOWAY HEAD, BIRMINGHAM, 1
**TECHNICAL TOPICS**

for Amplifier designers

- **Pentode (or beam Tetrode) or Triode output.**

With the demand for high sensitivity the popularity of an output Pentode (or beam Tetrode) has grown. OSRAM output tetrodes, in particular type KT61, are therefore widely used where the maximum sensitivity is required. Type KT66—a larger tetrode with aligned grids—is unsurpassed in combining high sensitivity with large power output and a long reliable life performance at maximum rating.

For those who demand high quality, triode output is often preferred because of its lower impedance, and not only are directly heated triodes such as types PX4 and PX25 in wide demand, but the tetrode KT66 is also eminently suitable for wiring as a triode, giving similar characteristics to those of the PX25, but with a 6.3 volt indirectly heated cathode.

---

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FILAMENT OR HEATER</th>
<th>V_a</th>
<th>V_g</th>
<th>I_a</th>
<th>OUTPUT POWER*</th>
<th>AS TETRODE</th>
<th>AS TRIODES PUSH PULL PAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SINGLE</td>
<td>PUSH</td>
<td>PULL</td>
</tr>
<tr>
<td>KT61</td>
<td>6.3</td>
<td>0.95</td>
<td>40</td>
<td>4.3</td>
<td></td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>KT66</td>
<td>6.3</td>
<td>1.27</td>
<td>85</td>
<td>7.25</td>
<td></td>
<td>35</td>
<td>400</td>
</tr>
<tr>
<td>KT33C</td>
<td>26</td>
<td>0.3</td>
<td>60</td>
<td>5.0</td>
<td></td>
<td>15.5</td>
<td>300</td>
</tr>
<tr>
<td>PX4</td>
<td>4</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PX25</td>
<td>4</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*With auto-bias in every case.*

---


---

www.americanradiohistory.com
ON CONTAINERS...

Ever considered how important containers are to so many industries? Just look at these containers and imagine what would happen if there were no such things.

Dwell upon madam's temper if she was denied the exquisite pleasure of encasing her figure in armour; what indeed would be lost to the world of gourmets if lobster a la what you please vanished from the à la carte; think of all the funny tales which never would have been if bangers were just a shapeless mass and not their customary disciplined, delectable selves. Above all, think how the further progress of Electronics would have been halted if the new Parmeko Mercury series in their seamless containers had never been developed to operate under any abnormal conditions...

PARMEKO OF LEICESTER
Makers of Transformers.
"...and you shall have music..."

Classics, Ballads, Swing or Jive—whatever your music tastes—you'll get more infinitely more enjoyment from your records if you play them on the new Collaro "De Luxe" Microgram!

Hear your records as they were meant to be heard... enjoy the pure, mellow tone... the faithful, sparkling reproduction... as sharply defined, and as clearly recorded as your reflection in a new cut mirror! Without a doubt, the new Collaro "De Luxe" Microgram is one of the world's finest electric gramophones—and it's portable!

Outstanding design, first class workmanship... the new Collaro lightweight Crystal Pick-up... automatic stop... 6½" Speaker and handsome imitation lizard-skin case with finest chromium fittings—see it... admire it, but above all, ask to HEAR the Microgram at your dealer's showroom today!

Should your usual dealer not have a "DE LUXE" Microgram in stock when you call... just drop a line to Collaro, Ltd. for illustrated literature which describes the Microgram in detail.

RETAIL PRICES

"DE LUXE" MODEL £19 19 0
Plus Purchase Tax, £6 9 8
STANDARD MODEL £16 16 0
Plus Purchase Tax, £5 9 3
Both the "DE LUXE" and Standard Models are suitably connected for A.C. mains supply of 200-250 volts at 50/60 cycles.

The Collaro Microgram
Portable Electric Gramophone

Trade enquiries to COLLARO LTD., Ripple Works, By-Pass Road, Barking, Essex. Telephone: Rippleway 3333
A new range of Eddystone transmitting condensers is now available for immediate delivery. A standard type of construction is employed in all three, the ceramic end plates being 2½ in. square. Losses are extremely small.

The metal mounting plates supplied provide alternative methods of fitting—either directly to a metal chassis or on small stand-off insulators. The former method is satisfactory for C.W. operation with up to 1,000 D.C. anode volts or for telephony with somewhat lower anode volts. If higher voltages are employed, the second method is preferable, since the condenser is then subject to the R.F. voltages only. The rotor plates should be connected to the chassis via a .001 volt fixed condenser.

All three are of split stator type, and are therefore suitable for balanced and push-pull circuits. By strapping the stator plates together, additional capacity values are available for use in single ended or aerial tuning circuits.

The Cat. No. 611 is particularly suitable for use with modern low capacity triodes such as the T20, 4304, and 3ST. The built-in neutralising condensers enable a very compact and efficient push-pull amplifier to be constructed.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Cap. per Section.</th>
<th>Effective Capacity</th>
<th>As Single cond.</th>
</tr>
</thead>
<tbody>
<tr>
<td>611</td>
<td>25 pF</td>
<td>12.5 pF</td>
<td>50 pF</td>
</tr>
<tr>
<td>612</td>
<td>50 pF</td>
<td>25 pF</td>
<td>100 pF</td>
</tr>
<tr>
<td>614</td>
<td>100 pF</td>
<td>50 pF</td>
<td>200 pF</td>
</tr>
</tbody>
</table>

Please order from your Registered "EDDYSTONE" Retailer, as we do not supply direct.

STRATTON & Co., LTD
WEST HEATH
EDDYSTONE WORKS
BIRMINGHAM 31

DAWE
INSULATION
TESTER

TYPE 4028

DIRECTLY MEASURES
10,000 MEGOHMS
at low voltage.

A compact, highly sensitive instrument for measuring Insulation Properties and Leakage Resistance without destructive breakdown; also suitable for Moisture Determinations. A guard circuit is provided for proper elimination of surface leakages.

Range: 0-1 MΩ to 10,000 MΩ. Test Potential: Less than 50 volts. Power supply: Self-contained dry batteries. Size: 4½ x 7½ x 4 deep.

Technical data sent on request to: DAWE INSTRUMENTS LTD. 130, Uxbridge Road, Hanwell, London, W.7. Ealing 6215

Visit our Stand at the B.F. (S.I.M.A. section)

Denco - Chassis

DR 21. For A.C. mains, incorporating the well-known CT 6 Turret (see April W.W.), 5 bands, complete coverage, permeability tuned IF’s. 4 valves, plus rectifier and magic eye, completely aligned and ready to switch on (less loudspeaker) £15 0 0

P.T. £5 3 5

Ask your stockist for details of the Denco range of receivers or components (or write us in case of difficulty).

Denco (Clacton) Ltd.,
OLD ROAD, CLACTON, ESSEX
To take 16 mm. film. Fixed focus lens approx. 5 cm., f/3.5. The illustration shows loading chamber partly open. In metal case. Dimensions 12 x 84 x 21m. With 24 v. motor drive extra. With 12 v. drive, £3.

NEW MILNES H.T. UNITS (Everlasting) 120 v. 90 ma. Will charge from 6 v. LiUs accumulator. For Callers Only. £6.76

WAVEMETER W1191. With frequency chart £7

PIVOTED FLUXMETER A high-grade laboratory instrument unused and in brand new condition, made by Cambridge Instrument Co. Dial reading 90-3-60. Each division equals 10,000 Maxwell Turns. Limited Number Only.

Carr. & pkg. 10/0 £17.10.0

7-VALVE U.H.F. RECEIVER Type R1147A (with 4 Acorn Valves) Range approx. 200 megacycles

A Real Opportunity!

Beautifully constructed and fitted with micro condenser drive. Valve types: two EF39, one EPQ53, three 9B4, one 9A8. In black metal case, 8 x 7 x 6in. Set complete with valves. Carr. paid £27.6. With 4in Cathode Ray Tube, two EF50 and two VR54 valves, potentiometers, etc. Complete on chassis. 15 x 34 x 6in. Carr. and pkg. 15/6 extra. 10/- refunded on return of empty case.

Please Note: All carriage charges relate to the British Isles only • We do not issue lists or catalogues
A hundred years ago communication between prospecting parties and civilization was slow, uncertain and often hazardous. Today a radio telephony link eliminates the difficulties imposed by distance, terrain and climate. Geological, seismic and other prospecting parties all over the world are specifying the 50 watts Redifon GR.49 as essential equipment. This efficient new short-wave radio telephone is very simple to operate, sturdily built and finished to withstand tropical conditions.

Redifon GR.49
Radio Telephone

Redifon Radio

Radio Communications Division
REDIFFUSION LTD., BROOMHILL ROAD, WANDSWORTH, S.W.18
Designers and Manufacturers of Radio Communication and Industrial Electronic Equipment

Fine tone RADIOGRAM from present GRAMOPHONE easily and quickly made IN THE HOME with the

S.H.E.F.I. MOVING COIL PICK-UP
Voigt Patent No. 538058.

High fidelity without shielded transformer. No hum problem. Extreme lightness gives long record life. Complete with Transformer and full instructions. £2 plus Purchase Tax. De Luxe model now available with ball bearing suspension and spring counterbalance. £2.11.0 plus P.T.

Export enquiries invited.

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

You get years of faultless service from...

because they are:
INDIVIDUALLY DESIGNED
RIGOROUSLY TESTED
MECHANICALLY SOUND
ELECTRICALLY PERFECT

12113A
112/13A

S. NORTHGATE STREET, DEVIZES. Phone 536

www.americanradiohistory.com
WEBB'S HEAVY DUTY OPERATING KEY.

The experienced operator will appreciate the perfect balance of this well-made "G.P.O. pattern" key. Heavy lacquered brass movement with back and front contacts.

PRICE £1.8.6

EDDYSTONE SEMI-AUTOMATIC MORSE KEY.

At long last we have a British made "bug" key, capable of high speed and easy adjustment. It is totally enclosed in a streamlined diecast housing, with rubber feet on heavy base. No. 689.

PRICE £3.17.6

EDDYSTONE MINIATURE SPEAKER No. 652.

An efficient little unit in an attractive diecast housing approximately 5¼ in. diameter. Particularly suitable for use with Communication Receivers and as a small extension speaker, impedance 3 ohms. Finished either ripple grey to match "640" or ripple black, both with chromium relief.

PRICE £3.7.6

WEBBE'S "HEAVY DUTY OPERATING KEY.

The experienced operator will appreciate the perfect balance of this well-made "G.P.O. pattern" key. Heavy lacquered brass movement with back and front contacts.

PRICE £1.8.6

EDDYSTONE SEMI-AUTOMATIC MORSE KEY.

At long last we have a British made "bug" key, capable of high speed and easy adjustment. It is totally enclosed in a streamlined diecast housing, with rubber feet on heavy base. No. 689.

PRICE £3.17.6

EX-SERVICE MATERIAL

METERS New and individually cartoned in makers boxes. Extensive stock at a fraction of today's prices.

FLUSH-MOUNTING External Flange 2½ in. SQUARE Fixing Hole Round 2½ in. diameter:

<table>
<thead>
<tr>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/5 milliamps</td>
<td>5/9 each</td>
</tr>
<tr>
<td>0/5 amp. R.F. with self-contained thermo-couple</td>
<td>5/9 each</td>
</tr>
<tr>
<td>The internal thermo-couple can be disconnected, when the fundamental movement is a sensitive milliammeter, full-scale deflection between 1.5 and 3 mA. Four of the above meters (1 of 0/5 mA A and 2 of 0/5 amp. R.F.) at special rates. Four for 25/- (Post free 22/-)</td>
<td></td>
</tr>
<tr>
<td>0/150 milliamps</td>
<td>6/6 each</td>
</tr>
<tr>
<td>0/1 milliamp</td>
<td>10/- each</td>
</tr>
</tbody>
</table>

FLUSH-MOUNTING 2½ in. ROUND Type Meters. External Flange 3½ in. dia. Fixing Hole 2½ in. diameter:

One-milliamp Meters, scaled 0/100—ideal as foundation instruments. Internal resistance 75 ohms marked on each meter.

<table>
<thead>
<tr>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4 amp. R.F. with self-contained thermo-couple</td>
<td>10/- each</td>
</tr>
<tr>
<td>0/05 volts A.C. (moving iron)</td>
<td>7/8 each</td>
</tr>
<tr>
<td>0/20 volts A.C. (moving iron)</td>
<td>8/6 each</td>
</tr>
<tr>
<td>0/15 volts A.C. (moving iron)</td>
<td>8.6 each</td>
</tr>
</tbody>
</table>

Post Customers—Please add ½/- extra on orders for meters (except special 22/- offer of four specified meters).
E.H.T. DEVELOPMENTS

Come to the B.I.F. and see something that has never been done before—5kV D.C. from a 350-0-350 volt A.C. input. Simply connect three wires to the standard mains transformer in a television receiver. No E.H.T. transformer required. Also, a complete new range of high voltage metal rectifiers giving up to 15,700 volts from a pulse input.

WESTINGHOUSE METAL RECTIFIERS

"Westeht" unit, which gives 5kV output from a 350 volt input.

WESTINGHOUSE BRAKE & SIGNAL CO. LTD.

Which Switch

is the right switch?

... is it Rotary or Pushbutton or Slider? Is it wanted for circuit selection, band selection, tap switching? Is it for a new design or in quantities for a well proved circuit?

Whatever it is — the answer is always OAK!

The basic design of all Oak switches is one of strength and efficient functioning, including such exclusive features as the double-contact clip and the floating rotor, ensuring self-alignment of each section.

OAK SWITCHES

BRITISH N.S.F. CO. LTD., Keighley, Yorkshire
(Sole Licensees of OAK Manufacturing Co., Chicago)
A.B. METAL PRODUCTS LTD., Feltham, Middx.
(Sub-Licensees of N.S.F.)
The only Manufacturers of OAK Switches under Patent Nos. 478391 & 478392

DYNAMIC RADIO FREQUENCY RESPONSE CURVES
DYNAMIC AUDIO FREQUENCY RESPONSE CURVES
DYNAMIC MECHANICAL RESONANCE CURVES
DYNAMIC THERMIONIC VALVE CHARACTERISTIC CURVES

The model 1200 Oscilloscope is a basic unit which is complete in itself. It is a first-class general purpose oscillograph with a wide field of application. Its special features include high gain D.C. amplifiers, symmetrical deflection, and excellent trace definition. It is compact enough to be truly portable. For any of the above special applications we can supply a unit which will plug into the oscilloscope forming one compact instrument.

Illustrated is the Model 1200 Oscilloscope and the Model 1400 Visual Alignment Generator Unit for R.F. response curves. With these instruments one can show the response curve of an L.F. or R.F. amplifier on the oscilloscope screen. General shape, band width, and attenuation effect can be seen, and perfect alignment is easily accomplished. Overall size dimensioned in combination Instruments, 7in. wide, 11in. high, 9in. long.

- We also make special test equipment for production of radio receivers. We welcome any inquiries in this and allied fields.

Enquiries to:

INDUSTRIAL ELECTRONICS

229, Hale Lane, Edgware, Middx. Tel.: EDG. 7312
Makers of Industrial Controls and Precision Instruments.

Model 1200 Oscilloscope. Price £32
Model 1400 Unit. Price £8 10 0

www.americanradiohistory.com
No. 2 Padding Capacitors

The accuracy and stability of the padding capacitor in a superheterodyne receiver is a major factor in ensuring efficient operation of the set. The high stability and close tolerance of capacitance of U.I.C Silvered Mica Capacitors guarantee efficient operation of the receiver under the most arduous conditions of service. U.I.C Silvered Mica Capacitors used as padding capacitors ensure long, trouble-free life in new designs and reliable performance after servicing.

Build and Service the set with . . .

U.I.C High Stability Capacitors

United Insulator Co. Ltd. Oakcroft Rd. Tolworth Surbiton Surrey
A Growing Audience

More and more people are enjoying good radio entertainment through the smooth power provided by Pertrix accumulators. Every Pertrix product gives a consistently high performance—just a little more than the promise. For trouble-free listening choose the accumulator in the red and yellow pack. Most good dealers stock them.

Holsun Batteries Ltd.
137 Victoria Street, London, S.W.1

Ambassador Radiograms

The best British Radiograms are Ambassador! Overseas buyers will be particularly impressed at our new range and attractive prices.

Limited supplies for home Sales. Write for details.

Ambassador Radio Works
Hutchinson Lane, Brighouse, Yorks.

Varley

Products of Quality & Reliability

Mains Transformers
A.F. Transformers
Smoothing Chokes
Thermal Delay Switches
Power Resistances

Made by
Oliver Pell Control Ltd
Telephone: Woolwich 1422
Cambridge Row, Woolwich S.E.18
The voice coil and centring member assembly of the "Series 700" Reproducers is a further example of the advanced design of these models. The voice coil is wound with wire especially enamelled to give perfect adhesion between the wire and former and between layers and is of the optimum number of turns and weight for maximum efficiency; all models have an impedance of 3.0Ω at 400~. The centring member is made of two layers of Bakelised linen, moulded under heat and pressure with beryllium-copper strips inserted between them; two of these strips form the connections to the voice coil and a third is a balancing member to ensure truly axial movement.

The removal of voice coil leads from the diaphragm itself, hitherto inseparable from the design of the loudspeakers employing corrugated centring members, prevents the inevitable distortion of the cone in assembly by the insertion of eyelets or soldering tags and the asymmetrical loading due to the inertia of the leads and attachments. The two layers of material with fibres disposed at 45° provide a centring member of exceptional radial rigidity, at the same time giving the maximum flexibility in the direction of motion. Lastly, as are all other component parts, this assembly is non-hygrosopic and fully tropicalised.

Reproducers & Amplifiers Ltd., Wolverhampton
Advertisements

Wireless World  May, 1948

Your designs
LET US BRING THEM TO LIFE!

Made in Three Principal Materials

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

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

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

the most difficult problems solved by . . .

Bullers
BULLERS LOW LOSS CERAMICS

BULLERS LTD., 6, LAURENCE POUNTNEY HILL, LONDON, E.C.4
Telephone: Mansion House 9971 (3 lines)  Telegrams: "Bullers, Cannon, London"

Small Geared MOTOR UNITS

Operating valves, dampers on projectors, rotating screens, illuminated signs, small working models, graphic movements for rocking paths, work movement, soldering and welding fixtures, feed of light strip, under process oil.

Drayton "R.Q." Motors are supplied reversing or continuous running, with or without self-switching for 100/110 or 200/250 volts A.C. Final Shaft Speeds 600 r.p.m./127 min. per rev. Torque 60 in. lbs. Consumption 25 W. Send for List 302-1/

Compact-Efficient

This Vibratorpack developed by Specialists will enable users of battery sets to operate from a 6-volt car accumulator, thus eliminating expensive H.T. battery replacements. Careful design has eliminated all interference. Consumption is less than ½ amp.

Masteradio VIBRATORPACK

MASTERADIO LTD., Sales Dept., 319/321, Euston Road, London, N.W.1

www.americanradiohistory.com
It's easy to make Pick-ups — if you know how.

The know-how in the manufacture of

**Lexington**

**MOVING COIL PICK-UPS**

is the result of long experience and precision watch - making standards which give a finely constructed instrument the details of which are shown in the sectional diagram.

**DELUXE MODEL**
- Robust design
- Accidental dropping on record will not damage Pick-up
- Extremely low moment of inertia (80 milligrams total weight of movement)
- Pure sine wave with no harmonic distortion
- Automatic needle or sapphire changing opens new fidelity field to the amateur
- Can be used with normal record changer without fear of damage

Price: £5.10.0. plus 24½ P.T.

**PLUG-IN HEADS**
Available in both junior and De Luxe types to fit Collaro and Garrard arms, thus providing easy change-over from Magnetic types. Input conversion may be required. (See our Technical Brochure.) Price 49/6, plus 11/- P.T. Separate Ejector for De Luxe type, 30/10, plus 5/10 P.T.

Sapphire Needle with specially tapered shank, 15/3 (incl. P.T.).

**PRE-AMPLIFIERS**
Having an inverse of the recording characteristic incorporated are available for use with pick-ups. These are necessary with some amplifiers. Price complete with valve and input Transformer. £6.1.0.

Announcing **The NEW LEXINGTON**

**IS-WATT HIGH FIDELITY AMPLIFIER**

Designed in our laboratories for use with our own Pick-ups; also as an Audio-channel for high quality local station radio feeder units.

The amplifier is available completely constructed or the necessary circuit diagrams and technical details can be supplied to technical amateurs who prefer to do their own construction.

In addition technical details and circuit are also available showing the construction of a high quality **RADIO FEEDER UNIT** incorporating local stations and television sound bands for use with the above amplifier, making a perfect combination for the connoisseur.

Prices and details of the above will be sent upon request.

This service is introduced at the request of the many satisfied users of our Pick-ups.

*Illustrated Technical Brochure* upon request.

Export and Trade Enquiries invited.

---

**Plans for a neighbourly world**

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.
SIX
TRANSFORMERS
& CHOКES

Representing
a range of

144

tyрes

For Immediate or Prompt Delivery

1 Somerford MAINS POWER
TRANSFORMERS—66 types.
2 Somerford OUTPUT TRANS-
FORMERS—8 types.
3 Somerford SMOOTHING
CHOКES—42 types.
4 Somerford DRIVER TRANS-
FORMERS—9 types.
5 Somerford E.Т.Η.
TRANSFORMERS—5 types.
6 Somerford AUTO (voltage change)
TRANSFORMERS—11 types.

Our range of 144 standard
types of Transformers and
CHO克es covers every normal
need of the Radio Industry
and Research Laboratories.
Specifications, prices and
dimensions are given in full
in leaflets available on
request.

All Transformers and
CHO克es are made to meet
the requirements of rele-
vant Government Specifica-
tions.

The name Gardners is synonymous with
the highest standard of material and
workmanship.

GARDNERS
SOMERFORD TRANSFORMERS

Write for List and Specifications to
GARDNERS RADIO LIMITED
Somerford, Christchurch, Hants.
Goodmans 12" P.M. Loudspeaker T.2 is undeniably a most successful loudspeaker. Soundly constructed in every particular, it provides radiogram manufacturers and users of P.A. equipment with a medium-duty reproduce that is robust and capable of providing a very high standard of reproduction.

**GOODMANS**

Loudspeakers

**GOODMANS INDUSTRIES LTD., LANCELOT ROAD, WEMBLEY, MIDDLESEX.
TELEPHONE: WEMBLEY 400 (9 LINES)**

---

The famous Marconi 'Q' METER, TF329G — range 50 kc/s to 50 Mc/s — is now available for immediate delivery.

A range of Inductors and Test Jigs can also be supplied from stock. There is thus no need to wait for the satisfaction that only a Marconi product can give. Full specification on request.

**THE MARCONI 'Q' METER TF329G**

**A DEMONSTRATION CAN BE ARRANGED**

**MARCONI INSTRUMENTS LTD**

ST. ALBANS, HERTS.

Telephone: St. Albans 6161/5

Northern Office: 30 ALBION STREET, HULL. Phone: Hull 16144. Western Office: 10 PORTVIEW ROAD, AVONMOUTH. Phone: Avonmouth 438.
Southern Office & Showrooms: 10 EATON SQUARE, LONDON, S.W.1. Phone: Sloane 8615
Fifteen years ago we introduced the first British-made low-loss ceramic. To-day the range of Frequentite components covers more than a thousand pieces of every shape and size.

With such a store of manufacturing experience we are able to offer advice backed by practical knowledge on your insulation problem. Please consult us before you finalize your design.

STEATITE & PORCELAIN PRODUCTS LTD.

The Brimar metal rectifier type SB3 is a big brother to the popular SB2 and is rated at 270 volts, 65mA. It is fitted with an insulated bracket and may be mounted horizontally on chassis or cabinet as required.

The SB3 will replace the 117Z6GT in the usual American AC/DC/Battery receiver and will substitute for the rectifier sections of types 117N7GT, 117P7GT and 117L/M7GT. In such receivers, the filament supply for the battery valves is taken from the rectified H.T. via a suitable dropping resistor.

After Brimarizing, the H.T. should be between 80 and 100 volts and this must give 1.4 volts across each filament section. To obtain these readings the line cord may need adjustment, an average value being 800 ohms for a mains input of 230 volts.

If modulation hum is present, it may often be eliminated by fitting an 8 mF condenser between the screen grid (Pin 4) of 1A7G and chassis.

**KEY CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Type</th>
<th>117Z6GT</th>
<th>SB3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Voltage</td>
<td>117 v.</td>
<td></td>
</tr>
<tr>
<td>Heater Current</td>
<td>0.075 amp.</td>
<td></td>
</tr>
<tr>
<td>R.M.S. Input</td>
<td>235 250 v.</td>
<td></td>
</tr>
<tr>
<td>D.C. Output</td>
<td>60 65 mA.</td>
<td></td>
</tr>
</tbody>
</table>

**TYPE CHANGE FROM OTHER WORK NECESSARY PERFORMANCE CHANGE**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CHANGE SOCKET FROM</th>
<th>TO</th>
<th>OTHER WORK NECESSARY</th>
<th>PERFORMANCE CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>117Z6GT</td>
<td>International</td>
<td>NO CHANGE</td>
<td>1. Fit rectifier Type SB3.</td>
<td>Receiver will function almost immediately on switching &quot;on,&quot; no warm-up time being necessary.</td>
</tr>
<tr>
<td></td>
<td>Detail</td>
<td></td>
<td>2. Connect + ve (Red) tag to Pins 4 and 8 of Valve Socket.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Connect - ve (Black) tag to Pins 3 and 5 of Valve Socket.</td>
<td></td>
</tr>
</tbody>
</table>

**SUPPLIES OF TYPE SB3**

Supplies of Type SB3 may be obtained via your wholesaler from:

Standard Telephones and Cables Limited, Valve Works, Footscray.

Retail price - 10/6 each.

The next issue will BRIMARIZE Types 117L/M7GT, 117N7GT & 117P7GT.
This is a 10-valve amplifier for recording and play-back purposes for which we claim an overall distortion of only 0.01 per cent., as measured on a distortion factor meter at middle frequencies for a 10-watt output. The internal noise and amplitude distortion are thus negligible and the response is flat plus or minus nothing from 50 to 20,000 c/s and a maximum of .5 db down at 20 c/s.

A triple-screened input transformer for 7½ to 15 ohms is provided and the amplifier is push-pull throughout, terminating in cathode-follower triodes with additional feedback. The input needed for 15 watts output is only 0.7 millivolt on microphone and 7 millivolts on gramophone. The output transformer can be switched from 15 ohms to 2,000 ohms, for recording purposes, the measured damping factor being 40 times in each case.

Built-in switched record compensation networks are provided for each listening level on the front panel, together with overload indicator switch, scratch compensation control and fuse. All inputs and outputs are at the rear of the chassis.

Send for full details of Amplifier type AD/47

C.P. 20A. 15 WATT AMPLIFIER

For 12 volt battery and A.C. Mains operation. This improved version has switch change-over from A.C. to D.C. and “stand by” positions and only consumes 5½ amperes from 12 volt battery. Fitted mu-metal shielded microphone transformer for 15 ohm microphone, and provision for crystal or moving iron pick-up with tone control for bass and top and outputs for 7.5 and 15 ohms. Complete in steel case with valves.

As illustrated. Price £28 0 0

RECORD REPRODUCER

This is a development of the A.C.20 amplifier with special attention to low noise level, good response (30-18,000 cps.) and low harmonic distortion (1 per cent. at 10 watts). Suitable for any type of pick-up with switch for record compensation, double negative feedback circuit to minimise distortion generated by speaker. Has fitted plug to supply 6.3 v. 3 amp. L.T. and 300 v. 30 m/a H.T. to a mixer or feeder unit.


Vortexion Limited

257-261 THE BROADWAY, WIMBLEDON, LONDON, S.W.19

TELEPHONES: Liberty 2814 and 6242-3.

TELEGRAMS: "VORTEXION, WIMBLE, LONDON."
British made to an exacting tropical specification. Most standard items available from stock. Enquiries invited from Dealers and Wholesalers. If you need sound equipment, write or phone the Amplifier Sales Manager.
Radio Gram Cabinets. Dignified £2 9s. good duty and robust.

METAL RECTIFIERS.

Output: 300 v. 60 ma., 250 v. 50 ma., 180 v. 50 ma., 50 v. 30 ma., 25 v. 30 ma., 7.5 v. 50 ma.

Main Transformers at exceptional prices. All heavy duty and robust. All 250 v. 50 cycles input.

Type

300 v. 60 ma., 250 v. 50 ma., 180 v. 50 ma., 50 v. 30 ma., 25 v. 30 ma., 7.1 v. 50 ma.

35 v. 4 ma., 30 v. 4 ma., 20 v. 4 ma., 25 v. 4 ma., 10 v. 4 ma.

Also available complete with electric motor, auto duty and magnetic pick-up £37 19s. Ditto, with Rotherham Crystal Pick-up £29 12s.

Riolo, One of the Army’s finest Communications Receivers. (See "Outfit," Aug., 1945.) 9 Valves, R.F. and one Frequency Changer. 2,1 F.F., 465 v. (2D) 2nd Detector, A.V.C. A.G., A.C. mains, 100-250 volts or 12 v. accum. Frequency range 175 to 7 m.c., 7.25 to 29 m.c., 29 to 37 m.c. 120-220 v., 100 ma. Monobloc L.B. built in. Complete. Write for full details. £16 10s. complete.

GoverNMENt SuRPLUS

New 1948 Midget "K" R.F. Radio Kits with illuminated Glass Dial. All parts including Valves, M.C. Speaker and instructions. 4 Valves plus Metal Rectifier, 200-257 volts 500 to 250 v. A.C. or A.C./D.C. mains. State which is required. Price, £14 6s. 6d. including Purchase Tax. An attractive boxed Raxallie Cabinet can be supplied for either kit at £17 6s., including Purchase Tax.

GovernMENt SuRPLUS

Kiosk, one of the Army’s finest Communications Receivers. (See "Outfit," Aug., 1945.) 9 Valves, R.F. and one Frequency Changer. 2,1 F.F., 465 v. (2D) 2nd Detector, A.V.C. A.G., A.C. mains, 100-250 volts or 12 v. accum. Frequency range 175 to 7 m.c., 7.25 to 29 m.c., 29 to 37 m.c. 120-220 v., 100 ma. Monobloc L.B. built in. Complete. Write for full details. £16 10s. complete.


New 1948 Midget "K" R.F. Radio Kits with illuminated Glass Dial. All parts including Valves, M.C. Speaker and instructions. 4 Valves plus Metal Rectifier, 200-257 volts 500 to 250 v. A.C. or A.C./D.C. mains. State which is required. Price, £14 6s. 6d. including Purchase Tax. An attractive boxed Raxallie Cabinet can be supplied for either kit at £17 6s., including Purchase Tax.

Riolo, one of the Army’s finest Communications Receivers. (See "Outfit," Aug., 1945.) 9 Valves, R.F. and one Frequency Changer. 2,1 F.F., 465 v. (2D) 2nd Detector, A.V.C. A.G., A.C. mains, 100-250 volts or 12 v. accum. Frequency range 175 to 7 m.c., 7.25 to 29 m.c., 29 to 37 m.c. 120-220 v., 100 ma. Monobloc L.B. built in. Complete. Write for full details. £16 10s. complete.

GoverNMENt SuRPLUS

New 1948 Midget "K" R.F. Radio Kits with illuminated Glass Dial. All parts including Valves, M.C. Speaker and instructions. 4 Valves plus Metal Rectifier, 200-257 volts 500 to 250 v. A.C. or A.C./D.C. mains. State which is required. Price, £14 6s. 6d. including Purchase Tax. An attractive boxed Raxallie Cabinet can be supplied for either kit at £17 6s., including Purchase Tax.

Riolo, one of the Army’s finest Communications Receivers. (See "Outfit," Aug., 1945.) 9 Valves, R.F. and one Frequency Changer. 2,1 F.F., 465 v. (2D) 2nd Detector, A.V.C. A.G., A.C. mains, 100-250 volts or 12 v. accum. Frequency range 175 to 7 m.c., 7.25 to 29 m.c., 29 to 37 m.c. 120-220 v., 100 ma. Monobloc L.B. built in. Complete. Write for full details. £16 10s. complete.

GoverNMENt SuRPLUS

New 1948 Midget "K" R.F. Radio Kits with illuminated Glass Dial. All parts including Valves, M.C. Speaker and instructions. 4 Valves plus Metal Rectifier, 200-257 volts 500 to 250 v. A.C. or A.C./D.C. mains. State which is required. Price, £14 6s. 6d. including Purchase Tax. An attractive boxed Raxallie Cabinet can be supplied for either kit at £17 6s., including Purchase Tax.

Riolo, one of the Army’s finest Communications Receivers. (See "Outfit," Aug., 1945.) 9 Valves, R.F. and one Frequency Changer. 2,1 F.F., 465 v. (2D) 2nd Detector, A.V.C. A.G., A.C. mains, 100-250 volts or 12 v. accum. Frequency range 175 to 7 m.c., 7.25 to 29 m.c., 29 to 37 m.c. 120-220 v., 100 ma. Monobloc L.B. built in. Complete. Write for full details. £16 10s. complete.

GoverNMENg SuRPLUS

New 1948 Midget "K" R.F. Radio Kits with illuminated Glass Dial. All parts including Valves, M.C. Speaker and instructions. 4 Valves plus Metal Rectifier, 200-257 volts 500 to 250 v. A.C. or A.C./D.C. mains. State which is required. Price, £14 6s. 6d. including Purchase Tax. An attractive boxed Raxallie Cabinet can be supplied for either kit at £17 6s., including Purchase Tax.
Quali... ACKNOWLEDGED THROUGHOUT THE WORLD

ERIE Radio Electronic Components

RESISTORS · CERAMICONS · HI-K CERAMICONS · POTENTIOMETERS
SUPPRESSORS · VITREOUS ENAMELLED WIRE-WOUND RESISTORS

Erie Resistor Ltd., The Hyde, London, N.W.9, England
Telephone: COlindale 8011-4. Cables: RESISTOR, LONDON.
Factories: London & Gt. Yarmouth, England · Toronto, Canada · Erie, Pa., U.S.A.
They'll never miss a minute of Children's Hour if you rely on Exide H.T. Accumulators and Drydex H.T. Batteries

Issued by The Chloride Electrical Storage Company Limited

---

Wireless World

Your Best Set's Most Important Accessory

No set is complete without at least one Stentorian speaker to allow you to enjoy the luxury of radio away from the receiver—in the kitchen or bedroom, for instance. And the quality of the most magnificent set will be matched without fault, for each Stentorian provides a high level of output with distortion-free reproduction—and is housed in a handsome wooden cabinet of perfect acoustical construction. Ask your local dealer about them. Prices from 39/6d. with 5" speaker, to £5. 15. 6d. with 9" speaker and matching transformer.

---

Stentorian

—the finest extra SPEAKER for any set

Whiteley Electrical Radio Co. Ltd., Mansfield, Notts.

Aligned in actual receiver OSMOR "Q" Coils Pack Will improve Superhets 15%

| 3⅛ x 2⅛ x 1⅛ |

33'-

Including Full receiver circuit and diagram

All Wave-Bands

One hole fixing—only 5 connections.

Efficient • Sensitive • Selective

Individual OSMOR "Q" Coils, S'het or T.R.F. 3/- each with full circuit.

Enquiries are invited from Receiver Manufacturers for Standard or Special Coils

Morgan, Osborne & Co. Ltd.
Warlingham, Surrey
Announcing...

Stabilized Power Supply Unit
Type S.P. 200/100

* 200 volts DC constant from zero to 100 milliamperes.
* Effective 'Internal' resistance is 2 ohms.
* Ratio of mains fluctuations to change in DC volts better than 60/1.
* Less than 2 millivolts of ripple.
* Rectified LT voltage variable from 6.5 volts at 2 amps to 12.6 volts at 1.5 amps.
* LT volt meter and Rheostat.
* Available for rapid delivery—send for descriptive leaflets.

BIRMINGHAM SOUND REPRODUCERS LTD.
CLAREMONT WORKS, OLD HILL, STAFFS.
PHONE: CRADLEY HEATH 6212-3

To test the effectiveness of a transformer screen, measure the capacity between primary and H.T. secondary; then connect the Neutral terminal of the Bridge to the transformer screen or frame, and the capacity should virtually disappear. This test can be used to determine the existence of an electrostatic screen which may have been connected internally to the frame of the transformer.

Wayne Kerr

WAYNE KERR LABORATORIES LIMITED., NEW MALDEN, SURREY • TELEPHONE MALDEN 2202

COMPONENT BRIDGE B101
5 pfd. to 500 mfd. — — 8 ranges
5 ohms to 500 M/ohms — — 8 ranges
0-1 Hy. to 5,000 Hys. — — 4 ranges
Leakage 0 to 1.5 m/s.
Precision Comparator
PRICE 26 GNS.
The LARGEST PRODUCERS of FLEXIBLE SHAFTING

TORSIONAL REMOTE CONTROL and FLEXIBLE SHAFT ASSEMBLIES

Power shafts for High Speed Operation
Deflectionless Slow Speed Operation
Torsional Shaft Operation

SSW

The S.S.W. White Company of Great Britain Ltd
BRITANNIA WORKS - SAINT PANCRAS WAY - CAMDEN TOWN - LONDON - N.W.1
TELEPHONE: EUSTON 5393

W. T. 59

The MICOVAC ELECTRONIC TESTMETER

22 Ranges.
Long-life batteries.
VHF probe and 5000v. D.C. multiplier optional.

The multi-range meter that will measure A.F. & R.F. signal voltages!

PRICE £24.10s.

ELECTRONIC INSTRUMENTS LTD
17 Paradise Road, Richmond, Surrey

Resistors produced by the cracked carbon process remain stable to ± 1% of initial value.
★Tolerance ± 1%
± 2% ± 5%
Low temperature co-efficient.

Two Amplifiers covering all normal requirements for the highest quality record reproduction.

THE CONCERTO 12 watts—8 triodes plus rectifier. Separate treble and bass controls with two steps of bass boost. £27.10s.

THE K1 5 watts—7 valves. Compare this specification with any other 5 watt amplifier in this price region. Push-pull with negative feed-back, distortion less than 1 per cent. Separate treble and bass controls. 17 gns. Available as a kit 13 gns. Blueprint separately 2/6.

Both Amplifiers are designed to take any type of Pick-up, Moving Coil, Moving Iron, or Crystal, without additional pre-Amplifiers or Tone corrections. Radio input sockets are provided and tapped output transformers provides 15, 7 and 3 ohm impedances.

Send stamps for fully illustrated catalogue of Amplifiers, Pick-ups and Speakers.

CHARLES AMPLIFIERS LTD., 1e, Palace Gate Kensington, W.8.
(WEStern 3350)
**CONSOLE REPRODUCER MODEL KC10**

Designed for better listening in the home, the KC10 Console Reproducer incorporates the K12/10 12 in. moving coil loudspeaker in an acoustically damped, totally enclosed, cabinet of optimum dimensions. The walnut veneered cabinet is hand polished and fitted with an anodised aluminium grille. **PRICE 20 Gns.**

**VITAVOX**

**MANUFACTURERS OF SOUND EQUIPMENT**

**VITAVOX LIMITED**
Westmorland Road, London, N.W.9, England

---

**PRECISION COMPONENTS**

**CORD DRIVES**
Now available in five types as illustrated (left to right) Standard, R/V, Reverse, "D" type and "A" type. All one hole fixing.

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

Write for Catalogue No. (W.W.1.)

**JACKSON BROS [LONDON] LIMITED**
KINGSWAY · WADDON · SURREY
TELEPHONE: TELEGRAMS WALTILCO.
CROYDON 27545 PHONE LONDON

---

ELIMINATE SOUN DISTORTION

Can distortion be eliminated? Not quite, of course, but it can be reduced to a minimum by the use of loudspeakers which will introduce as little discoloration as possible—well designed loudspeakers—Vitavox loudspeakers in fact.
OUR packs have been designed for the more advanced type of Radio Receiver, covering wave bands from 5 to 2,000 metres up to 6 Bands. High frequency stages are included together with the necessary padding and trimmer condensers, the whole being carefully aligned and receiver tested. Full details of these packs and other combinations are available on application.

LABORATORY

H. C. ATKINS Laboratories, 32 Cumberland Road, Kew, Surrey

AT 108
PARTRIDGE TRANSFORMERS LTD

FECKING PLACE, LONDON, S.W.9

Telephone: Brixton 6506

19w feeder units. Complete range of aligned and calibrated feeder units with accuracy to ±2% on all models. From 450 to 1,500w. 3, 5, 10, 15, and 20w wave frequency chanter and I.F. stage. £3.75 to £16.10. 1st and double diode tritio; model BS 20, 6 shortwave bands, m.f., S.h.f./S.e.f. scale. Magic Eye Receiver. £3.10. Standard for the finest transformer factory, our offices, stores and workrooms will now be located at this address.

WARNING
Readers are warned that Government surplus components which may be offered through this medium are excluded from the manufacturer's guarantee. Many of these components will have been in storage for a period of time and may have deteriorated as a result of the conditions under which they were stored. We are not responsible for any claims regarding such components purchased.

NEW RECEIVERS AND AMPLIFIERS
WAKE the Easy Way with the Heathkit-Whammy Kit. Includes instructions, volume, tone controls, etc. 

5-WAVEBAND receivers with bandspread L.R.A. transformers, i.f., g.c., pre-amplifiers; 15, 20, 25, 35, 45, 60, 75, 105, 150 watts. £11.05. For end users, trade inquiries invited. 

NEW TRANSFORMERS, FILTERS and other parts throughout the finest quality. Available at factory prices, from stock, same day. Write for additional information and catalogue. 

PARTRIDGE TRANSFORMERS LTD

FECKING PLACE, LONDON, S.W.9

Telephone: Brixton 6506

For the benefit of our many friends we have made arrangements for the immediate supply of special quantities of our standard components (see paragraph below). These can be collected from our offices, stores and workrooms at our standard components prices. Write for details of these and similar items, upon receipt of which you will be supplied. 

SHORT-WAVE Denco communications receiver. Complete kit with all materials, J.F.T. and P.P. in a short-wave technique, you simply have to add the list of this fine instrument. 

For immediate delivery. 

A comprehensive range of mains and audio components is now available from our special stock with quantities of these per return. We would stress that before ordering you send for our list detailing these components. Our stock range now covers almost all normal requirements, and by availing yourself of this service you will save the inevitable delay in the production of special requirements. 

We shall be pleased to send you our list upon receipt of your address.

THE NEW PARTRIDGE MANUAL

The completely revised post-war edition of this new Manual, now available, contains:—

Many useful circuits including New 15 watt high quality amplifier with 40 db of feedback to every stage. Complete information on Sound Reinforcing and Public Address, Acoustical Problems, Cross-overs, etc. An extensive appendix is included consisting of six selected design charts.

Price 5/- Post Free.

PARTRIDGE TRANSFORMERS LTD

FECKING PLACE, LONDON, S.W.9

Telephone: Brixton 6506

WIRELESS WORLD CLASSIFIED ADVERTISEMENTS

ay. 1948
HARLEY-TURNER HIGHEST FIDELITY SERVICE

Having overcome the trials and tribulations inseparable from present-day production we can now offer the complete answer to all your high-fidelity problems.

We can supply limited numbers of amplifiers and our unique T.R.F. local-distant radio unit and, of course, our Harlney-Turner 3 Speaker. In the opinion of those who use our equipment and have seen it out in direct comparison with other outfits costing up to hundreds of pounds, we are, where we always were—at the top of the high-fidelity table.

If you want this unequaled performance readymade, the vital prices are: Speaker £9; Pick-up £6/6/2; 25 watt Amplifier £40/10/.; T.R.F. Radio Unit £19/10/.- P.T.

But if you want to save money without sacrificing anything except a little leisure time in building it, we can supply you with all the information or without the components so that you can make it yourself, always excepting the speaker. Thus a complete kit of parts down to the last screw, to make the amplifier costs £4, and the results will be precisely the same as we guarantee with one we produce.

How this is done is given in the Harlney-Turner Technical Bulletins, price 10/- each, with full text and photo-prints.

The following are ready:

T.B. No. 1 25-watt Amplifier and Power Unit.
T.B. No. 2 T.R.F. Radio Unit.

Others are being prepared.

"New Notes in Radio," at 3½ pt post free, is the indispensable guide to the whole subject, and has already earned hundreds of testimonials for the accuracy of its information and the logic of its arguments. Send for your copy today.

LEWIS GEORGE LABORATORIES LTD.

Solo Agents
Gordon Lawrie & C. Ltd., 47, Deansgate, Manchester, M.1
Some excellent examples of ELECTRAXI BARGAINS

PETROL ELECTRIC PLANTS
Stuart Turner or Pelapar 500 or 1000 c.c. units, £27. All include single cylinder petrol engine, magneto, coupled to 50/70 volt, 10 amp shunt wound dynamo 1,000 r.p.m. on C.F. or T.R.F., 1/50 volt, £4 5s. ex. Battersea Stores. We have a few 1 h.p. engines as above without dynamo but with bed plate, £20 ex. Battersea Stores.

285 LATEST type. 12 volt 10 amp. C.A.V. 1,000 r.p.m., new condition, £4 10s. 6d. 30 volt 5 amp. 1,500 r.p.m. £5. 12 volt 30 amp. 2,000 r.p.m. £7. D.C. Motor Blowers, 24 volt Keef Blackman, 5in. inlet, 5in. outlet, £5.

MOTOR RADIO.
For the Bungalow or Caravan; 12 volt D.C. will lift 3t. throw 10ft. and handle 100 g.p.h., £15 ex. Battersea Stores.

MOTORS a/c/d/c
230 volt sewing machine type, 1/25 h.p., totally enclosed square construction with pulley belt and coupling. Approx. speed 2,800 r.p.m. totally enclosed, ball bearings, as new, £6 10s. 6d.

110 volt D.C. table fans, 10in. blade and guard, 45/-, 50s. D.C. blowers, £7 10s. 6d. ex. Battersea Stores.

INDUCTOR ALTERNATORS.
Output 400/500 watts single or 3 phase 50 cycle 415/240 volts. 4 1/2 h.p. alternator is needed; approx. £35. 110 volt D.C. £2 5s. 6d. 12 volt D.C. £3 10s. 6d. ex. Battersea Stores.

DYNAMOS.
Dynamo 220 volts, 10,000 rev. min., £10. 24 volt 500 rev. min. £3 10s. 6d. ex. Battersea Stores.

TELEVISION SETS.
200/200/500/50 volt 50 cycle 415/240 volts. input. 2 volt 3 amp. and 75 volt 6 amp with 15 taps output, 70/- carriage paid England.

METAL RECTIFIERS.
75 volts 6 amp, £4 10s. 6d. 10 amp 30s. 6d. 15 amp 55s. 6d. ex. Battersea Stores.

ROCKET TUBE.
Small rocket tube, 3 volt 2 amp., exc.

PREPAYMENT HOUSE METER.
Transformer 200/500 watts per 100/- coin by Chamberlain & Hookham, £4.

BATTERY CHARGERS.
A.C. 230 volts 50 cycle 3 amp. £5.45. 36 volt 6 amp, £3 15s. 6d. ex. Battersea Stores.

PREPAYMENT HOUSE METER.
Transformer 200/500 watts per 100/- coin by Chamberlain & Hookham, £4.

INFRA-RED TRANSFORMERS FOR INFRARED LIGHTS.
A.C. 230 volts 50 cycle 3 amp. £5.45. 36 volt 6 amp, £3 15s. 6d. ex. Battersea Stores.

PAYMENT MACHINES.
200/500 watts single or 3 phase 50 cycle 415/240 volts. 4 1/2 h.p. alternator is needed; approx. £35. 110 volt D.C. £2 5s. 6d. 12 volt D.C. £3 10s. 6d. ex. Battersea Stores.

查一下,

<table>
<thead>
<tr>
<th>BATTERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIDE car batteries, quality assured, £40 12v, £60 12v-24v. offers, Jones &amp; Jones, 66 Todd Rd., Leicester.</td>
</tr>
<tr>
<td>BENMOTOR new and unused spares bargain, £20 24v-72v. telephones, £50. 24v-48v. suit first aid kit.</td>
</tr>
<tr>
<td>GLOBE-SKYTE, powerful 211 long, adjustable 21/4 in. lens, £25-£35. 240 volt, £50. carraige paid.</td>
</tr>
<tr>
<td>DYNAMOS, 240 volts, £1,000, 59s. in 5, 7in. spindle, or send 80/- carriage paid.</td>
</tr>
<tr>
<td>BATTERIES, telephones, £50 220 volt, £100-£150. 230 volt de/c. 0.45 amps. filters, £7 10/- Box 6266.</td>
</tr>
<tr>
<td>COBY 240 volt, £100. 240 volt, £120. 220 volt model, £100. 240 volt, £120.</td>
</tr>
<tr>
<td>WESTINGHOUSE, 230 volt de/c. 0.45 amps. filters, £7 10/- Box 6266.</td>
</tr>
<tr>
<td>BATTERY CHARGERS, 240 volt D.C., £50-£60. 240 volt D.C., £60-£70. 240 volt D.C., £70-£80.</td>
</tr>
<tr>
<td>REMARKABLE bargains! We offer two exceptional bargains, ac. 240 volt, £50-£60. separate; 500 watt, £20-£25.</td>
</tr>
<tr>
<td>Some excellent examples of ELECTRAXI BARGAINS</td>
</tr>
</tbody>
</table>


CROMPTON PARKINSON rotary converters, £250. 400 rev. min., £350 750 rev. min., £650. |

DEALER Sells NEW car radio, £395. fitted, £300. 30/6 for spec. |
YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.

YOU can become a first-class RADIO ENGINEER

We are specialists in Home-Study Tuition in Radio, Television and Mathematics. Post-education, now for free booklet and learn how you can qualify for well-paid employment or profitable spare-time work.

T. & C. RADIO COLLEGE

King Edward Ave., Aylesbury, Bucks.

(Post in unsaled envelope, id. stamp)

Please send me true details of your Home-Study Mathematics and Radio courses.

NAME

ADDRESS

W.W.T.
ARMSTRONG

Model RF103
10 VALVE ALL-WAVE SUPERHETERODYNE RADIOGRAM CHASSIS.

SPECIAL FEATURES

10 VALVE CIRCUIT.
R.F. PRE-AMPLIFIER.
WAVE BAND EXPANSION.
LARGE GLASS SCALE.
3 STAGES A.V.C.
TREBLE LIFT CONTROL.
OPERATES ON BOTH RADIO AND GRAMO.
PLUS 6 DB. BASS LIFT ON GRAMO.
(To restore bass cut on some records.)
10 WATT PUSH-PULL OUTPUT.

To export buyers we can confidently recommend the RF103 to any firm abroad contemplating making a high-grade Radiogram or Console radio receiver.

The lively short-wave performance coupled with the excellent quality reproduction ensure an outstanding performance.

We shall gladly make any alterations to the specification to meet individual requirements.

To home buyers demonstration model now available to interested listeners to hear, and to these we can offer a special specification now on request.

It is hoped that a number (very limited unfortunately) will be available for early delivery.

The above model is for A.C. Mains.

We have also a similar model Type UNI 103 for D.C./A.C. Mains.

For sale, B.P.L. oscillator, all ranges, mains operated. — £27.
For sale, Elsmir Avo, Webley. — £65.
Universal Junior Taylormeter, nearly new. — £25.
Philips Tube, 680,000 volt, used, and calibrated to 0.1% accuracy. — Box 6427.
F.R.L. Brand new 6 A oscillator, 50,000 Hertz, liberty built, and calibrated to 1.1% accuracy. — Box 63.
Universal Junior Taylormeter, £6.50.
F.R.L. Junior Portable, crystal, 200,000 volt, with capacity-inductance meter, used, perfect. — Box 659.
For sale, Mullard type 7625 valve tester with bulbs and approximately 400 mA meters. — £15.
A.M. Tube, 5th. as, £10. — Box 94.
Universal Junior Taylormeter, £7.
Philips Tube, 680,000 volt, used, and calibrated to 0.1% accuracy. — Box 6427.
A.M. Tube, 5th. as, £10. — Box 94.
Universal Junior Taylormeter, £7.
LASKY'S VALVE

VALVE MOUTH.

A FEW EXAMPLES OF OUR EXTENSIVE STOCK OF RADIO VALVES:

BRITISH, AMERICAN, AND CONTINENTAL TYPES, AT ALL R.G.T. PRICES.

WE HAVE THE VALVE YOU WANT.


BRAND NEW.

S.62.


BRAND NEW.

S.62.

BRAND NEW G.P.12 CRYSTAL PICK-UP FLANGES TO MATCH WITH PERMANENT WAX STICKS.


This remarkable pick-up, which represents the ultimate in high-fidelity reproduction, is now available in limited quantities through your radio dealer, price $17.65 incl. P.T.

FREE ILLUSTRATED FOLDER describing this new pick-up may be obtained by returning the coupon below.

TO COSMOCORD LTD.

ENFIELD, MIDDX.

Please send folder of ACOS Pick-ups.

NAME

ADDRESS

W.W.

LASKY'S RADIO

370 Harrow Road, Paddington, London, W.9.

Telephone: Cunningham 1979.

HOURS: Mon. to Sat. 9 A.M. to 6 P.M. Thurs. 9 A.M. to 11 A.M.

NEW G.P.12 CRYSTAL PICK-UP FLANGES TO MATCH WITH PERMANENT WAX STICKS.


This remarkable pick-up, which represents the ultimate in high-fidelity reproduction, is now available in limited quantities through your radio dealer, price $17.65 incl. P.T.

FREE ILLUSTRATED FOLDER describing this new pick-up may be obtained by returning the coupon below.

TO COSMOCORD LTD.

ENFIELD, MIDDX.

Please send folder of ACOS Pick-ups.

NAME

ADDRESS

W.W.

COMPONENTS — SECOND-HAND, SURPLUS

CHARLES BRITISH RADIO (LTD.), Ltd.

BRAND NEW MAINS TRANSFORMERS, SEMI-CONDUCTORS, RADIO VALVES, ETC.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.

For the use of semi-conductors, radio valves, etc., the following valves are available:

· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
· 855s Volts 8.5 Volts, Sats. price 21/-.
DENSCERS, 350v, 1. 05mdf, tubular, 3/9 per dozen, 43/- per gross; cash. in advance. manufacturers, Northants.

RIAL rods, whip aerials, tipped molybd-
denium, 12 ga., 3½in x 1in brass spigot one end, 12/- doz.

(1) 41 screened lead-in, skin cable, 181ft long, shielded with splicing tape, 10/-

TAL frypans, copper, 25½ lengths in
each, 27 gauges for operators and stay-
men, 5/-.

DIF switches, 12/- doz., terminal blocks, 2-
small, 7/6 per 100.

20 camera 10 per 100, below.

60 camera 6 lb., (D/PHONES) banana jack-driven coupled alu-
nium diaphragms, double voice-frequency 60db. and 15 db., in new boxed, super sensitive, 22/- asstd., 5/- asstd.

2 new, boxed, super sensitive, 22/- asstd., 5/- asstd.

5% 210 and 230 volts, 560va., 225, 240, and 250 volts, 560va., 1100w.

BER lip, 200-250 ac vol, per 100.

30 ga, brand new, only 45/-

TARY transformers, in 19in long 40. 1/2v. 4/6, 6v. 4/8, 6v. 5/6, 6v. 6/6, 10v. 6/6, 15v. 15/6, 20v. 20/6, 20v. 25/6, 20v. 25/6, 30v. 30/6, 35v. 35/6, 35v. 35/6, 50v. 50/6, 60v. 50/6, 60v. 30/6, 90v. 30/6, 90v. 100/6, 125v. 100/6, 150v. 150/6, 300v. 150/6, 500v, 500v. 500v. 500v. 500v. 500v. 500v.

Mains Transformers (Auto.

HIGH STREET, LEWISHAM, 1.

3 Test SETS. Type II, complete with 4 x 60, (new), 1/25, each. 2/6.

2 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

1 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

Electrical STORES, E. 488.

Telephone : LEE GREEN 0309.

(Great Lewisham Hospital.)

GALPINS - Gals.

TERMS: CASH WITH ORDER.

NO C.O.D.

MAINS TRANSFORMERS (AUTO-

HIGH STREET, LEWISHAM, 1.

3 Test SETS. Type II, complete with 4 x 60, (new), 1/25, each. 2/6.

2 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

1 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

Electrical STORES, E. 488.

Telephone : LEE GREEN 0309.

(Great Lewisham Hospital.)

GALPINS - Gals.

TERMS: CASH WITH ORDER.

NO C.O.D.

MAINS TRANSFORMERS (AUTO-

HIGH STREET, LEWISHAM, 1.

3 Test SETS. Type II, complete with 4 x 60, (new), 1/25, each. 2/6.

2 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

1 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

Electrical STORES, E. 488.

Telephone : LEE GREEN 0309.

(Great Lewisham Hospital.)

GALPINS - Gals.

TERMS: CASH WITH ORDER.

NO C.O.D.

MAINS TRANSFORMERS (AUTO-

HIGH STREET, LEWISHAM, 1.

3 Test SETS. Type II, complete with 4 x 60, (new), 1/25, each. 2/6.

2 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.

1 Test SETS. Type III, complete with 4 x 60, (new), 1/25, each. 2/6.
WIDE BAND R.F. AMPLIFIERS (Amplifier Type A1416A). The unique R.F. equipment designed to feed 7 radio receivers from a single set and covering the frequency band 2 to 20 Mcs, is now offered exclusively by M.O.S. at £101/6d (c. paid).

The power supply forms part of the instrument and will operate any type of receiver. The mains circuit consists of 2 stages of R.F. amplification-giving 20 to 30 Mcs. output between 2-20 Mcs. The input is fed to seven 75 ohm attenuators, each of which is switched in 7 steps. Each step decreases the output by 2.7 db. Valve line-up: E.607, E.605, 5U4G. Each Amplifier supplied with a Burndy Coxial Aerial Connector. ALL INSTRUMENTS BRAND NEW.

RI70A RADAR ANTJAMMING RECEIVERS. A brand new R.F. equipment, complete with 15 new valves. Supplied in transit case. Valve line-up: B EFSO, 2 RL7L, 1 RL8, 1 HRV2, 1 R3, 1 EASO, and 1 CV188. Ideal for conversion to television use. M.O.S. price £30/6d (carr. and pkgs. 5/-).

Stepney, Green 2760-3960.

INFRA-RED IMAGE CONVERTER TUBE. This, in addition to being a highly sensitive photo-tube, can be used for the direct conversion of infra-red into visible light. The action is as follows:—Infra-red falling on the sensitive','layer of photo-electric cells to the size for which a fluorescent image similar to the infra-red image. BUCE. 18-6, each. subassembly 1/6 extra. Explainatory labels (see or on request. BULL'S EX-GOVERNMENT DEPOT, 42-48, WINDMILL HILL, RUISLIP, MIDDLESEX.

HILL & CHURCHILL LTD., BOOKSELLERS

SWANAGE, DORSET

Available from Stock:

Browne, "Theory and Application of Photowaves."

"Electronic Circuits and Tubes," by the War Training Staff of the Craft Laboratory, Harvard University.

Sarbach & Edson, "Hyper & Ultra-high Frequency Amplifiers."

Starr, "Electronic Circuits and Wave Filters."

Terman, "Radio Engineer's Handbook."

Terman, "Measurements in Radio Engineering."

Fink, "Principles of Television."

CATALOGUE ON APPLICATION

WIRELESS WORLD

MIDLAND INSTRUMENT CO. OFFER BRAND NEW GOVT. SURPLUS STOCK

GENERATORS (D.C. Dynamo) output 12-5 v., 125 watts, £3.10s. 6d.; 3 phase 440 volt, 3125 watts, £11.10s. 0d.; 3 phase 440 volt, 50 horse power, £25.10s. 0d.; 3 phase 440 volt, 50 horse power, £50.10s. 0d.

WINDING MACHINES, A.C. 220 volt, 3 phase 25 horse power, £15.10s. 0d.; 3 phase 240 volt, 30 horse power, £15.10s. 0d.; 3 phase 240 volt, 25 horse power, £10.10s. 0d.

AMERICAN L.K. HEADPHONES. No. M12, £5.0s. 0d.; No. M22, £5.10s. 0d.; No. M20, £5.0s. 0d.; No. M21, £5.10s. 0d.; No. M55, £5.10s. 0d.; No. M56, £5.10s. 0d.; No. M25, £5.10s. 0d.; No. M21, £5.10s. 0d.; No. M55, £5.10s. 0d.; No. M56, £5.10s. 0d.

COIL PICKUP

Heads are available to fit Record Changer Arms

WILKINS & WRIGHT LTD.

267, High Road, Handsworth, B'ham 21.

Charles British Radio offers:—

(GOVERNMENT SURPLUS)

BRAND SPANNING NEW 66 INDICATOR UNIT. Type 6A in maker's packing. In Grey Metal case size 18 x 18 x 6 in. Medial-Perrinɩter. Type VCB67, suitable for either scope or televisor. New value as follows: £4.60s. ERM E.39. 20 meters, etc. Price £3.10s. Carriage and packing paid.

TEST SET 67. A mini special edition special purpose scope with 2m. C.B. tube with built in receiver decoder (FPD), contains 11 valves, ± 50, 1,000, ± 3,000, ± 5,000, ± 750, ± 500, ± 50, ± 30, ± 20, ± 10, ± 5, ± 2, ± 1, ± 0.5 volt. Mains 200/250 volt, sets. Price £29.10s. Plus carriage and packing paid.

BRITISH TFP UNIT, complete with 10 valves and many accessories, etc., for test and tuning bargains. Price 25s. carriage and packing paid.

INDICATOR TYPE 162, Contains 2 tubes, VCB437 and VCB67, type 162, 1,000, ± 50, ± 250, ± 500, ± 1,000, ± 3,600, ± 10,000, ± 50,000. Mains 200/250 volt, ^x. Set. Price £2.10s. Carriage and packing paid.

MICROPHONE TYPE 157, Condenser microphone with single channel, £4.10s. Carriage and packing paid.

CHALRES BRITISH (RADIOS) LTD.


Phone: B.Shopegate 2966

www.americanradiohistory.com
THE "FLUXITE" QUINS AT WORK

"Your clothes line won't budge," pointed EE
"It's fixed tight with FLUXITE strikes me."
Bowed Of "Yes, you're right.
You can pull all your might.
That clothes line's over the aerial, see!"

See that FLUXITE is always by you—in the house garage workshop—whenever speedy soldering is needed. Used for over 40 years in Government works and leading engineers and manufacturers. Of all Ironmongers—in tins, 10d, 1/6 & 3/6.

To Cyclists! Your wheels will not keep round and true unless the spokes are tied with fine wire at the crossings and soldered. This makes a much stronger wheel. It's simple—with FLUXITE—but IMPORTANT.

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

ALL MECHANICS WANT FLUXITE

IT SIMPLIFIES ALL SOLDERING

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

FLUXITE LTD.

(Dept. W.W.), Bermondsey Street, S.E.1
COVENTRY RADIO
COMPONENT SPECIALISTS SINCE 1925
ELECTROLYTIC CONDENSERS
New delivery of 1st grade well-known makes; Note our Low Prices.

- Tubular Metal, 2 or 4 mfd., 350 volt
- 8 mfd., 450 volt
- 25 mfd., 25 volt

Prompt Service, Complete Satisfaction.

MOVING COIL HAND MICROPHONES (No. 13)
Bakelite case 2 1/4 diam.
Press-to-talk switch.
Soft rubber suspension.
Cell 40 ohms
(except 450 ohms)
Excellent performance.
Brand new, in original package.
Including postage, 5/- each, or case of ten for 40/-.
 Dispatched same day.

WIRELESS SUPPLIES UNLIMITED
(Props. Unlimited Radio Ltd.)
264-266, Old Christchurch Road, BOURNEMOUTH, Hants.
**HIGH FIDELITY**

A much improved version of our Corner Cabinet is now available, in either whitewood
or walnut veneer. Full details on request.

Our Dealer Units and Amplifiers are now available from stock.

A prototype miniature Hi. Fi. receiver and a special dual button base valves is in course of
development and will soon be demonstrated in our showrooms.

Comes complete for the Partridge 15 Watt Quality Amplifier equipment is available from stock.

Our Price List covering components for High Fidelity equipment will be forwarded on request.

ROGERS DEVELOGMENTS CO.
106 HEATH STREET, HAMPSTEAD, LONDON. N.W.3.

Telephone : HAMPSTEAD 6901

---

100 kcs. QUARTZ CRYSTAL UNIT

**Type Q5/100**

for Secondary Frequency Standards

★ Speed Accuracy better than 0.01%.
★ New angles of cut give a temperature coefficient of 2 parts in a
million per degree Centigrade temperature change.
★ Viscous silver electrodes fired direct on to the faces of the crystal itself, giving permanence
of calibration.
★ Single simple valve circuit gives strong harmonic isolation up to
20 Mcs.
★ Starred based mount of compact dimensions.

PRICE £5.95 Post Free

Full details of the Q5/100, including circuit are contained in our leaflet QI. Send stamp
today for your copy

THE QUARTZ CRYSTAL Co., Ltd.
65-71 Kingston Road,
NEW MALDEN, SURREY

Telephone : MALDEN 0334

---

A SENIOR laboratory engineer required by a well-known radio and television instrument manufacturer, and possesses
a good knowledge of electronics and radio engineering. Applicants should be aged between 25 and 35 years old, possess
at least a B.Sc. degree in Electrical Engineering, and have a minimum of 5 years' experience in the design of
radio and television equipment. Applicants should be able to work independently and in a team environment, and
be able to interpret technical drawings and specifications. Applicants should also be able to write clearly and
accurately, and have good communication skills. The successful applicant will be offered a competitive salary
package and benefits package. Applications should be sent to the Personnel Manager, the company.

---

For Export And Home

LOWTER SWIFT

Described & Manufactured by:

THE LOWTER MANUFACTURING CO.
Lowther House, St. Mark's Road,
BROMLEY, KENT.

Rav. £25.

TELEVISION

The advance in Radio Telegraph offers unlimited opportunities of high pay and secure posts for those
Radio Engineers who have the foresight to become technically qualified. The situation is
good and earnings can be expected to continue for some years. The demand for
radio engineers is high and will continue, and a very high starting salary and
an attractive remuneration package are available. Applications are invited for
the post of radio engineer for a well-known radio and television equipment manufacturer
in the South East. The successful applicant will be expected to work on the design and
development of new products and to contribute to the overall strategy of the company.

Applications should be sent to the Personnel Manager, the company.

---

54 Advertisements

Wireless World

May, 1
ALLANCE'S OFFER
A FAMOUS B2 RECEIVER, COMPLETE WITH POWER SUPPLY.
is receiver is a 4-valve superhet covering 3
quency bands, 150-0.5 mcps, 0.5-90 mc, 9-150 mc. Valve line-up: 7R7 mixer-collator, 7R7 1st F. AVC, 7Q7 2nd F. d. L.E. 7R7 Q.C. and audio output. It is made for phone or C.W. reception, input being taken through a matching transformer, for headphone operation, but can be easily converted for loudspeaker operation.

Ower Supply is self-contained in black metal cabinets, size 9 in. x 4 in. x 4 in. suitable for operation on any voltage between 7 and 250 volts AC or DC; alternatively direct from a 6-volt source. Additional output of 500 volt and 63 volt. Both units are supplied complete in a black metal cabinet with lid. and fixing clamps, measuring 11 x 10 x 10 in.
Complete with the following accessories:
- mains cord with 5 amp. 2 pin plug, plug B.D. adaptor.
- B.C. adaptor to Edison Screw.
- Pair of headphones, spare fuses, two screws.
- Battery, 9 volt, storage cell.


Goods can be sent C.W.O. or C.O.D.

Vallance & DAVISON, LTD.
144 BRIGGATE, LEEDS.
Staff call sign: GERRY, GBSX, GBAD, GBAY.

Wireless World

ALLIANCES OFFER
A FAMOUS B2 RECEIVER, COMPLETE WITH POWER SUPPLY.
is receiver is a 4-valve superhet covering 3
quency bands, 150-0.5 mcps, 0.5-90 mc, 9-150 mc. Valve line-up: 7R7 mixer-collator, 7R7 1st F. AVC, 7Q7 2nd F. d. L.E. 7R7 Q.C. and audio output. It is made for phone or C.W. reception, input being taken through a matching transformer, for headphone operation, but can be easily converted for loudspeaker operation.

Ower Supply is self-contained in black metal cabinets, size 9 in. x 4 in. x 4 in. suitable for operation on any voltage between 7 and 250 volts AC or DC; alternatively direct from a 6-volt source. Additional output of 500 volt and 63 volt. Both units are supplied complete in a black metal cabinet with lid. and fixing clamps, measuring 11 x 10 x 10 in.
Complete with the following accessories:
- mains cord with 5 amp. 2 pin plug, plug B.D. adaptor.
- B.C. adaptor to Edison Screw.
- Pair of headphones, spare fuses, two screws.
- Battery, 9 volt, storage cell.


Goods can be sent C.W.O. or C.O.D.

VALLANCE & DAVISON, LTD.
144 BRIGGATE, LEEDS.
Phone 29428.
Staff call sign: GERRY, GBSX, GBAD, GBAY.

Judix
B.B. LTD.
Electro-Mechanical Engineers

- Disc Recording Equipment
- Studio and Mobile
- Gramophone Reproducer
- Turntables, Synchronous and Non-Synchronous Types.
- Ribbon Microphones.
- Specialised Receivers and Amplifiers for Schools Instal.
ations.

EXPORT ENQUIRIES INVITED

39/43 WEST HILL,
LONDON, S.W.18
Telephone: BERmondsey 1220

THese are in stock

Television Receiver Construction.
2s. 6d. Postage 4d.

Radio Valve Data Pocket Book.
By F. J. Cam. 5s. Postage 3d.

Television Receiving Equipment.
By W. T. Cocking. 12s. 6d. Postage 5d.

The Cathode Ray Oscillograph in Industry
3rd Ed. By W. Wilson. 18s. Postage 6d.

A Practical Course in Magnetism, Electricity
and Radio.
By W. T. Perkins and A. Charlesby. 10s. 6d. Postage 4d.

Foundations of Wireless
By M. G. Scroggie. 7s. 6d. Postage 4d.

Classified Radio Receiver Diagrams.
By E. M. Squire. 10s. 6d. Postage 4d.

Radio Aids to Navigation.
By R. A. Smith. 9s. Postage 3d.

Radio Data Charts.
By R. T. Beatty. 7s. 6d. Postage 4d.

The Principles and Practice of Wave
Guides.
By L. G. H. Huxley. 21s. Postage 6d.

By Henney. 4s. Postage 9d.

Elements of Radio Servicing.
By Marcus and Levy. 27s. Postage 7d.

Frequency Modulation Engineering.
By C. E. T. 28s. Postage 6d.

The Wireless World Data Valve.
Postage 2d.

Cathode Ray Oscillographs.
By Reyner. 12s. 6d. Postage 4d.

We have the finest selection of British
and American radio books. Complete
list on application.

THE MODERN BOOK CO.
(Dept. W 4)
19-23, PRAED STREET, LONDON, W.2.

A NEW TELE-RADIO
CHASSIS
Model A70

6-Valve A/C MAINS R/G CHASSIS:
15-50, 200-600, 540-2,000 Metres
with TUNING INDICATOR, TONE
CONTROL.

14 Gns. plus P. Tax.

Also available is tuning unit feeding push-pull !

Send 24d. stamp for full illustrated lists to
THIS TELERADIO CO.,
157, FORE STREET, LONDON, N.13
Tott.: 3386

www.americanradiohistory.com
MORSE CODE TRAINING

There are Candler Morse Code Courses for
BEGINNERS AND OPERATORS. Send for this Free
"BOOK OF FACTS" It gives full details concerning all Courses.

THE CANDLER SYSTEM CO.,
Room 55W, 121 Kingsway, London, W.C.2
Candler System Co., Denver, Colorado, U.S.A.

IN SPITE OF DIFFICULTIES SERVICE ON LOUDSPEAKERS IS BEING MAINTAINED. Use service on PMU's must await an improvement in Mr. Viogt's health.

VOIGT Patents Ltd.

NON-MAGNETIC TURNTABLES

with

STROBOSCOPIC MARKING

An essential accessory for serious PICK-UP DESIGN RESEARCH

SOUND SALES LIMITED

57 St. Martin's Lane, London, W.C.2
Temple Bar 4284
Works: Farnham, Surrey

VIBRO-ARC ELECTRIC METAL ENGRAVING TOOL

Engraves, etches, marks, writes... on
BRASS, COPPER, SILVER, NICKEL, ALUMINIUM, CHROMIUM, Harlessen Steel

WE OFFER

A large range of used and new Test Equipment, Converters, Recorders, Amplifiers, Motors, Transformers, etc.
All guaranteed and at very attractive prices.

We buy good modern used equipment of all types for spot cash.

UNIVERSITY RADIO LTD.
22 LISLE STREET, LONDON, W.6.2.
Tel. : GER 4447 & 8582.


COMPLETE correspondence course covering amateur and C. & G.I. exans. consisting of 12 lessons, with particulars—everything contained on application from Correspondence College, 72, St. Stephens House, Westminster, S.W.1.


ENGINEERING opportunities—Have you a radiogram to send or a wireless message to read? Ask Mr. Viogt for full particulars—A.M.I.Mech. E, A.M.I.E.E., and all branches of electrical and mechanical engineering. Become technically trained on "no pay--no fee" terms for higher pay and security. The free copy write to I.E.E. (Dept. 50717), 17 Stratford Place, London, W.1.

THE RADIO ENGINEERING SCHOOL—Tuition training, Hamble. Southampton offers full-time residential training for radio engineers seeking responsible positions in industry or civil aviation, students are entered for C. & G. Telecoms and B. I.E.E. examinations as preferred, tuition also available to prepare for A. M. I. E. E. requirements in radio and radar.—For full details send 9d. to 9. E. 506.

THF Institute of Practical Radio Engineers have available Home Study Courses covering the theoretical, mathematical, and practical training in radio and television engineering. The work is suitable for schoolmasters and for I.P.R.E. Service entry and progressive exams, also top class coaching—any make, any price.

The Syllabus of Instructional Text may be obtained free. Apply I.P.R.E., 17 Stratford Place, London, W.1.

AIR BIOGRAPHY.

WEBB'S radio map of the world locates any station heard, size 40 x 30 in. 4/6, post free; on linen or linen, 10/6, post free. WEBB'S radio, 11, Soho St., W.1, Gerrard 2669.

RADIO-TECHNICAL TRAINING

A.M.I.E.E., City and Guilds, etc., on "No Pass—no fee" terms; over 95% success; for full details of modern courses in all branches of electrical technology send for our 112-page hand-book, free and post free-B.I.E.T. (Dept. 388A), 17 Stratford Place, London, W.1.

A.M.I.E.E. Institute of Electrical Engineers.-For radio engineers seeking responsible positions in industry and civil aviation, students are entered for B. I.E.E. and B. M. G. tests. The Institute also offers radio and radar training.-For further particulars write to A.M.I.E.E. (Dept. 388A), 17 Stratford Place, London, W.1.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.-Incorporated under the Stature of the State of New York. Membership is open to all who have graduated as a Bachelor of Science in electrical engineering or equivalent, who are not members of other professional organizations.

A.C.S. RADIO

SPECIALISTS IN AMATEUR AND EXPERIMENTAL SHORT-WAVE EQUIPMENT.

Communications Receivers, Television, High Quality Amplifiers, Radio Receivers and Transmitting Transformers, Valves and Meters, etc.

Send "W" free on request to—

A.C.S. RADIO, 44 Widdmore Rd., BROMLEY Kent.

Phone : RAV 0135

RADIO BATTERY TESTER

Use "Quixo" method of battery testing. Reliable results. Guaranteed.
Send for interesting leaflet £115 on battery testing.

RUN BAFEN, MANCHESTER-

PHOTO-ELECTRIC CELLS

for Talking Picture Apparatus.
Catalogue now available

RADIO-ELECTRONICS LTD.,