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A Multi-range Meter
The "1C5" Short-wave Set
Notes on Photo-electric Cells
Frame Aerials for Portables

The Resistance-coupled Amplifier
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A Study of Oscillators
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B.B.C. Programme Plans

THOSE interested in television are to have at least two full-length plays each week and schedules are now being planned at Alexandra Palace. The service which began on June 7th has already given viewers an indication of the lines on which the service will be planned at least for the next few months. To give all viewers a chance of seeing them, plays first televised during evening transmissions will be given a second performance a day or two later in the afternoon and vice versa. In the case of transmissions of outstanding interest a second repeat may be given.

The general aim of the programme architects is something for everybody including the children, who will have frequent shows of their own on Saturday and Sunday afternoons, though a regular children's feature will be difficult to arrange because transmission hours clash with school times. The outside television unit will transmit direct from the Zoo.

The weekly television magazine "Picture Page," which had such a large following before the war, now takes place on Thursday afternoons and evenings.

Fixtures for the mobile units include visits to Wimbledon tennis for the Wightman Cup and to Lords for the Test Match.

Besides the outside broadcasts viewers will see a number of local O.B.'s from Alexandra Park with visits to the television garden, which has been kept in good condition during most of the war.

The early programme plans cover items like fashion displays and cookery demonstrations, television quizzes, guest nights and regular appearances of well-known dance bands.

Mr. Donald Hobley has been appointed temporarily as a television announcer at Alexandra Palace and will share duties with Miss Jasmine Bligh and Miss Winifred Shotton.

Other posts, it is thought, will be available later.

Queries

WILL readers please note that our query service is discontinued owing to staff shortage, and that letters intended for the Editor should not be enclosed with orders for blueprints or books.

Committee on Patent Law

THE Second Interim Report of the Committee appointed by the President of the Board of Trade to inquire into the changes necessary in the Patents and Designs Acts and the practice of the Courts in connection therewith has now been published. The Report deals mainly with the question of the abuse of monopoly rights in connection with patents and with the trial and cost of patent actions. Copies of the Report (Cmd. 6789), are obtainable, price 9d. (by post, 12d.), through any bookseller or newsagent or direct from H.M. Stationery Office, Kingsway, London, W.C.2.

The Committee are now able to consider proposals for the amendment of the law of patents and designs outside the particular subjects dealt with in the present Report. Any person who wishes to submit suggestions for consideration by the Committee should communicate with the Secretary, The Patents Committee 1944, 25, Southampton Buildings, London, W.C.2.

Amateur Wireless Stations

AS announced elsewhere in this issue applicants for a licence to establish an amateur wireless station who have not previously held a licence to install wireless transmitting apparatus can now apply for such licences, but they will be required to furnish evidence of British nationality and proof that their technical knowledge and operating ability reaches a certain standard.

The proof normally required will be:

(a) in a test, conducted by the Post Office, in sending and receiving morse signals at the rate of 12 words a minute, and

(b) in the City and Guilds of London Institute's "Radio Amateurs' Examination."

Exemptions from one or both of these examinations will be allowed where applicants can produce proof of equivalent or better qualifications. A leaflet will shortly be obtainable from the Engineer-in-Chief (W.S/5) G.P.O. London, E.C.1, setting out particulars of such exemptions. These particulars will include a list of grades in the Forces, as qualifying for exemption.

October 1946

PRACTICAL WIRELESS

Every Month

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The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Wireless." Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, "Practical Wireless" George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

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" Practical Wireless" incorporates "Amateur Wireless."
Sales on Hire Purchase and Credit Terms

The Board of Trade have made an Order, the Hire Purchase and Credit Sale Agreements (Control) Order, 1946 (S. R. & O., 1946, No. 585), adding the following goods to those which are exempt from the control exercised under the Hire Purchase and Credit Sale Agreements (Control) Order (S. R. & O., 1943, No. 321): (1) New gramophones and new radio gramophones and accessories thereto (other than gramophone records); (2) New musical instruments and accessories thereto (other than player piano records). The Order came into effect as from May 3rd.

A copy of this Order is obtainable, price 1d., through any bookseller or newsagent or direct from H.M. Stationery Office, Kingsway, London, W.C.2.

Hertzian Wave Cables

One of the most important problems studied for the after-the-war period in the whole world concerns the utilisation of hertzian wave cables for the simultaneous transmission of hundreds of telephonic ways or for the transmission of high quality television. This problem has now been solved, partly if not on a whole, by French scientists. The equipment offered by the Centre National d'Etudes des Telecomunications at Montmorency, near Paris, provides 13 simultaneous telephonic lines between Paris and Enghien transmitted by waves of 0 and 10 centimetres.

These waves, known as micro-waves, were utilised on a high scale during the war, in radar. An illustration of the whole apparatus is shown above.

Change of Address

The Sales Department of British Mechanical Productions, Ltd., has now removed from its wartime address at Leatherhead to 27, Bruton Street, London, W.1. Future orders and inquiries for Clix radio components should, therefore, be addressed to the Company at their new London office.

Forces' Radio Station

The Colombo broadcasting station of the South-East Asia Command, Radio Seac, is reputed to be the world's most powerful radio station, and one of the most powerful of all stations. Its new 100 kilowatt transmitter is now broadcasting programmes which are heard all over India and the Far East.

"Scrapbook for 1901"

The voice of Marconi was recently heard by listeners in the completely revised edition of "Scrapbook for 1901," first broadcast in 1936. The year 1901 was an important milestone in the development of radio, as it was in that year that Marconi sent the first transatlantic wireless message.

Regional Station to Go

There is a possibility that the B.B.C. will lose one of their Regional stations before the year is out. The reason for this is that the B.B.C.'s new C Programme, intended for the more serious listener, is due to go on the air within the next four or five months, but before it can do so one of the Regional stations will have to go. By international agreement the B.B.C. is allotted 12 wavelengths on the medium band, of which two are for broadcasting to Europe. It has not definitely been decided which station will disappear, but it may be that the Midland Regional and West Regional will be merged.

A Miniature Receiver

Manufacturers have placed miniature receivers on the market from time to time and now America have produced one half the size of a packet of cigarettes. It is capable of receiving time signals, weather reports and sports results.

E.M.I. Factories, Ltd.

Following the information recently released that Electric & Musical Industries, Ltd., were forming a number of new companies, each concentrating on particular activities of the group, the news is now released of the formation of E.M.I. Factories, Ltd. This company will be responsible for the operation of the whole E.M.I. manufacturing network, comprising:

2. The subsidiary factories in Britain.
3. Nineteen overseas factories distributed throughout the world.

The Hayes plant alone covers over 180 acres where, during the past six years, over 14,000 workpeople were engaged on a 97 per cent. war programme.

P.R.O. for Philips Companies

C. R. Lynton-Harris, formerly News Editor in the News Division, Ministry of Information, has joined the Philips group of companies, of Custury House, Shaftesbury Avenue, W.C.2, as Press Relations Officer. The post is a new one for Philips and has been created in advance of full production by the company of many of its standard products and a range of new lines.
Winifred Shotter, stage and screen star, who was recently chosen as woman television announcer for the B.B.C. She was selected from 119 candidates.

Mr. Lynton-Harris was connected with the radio and electrical business for thirteen years prior to his appointment, in 1937, as Press Officer to the National Fitness Council by the Ministry (then the Board) of Education.

Sets from Salvage

A HANOVER factory which builds civilian radio receivers from ex-German army radar and wireless equipment is now turning out finished three-valve utility wireless sets at the rate of more than 100 per week. The receivers, which were specially designed so that components taken from dismantled German army, navy and Luftwaffe equipment could be used, are sold for 250 RM each. Priorities, controlled by the German economic office in Hanover Region, are 90 per cent for schools, youth clubs, bombed-out families, etc., while the remaining 10 per cent go to Army Welfare Services for distribution to British troops.

Science Survey

For the first time in British radio there is a long and weekly period in which scientists talk about their work and current topics. The series is called "Science Survey," and it is heard on the Light Programme every Friday.

Cossor Radar, Ltd.

The above company has been formed as a subsidiary company to the well-known firm of A.C. Cossor, Ltd. Its object is to acquire the Cossor interest in any inventions, including valves, radio transmission and reception, radio-location, engineering equipment and domestic appliances.

Memorial Window to Sir Henry Wood

A WINDOW to the memory of Sir Henry Wood was recently unveiled in St. Sepulchre's Church, Holborn Viaduct. The window was designed by G. E. R. Smith in collaboration with F. O. Salisbury; the mural tablet of Portland stone and slate, in harmony with the general character of the church, was designed by Sir Charles Nicholson and executed by Mr. Esmond Burton. It bears the following inscription:

"This window is dedicated to the memory of Sir Henry J. Wood, C.H., Founder, and for fifty years Conductor of the Promenade Concerts (1895-1944). He opened the door to a new world of sense and feeling to millions of his fellows. He gave his life to music and he brought music to the people."

"Television is Here Again"

THE above is the title of a new film that the B.B.C. is producing in the Alexandra Palace studios. Upon completion it will be for trade transmission only and be used each morning. Many well-known stars are featured in the film.

Secretary Appointed

WING COMMANDER L. R. BATTEN, O.B.E., B.Sc., LL.B., has recently been appointed secretary of the Radio Communication and Electronic Engineering Association. It is one of the constituent associations of the Radio Industry Council.

English Electric and Marconi's

DURING an address to employees at the Marconi Works, Chelmsford, Admiral H. Grant stated that the shareholding of all the companies of the Marconi Group, comprising the Marconi Wireless Telegraph Co., Marconi Instruments and Marconi Marine Co., had been bought by the English Electric Co.
The Band-spread S.W. Three

A Simple Receiver which Brings in Many Stations at Good Loudspeaker Volume

By F. G. RAYER

The circuit of this receiver is shown in Fig. 5 and it will be seen that it is a 1-V-1 arrangement. The R.F. stage is untuned, and although this does not give quite so much gain as a tuned stage would, it is nevertheless worth while. Its use removes aerial dampening and obviates the necessity of ganging two circuits—a particularly difficult matter with band-spreaing—as would be necessary if it were tuned. Plug-in coils are used so that any wavelength can be tuned, and to remove resonant peaks and loss of reaction upon the limits of the tuning ranges a resistor is used in place of the normal reaction choke. V.M. volume control is used, and a paraseed A.F. transformer for maximum gain and stability.

It will be found that the receiver is simple to operate and that many stations can be received at really good loudspeaker volume if a fair aerial is used. For DX listening 'phones will be used. The band-spread capacitor has a reduction drive and enables stations with little frequency separation to be individually logged against dial readings.

Constructing the Receiver

The top of chassis layout is shown in Fig. 2. This is very straightforward and there is very little wiring—only the two leads from the band-spread capacitor and the anode and pre-set leads. The lead from the pre-set...
goes to the grid of the R.F. valve. The anode lead goes to tag 1 of the coil holder, and the band-spread capacitor is connected in parallel with the .00015 mfd. component below the chassis.

The chassis used in the original receiver was 10 in. by 8 in. by 2 in. deep. It was made from three-ply, except for the two side runners, which are of thicker wood to permit of the top, back and front runners being screwed to it. Before screwing the top sheet of ply in position a sheet of copper foil is placed upon it so that the runners hold it in position. The 6 B.A. screws holding the valve holders, etc., will also help to retain the foil in position. This foil is earthed via the mounting bracket of the band-spreaders.

Component Layout

Fig. 4 illustrates the wiring and component layout below the chassis. The reaction capacitor has a small internal-reduction drive to facilitate operation, although this refinement is not absolutely necessary and an ordinary component can be used. The 50,000 ohm potentiometer has an internal 3-point switch and is wired so that when switching on volume is at a minimum, further movement increasing volume. If the reverse proves to be the case the two connections to the outside ends of the potentiometer element should be changed round.

For accurate logging the band-set capacitor should have a very exact type of pointer, close to a dial, so that it may be accurately set. If this is not done the readings of the band-spreader will be modified and the very accurate logging possible will not be achieved. Because of this it is best to contrive a catch which engages with notches filed in the surface of the control knob adjacent to the chassis, or to use one of the special band-set capacitors if this can be obtained.

The earth terminal on the rear runner may be in direct
contact with the wood, but the speaker terminals should
for preference be insulated with paxolin washers. The
small stand-off insulator forms the aerial connection.

Wiring
Wiring should be with a fairly stout gauge of tinned-
copper wire, insulated sleeving being added where
necessary. Wiring connections should be run approximately
as shown, and particular attention given to those in
the tuned circuit. Long connections here will reduce
the minimum wavelength tunable, and connections from
the band-setter should be direct to the coil holder, not
via other connections.

All the battery leads are made from flex and are taken
out through a hole in the rear runner. They may then
be fitted with identifying connectors and twisted together.

The .05 mfd, coupling capacitor should for preference
be of mica insulation, and is screwed to the side runner.
The 1 mfd. component is screwed to the other runner,
and all other small parts are suspended in the wiring.
A knot should be made in the G.B. 4½ volt lead so that
the thin connection from the parafeed transformer will
not be pulled adrift. Connections for the transformer
are not shown as they vary with different makes and are
usually marked on the component.

Using the Receiver
Batteries should be connected as shown for the initial
trial, and the coil for 22-47 metres will probably be best
for the first test. Actually, the layout enables this coil
to tune down to 19.2 metres, when efficiency will be high.
All tuning is done with the band-spreader, and it should,
if course, have a dial upon the front of the cabinet in

Fig. 5.—The circuit diagram.

An A.C. Meter Rectifier

An efficient A.C. meter rectifier can be constructed
as shown in the accompanying sketches. All that is
required is a 4 B.A. bolt (with a piece of systoflex sleeving
pushed on), two copper oxide washers, two paxolin
washers, and three solder lugs. When assembling,
care must be taken to see that the oxide washers are
placed with their polarity reversed, as no reading will
be obtained otherwise.—F. Briggs (Sutton).

Details of the A.C. meter rectifier.
A Multi-range Meter

A Useful and Ingenious All-purpose Meter for the Testing of Components. By J. C. FLIND

(Concluded from page 270, June issue)

THE shunt resistors should be made from suitable resistance wire, and it is important to see, if the wire is taken from an electric heating appliance, that it is not required to carry more than a small fraction of its rated capacity. If this nickel-chrome wire is allowed to heat up its resistance rises, and one is apt to get false readings. Subject to this precaution, however, it is very convenient to use, as it avoids an unwieldy shunt containing perhaps several yards of copper wire.

For series resistors, the most satisfactory to use are the solid carbon type, which can be adjusted by careful filing to give a "spot-on" value, and then varnished to exclude moisture—this is very important if the values are to remain constant over a long period. It will be found, however, that this filing can be a most tedious job, and will very quickly take the edge off any file, so that it is well worth while trying to borrow a small grindstone—even one of the toy variety which used to be on sale for a few shillings—as this will enormously speed-up the job and possibly save spoiling a more expensive tool.

A stout pair of flexible leads, preferably at least a yard in length, completes the instrument, and can conveniently terminate in the largest size of wander-plugs. It is then an easy matter to adapt bulldog and crocodile clips to fit on to these, and also a pair of insulated test-prods some 5 in. or 6 in. long, which will be found handy.

Adjustments and Calibration

In making calibrations, it is advisable to commence with the four lowest ranges of ohms, i.e., those measurements made with the aid of the internal battery. The procedure is simplicity itself: begin with range 1, which uses 1 milliamperc of current. Close the switch S.1 and adjust the potentiometer P.1 until the pointer reads exactly full-scale, indicating a resistance in circuit of zero ohms. Open S.1, and connect across terminals 1 and 2 the known resistors to be used for calibration. The whole scale can be worked out mathematically, according to Ohm's Law, and it will be found that the deflections indicated are a function of the battery voltage, usually taken for this purpose as 1.5 volts per cell. Thus, using one cell, a deflection of 0.5 milliamps (half-scale) corresponds to a resistance in ohms of 1,000 x 1.5, or 1,500. If the test is repeated with the 10 milliamp shunt in circuit, the figure becomes 100 times the battery voltage, or very nearly so.

Actually there is a small difference due to the offset of the internal resistance of the battery, but for all practical purposes this can be neglected.

On range 3, between terminals 2 and 3, and using 1 milliamperc of current, a half-scale deflection, after zero has been set as before, indicates that the value in ohms of the resistor under test is equal to the internal resistance of the meter, irrespective of the voltage of the battery used. The resistors under test are shunted across the meter, and the deflections corresponding to each can be checked by simple mathematics.

In all this work the calculation of intermediate values will be very much simplified by the use of a table of reciprocals or, better still, a slide-rule.

It should be noted that, on ranges 1 and 2, zero ohms is indicated by a full-scale deflection; i.e., the pointer reads 1 milliampere, and at infinity, or open-circuit, the pointer does not move from its zero position. Then the scale thus reads from right to left. In making measurements on ranges 3 and 4, however, the lower the resistance under test the farther the needle moves back towards "zero," so that the scale will read from left to right, infinity or open-circuit corresponding to a scale-reading of 1 milliampere.

Turning now to the ranges of current and voltage measurement, the first thing to do is to choose a suitable set of ranges. Perhaps the ideal is to take 1, 10, 100 and 1,000 as involving no change in the meter scales, but if these values are considered not to give close enough coverage, the best is a series running 0-1, 0-2, 0-5, 0-10, 0-20, 0-50, 0-100, and so on. It will be seen that this

<table>
<thead>
<tr>
<th>COMPONENTS LIST</th>
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<tbody>
<tr>
<td>Case and panel (see text).</td>
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<tr>
<td>One milliammeter 0-1 mA. (Premier).</td>
</tr>
<tr>
<td>One Westinghouse rectifier, 1 mA. (Premier).</td>
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<tr>
<td>Two switches, single-pole 11-way.</td>
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<tr>
<td>Two switches, two-bank five-way (see text).</td>
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<tr>
<td>Two on-off toggle switches.</td>
</tr>
<tr>
<td>One carbon volume control, 100,000 ohms, with switch.</td>
</tr>
<tr>
<td>One wirewound potentiometer, 2,000 ohms.</td>
</tr>
<tr>
<td>Eleven large terminals.</td>
</tr>
<tr>
<td>Two capacitors, 2 mil. or over (one must be paper type, at least 250-volt test).</td>
</tr>
<tr>
<td>One special current transformer (Metropolitan Radio Service Co., see text).</td>
</tr>
<tr>
<td>One dry cell, type U.S.</td>
</tr>
<tr>
<td>Good quality flex for test leads, crocodile clips, probes, etc.</td>
</tr>
<tr>
<td>Flex and bayonet plug adaptor for mains inlet.</td>
</tr>
<tr>
<td>Connecting wire, soldering tags, etc.</td>
</tr>
<tr>
<td>Resistance wire for shunts (see text).</td>
</tr>
<tr>
<td>Carbon-type resistors for multipliers, as required (see text).</td>
</tr>
<tr>
<td>Four pointer-type knobs.</td>
</tr>
<tr>
<td>Two miniature round knobs.</td>
</tr>
</tbody>
</table>
factor multiplying or dividing the scale reading throughout is only 2, and the reason for taking this is that in the stress of experimental and servicing work it is very easy to make the most ridiculous errors in mental arithmetic, and a meter range which has to be multiplied or divided by an awkward figure, or even the familiar 4, can give a lot of trouble.

Calibrating Current

Quite the best method of calibrating current and voltage ranges is to borrow a reliable meter from a friend, but in the absence of this a good deal can be done by the use of accumulator cells for D.C. measurements, or even a good H.T. battery, and for A.C. purposes a transformer. In this connection, however, it must be remembered that the A.C. volts scale, below about 10 volts, is by no means linear and, further, that if the transformer used distorts the wave-form of the supply from a true sine-curve the rectifier will introduce still further errors. It follows that any transformer used

and make a note of the new reading, then close S.3, change the component-under test for another, and repeat the operation. Then, having gone through all the available spare components, close S.3, move the A.C. voltage selector switch to its next higher position, reset the needle to full scale by means of the potentiometer P.2, and repeat the series of measurements.

It will probably be found that the use of three of the voltage ranges, 10 volts, 50 volts and 200 volts, will cover all requirements, and will yield the best-spaced scales.

In the original instrument the ranges so covered are as follows:

- 10 volts: from 1,000 ohms to 500,000 ohms, and from 0.1 mfd. to 0.005 mfd.
- 50 volts: from 5,000 ohms to 2 megohms, and from 0.2 mfd. to 0.001 mfd.
- 200 volts: from 10,000 ohms to 10 megohms, and from 0.5 mfd. to 0.0001 mfd.

Owing to the rather wide tolerances permitted by manufacturers in present-day resistors and capacitors, it is advisable to take readings from as many specimens as possible, and to strike an average where differing readings are obtained.

This concludes the calibration of all ranges, and it remains to place the readings on record in an easily accessible form so that values can be ascertained at a glance, without reference to tables or graphs. The following is suggested as a convenient method.

The Scales

It is inadvisable to attempt to inscribe additional scales on the dial of the meter, as quite apart from the practical difficulties the small figures are not easy to read, and in many cases it will be found that the opening up of the meter will automatically invalidate the maker's guarantee.

The photographs of the completed unit show how this can be overcome. A piece of smooth white card should be cut so as to fit into the lid of the meter box. With ruler and compasses draw up, preferably in Indian ink, a segment of a circle including approximately the same angle as that traversed by the pointer of the meter. Mark off into 10 main divisions, and as many subdivisions as may be found convenient, and ink in clearly along the circumference, numbering from 1 to 10 to correspond with the divisions on the meter scale.

Using the same centre draw up as many more arcs as may be necessary to cover all the scales required, and divide each of them up to correspond with the values of resistance, capacity, etc., ascertained. The writer's instrument has nine such arcs, covering respectively the five ranges of resistance measurement; the three for capacity, and in addition an A.C. current scale, on which the values are plotted as 1.11 times the D.C. readings. For convenience the resistance scales have been drawn up in red ink, and the capacity and current scales in black. The outermost scale has a radius of about 7 in., which allows for good bold figures, and leaves plenty of room for further scales to be added when the instrument is put to other uses, such as direct measurement of output, etc.

The Pointer

If this scale is then fitted into the lid, and held in position with drawing-pins, a suitable pointer can be made up from a strip of transparent celluloid, with a hair-line scribed down the middle. This is pivoted on a drawing-pin or paper-fastener, so that it can traverse the whole area, and it becomes possible to read off instantly and with complete accuracy on any of the scales the values corresponding to any position of the meter needle. If the celluloid pointer is made an inch or so longer than the radius of the outermost scale, another piece of the same white card can be fitted along the top, over the pointer, so that while it is free to move the end will not whip about or suffer accidental damage.

A rear view of the completed meter.
SUCCESS with the 1C5 Midget Portable recently described in Practical Wireless led me to try out this valve for a s.w. receiver, and portability, and freedom from the trouble of large H.T. batteries and charging accumulators, make this a splendid little receiver for the s.w. ham who likes to "explore" for an hour or two the s.w. bands.

Various circuits from Practical Wireless were tried out, but eventually whittled down to a plain circuit using throttle-controlled reaction. The latter, however, was not so good as the normal reaction control, and so the circuit became practically the same as for the Midget Portable, using the 1C5 valve.

It was found, however, that by using a separate plug for H.T. to the screen grid at 18 volts, and 26 volts to anode, very fine reaction was produced. The reaction slides in with just the faint hiss so much desired with no "plop" and the slow-motion dial allows perfect control. It was further found that better results were obtained by isolating the H.F. choke somewhat by taking a short lead to a terminal from the anode and joining the choke from this to one side of phones and H.T. instead of direct from anode. The choke used was unscreened and 3in. in length. A smaller choke would make this procedure unnecessary.

L.T. Supply

The L.T. is a single cell Ever Ready U2 1.5 volts, and for neatness is housed in a bakelite shaving stick holder with a lead soldered to a metal disc (in my case an old penny) passing out at the bottom and going to L.T. positive on the on-off switch. In the lid of the holder a terminal is fitted, adjusted to make a rubbing contact with the negative bottom of the cell which goes into the case upside down. A recess bored in the baseboard makes a nice holding fit for the case.

The valve and coil are mounted on a small metal chassis raised about 1in. above the baseboard which is plain half-inch oak. No metal covering is necessary for the baseboard panel. The variable condenser is

The layout of the components.
The circuit diagram.

mounted well away from the panel and the slow-motion
dials have large metal centre plates. This gives absolute
freedom from body capacity, and no unwanted effects
are to be found in the headphone leads.

Only good components were used, and this, plus the
wide ratio of the slow-motion dial, accounts for much
of the success in this set. The series aerial condenser is
mounted on two porcelain insulators which give perfect
rigidity, and the aerial connector is also porcelain.
Extension spindles were not obtainable, so 1in. dowelling
was used with brass couplers. The reaction condenser
is fixed away from the tuning condenser to avoid
anode-to-grid interaction, but even so it is only 3in.
away. All wiring is 18 gauge, except the H.T. and L.T.
leads, and the wiring in no case (except battery leads)
exceeds 3in. (apart from the special anode and choke
lead which is 3in.).

Results Obtained

The aerial condenser is kept at loose coupling, and
first try-out fixed two American stations and Swiss
Radio. These are now used with ease as "locals" for
testing. Using coils for the 12-25 and 25-49-metre
bands, no dead spots anywhere were experienced.
I have not tried below 10 meters yet. I am convinced
that another IC5 suitably coupled to a speaker of the
right type would produce good speaker results. Myself,
I am content with headphones, which in my case are
of fairly high resistance.

Of course, one does not expect "communications type"
results, but it is highly gratifying to hear those
faint whispers and then bring in the stations, some of
them being real "DX." When I recall the many,
short-wavers I’ve built, of many types and valves, I
ask why wasn’t the IC5 valve produced before this?
Incidentally, I’ve tried one or two British valves of
the r4 type, with similar characteristics to the IC5,
but results do not seem to meet expectations. No
doubt they would if I could find the right circuit and
values. Meanwhile, my IC5 o-1-o gives me all I desire
at the moment.

The set in use is connected to a short aerial, about
23ft. in length, situated in the roof attic, with down
lead about 5ft. With a better aerial for s.w. working
more efficiency may be expected. Earth lead in my
case is rather long, as I live on the second floor of the
house. A short earth lead is recommended.

LIST OF COMPONENTS FOR THE IC5 SHORT Waver

- One tuning condenser, .00015 mfd. (Eddystone).
- One reaction condenser, .00025 mfd. (Eddystone).
- One IC5GT valve.
- One valve holder, Int. Octal, ceramic base.
- One 6-pin coil-holder, ceramic (Raymart).
- Six pin s.w. coils (Raymart).
- Four small stand-off insulators, porcelain (Eddystone).
- One medium stand-off insulator, porcelain (Eddystone).
- One .001 mfd. fixed condenser.
- One .0001 mfd. fixed condenser.
- One grid leak, 5 megohm.
- One s.w. choke 5 to 150 metres (Eddystone).
- One slow-motion dial, 10 to 1 ratio, for reaction
donkey (Ormond).
- One slow-motion dial, 100 to 1 ratio, for tuning
(Unity).
- One metal chassis, 6in. x 5in.
- Four brass couplers for extension spindles.
- Two extension spindles.
- Two condenser (valve) mounting brackets.
- Four terminals (or sockets).
- Three 9-volt grid bias batteries.
- One 1.4 volt dry cell.
- One on-off QMB switch (Bulgin).
- One pair earphones, 4,000 ohms each earpiece
(Sterling).

B.B.C. Year Book for 1946

The B.B.C. Year Book for 1946, recently published,
gives a complete record of the past year’s broad-
casting, and also looks into the future. It covers
every phase of broadcasting activity in the Home,
European and Overseas Services of the B.B.C.

Highly important leading articles, which are headed
with a discussion on "Religious Broadcasting," by
the Archbishop of York, give authoritative views and
inside information on many topics of current interest.
The historical section carries a complete broadcasting
story of how it was possible to keep the Home Service
and also looks into the future. It covers
every phase of broadcasting activity in the Home,
European and Overseas Services being described. The booklet concludes with the reference
section, including the B.B.C. balance sheet and revenue
account.

There are forty pages of photographs running
chronologically throughout the book, and these alone
give a dramatic view of the year. March and April,
for instance, show us Michael Reynolds in Venice and
Stanley Maxted in Munich Gladbach; the last photo-
graph of the book is Monsieur Harold le Druillenc,
New Amateur Wireless Station

APPLICANTS for a licence to establish an amateur wireless station and who have not previously held a licence, or who wish to install wireless transmitting apparatus may now make applications. They will be required to furnish evidence of British nationality and proof that they have a certain minimum standard as determined by the B.B.C. Post Office in sending and receiving morse signals at the rate of 12 words a minute, and in the City and Guilds of London Institute's Radio Amateurs Examination, exemption from one or both of these examinations will be allowed where applicants can produce proof of equivalent or better qualifications. A leaflet is now obtainable from the Engineer in Chief, G.P.O., London, E.C.1, setting out particulars of such exemptions. The full particulars with a list of grades in the forces, service in which will be regarded as qualifying for exemption, the first City and Guilds of London Institute's Radio Amateurs Examination was held on May 8th at technical institutes throughout the country. The fee for the examination which the examination centre may make a small charge for accommodation. Intending candidates who may experience difficulty in finding a suitable examination centre should write to the Superintendent, City and Guilds of London Institute, Department of Technology, 31, Brechin Road, London, S.W.7, who will also supply particulars of the Radio Amateurs Examination on demand.

Recording Television Programmes

LANCE-CORPORAL WOOD, of Enfield, apropos my paragraph dealing with the difficulty of recording television programmes, says: "I think my following scheme would work. All that is needed is to demodulate the vision waves so that they can be recorded, preferably on strip. Demodulation could be done with, say, just for this purpose, 30 m/s. Then, to retransmit the vision waves modulate with the recorded demodulated vision waves. The speech or music could then be recorded in the normal way and then synthesised with the vision waves, but, of course, sent on a different frequency. This method may be worked out on the new system of vision and sound on one frequency." This is the only communication I have received on the subject and I expect all of my readers can see the obvious snags in the above.

G.E.C. Radio Service Bulletins

To help facilitate the repair of G.E.C. radio receivers, radio service bulletins relating to all future G.E.C. receivers will be published in a new form. In past service bulletins the various diagrammatic details have been shown on separate pages opposite the appropriate text. 'To the service engineer this may have been inconvenient, since tracing out the circuit, component values and the relative position of the components may have entailed constant reference to various pages of the bulletin without getting a complete "picture" of all the essentials.

To overcome this, the format of the new G.E.C. Service Bulletins have been arranged so that the schematic diagram, the sub-chassis layout, coil details, underneath view of the bases and all the component values (including details of switch positions) are all once visible to the service engineer without the need for turning the pages. To achieve this, the last few pages of the Bulletin open out as a folder, one page being left blank for personal service notes.

"Their Business in the Great Waters"

DEE to latest developments in radiolocation, ships can now be navigated through the thickest fog with complete safety, be warned in time of unseen shoals and rocks, and the too near and dangerous approach of other vessels.

The mariner of other times
Wrote often in his log
Of two great dangers of the deep—
Uncharted rock and fog.
Through which how many vessels sailed,
Yet came not back again?
"Lost with all hands": their epitaph,
They sank beneath the main.

But science now a guardian finds,
To help our seamen brave,
And bring them safe to port at last
Across the heaving wave.
To those whose genius guards their lives,
With thanks our hearts will fill,
Let this of science be the aim
To save, and not to kill.

"Torch."
Notes on Photo-electric Cells

Reprint of Proc. I.P.R.E.
Technical Paper by
E. G. BULLEY

The structure of photo-electric cells is similar to that of thermionic radio diodes, both consisting principally of two electrodes, cathode and anode. The cathode is the electron source; the anode the recipient.

In some designs the cathode consists of a half-cylindrical or rectangular form of suitable metal coated with a specific photo-sensitive material; in other cases the cathode and photo-sensitive material are deposited upon the interior of the glass bulb. The anode usually consists of a single rod or rectangular nickel loop, assembled centrally in respect to the cathode. This electrode must be kept extremely small in area compared with that of the cathode, so enabling the even distribution of a substantial amount of radiant energy to reach the photo-sensitive surface.

Principle Involved

Bearing this in mind, the principle of the photo-electric cell can be understood by referring to Fig. 1 and studying the following description.

If the cathode is subject to a radiated light and the anode is operated at positive potential, an electron current will flow in the anode circuit. This can be explained by following the basic principle of photo-electric emission.

Discovery of this phenomenon was the result of experiments by Hertz in 1887. It can be linked closely with thermionic emission, but a difference is that the latter depends upon temperature, whereas photo-electric emission is the result of light or radiated energy being directed upon a photo-sensitive surface to cause a flow of electrons. These electrons, as in the radio valve, are attracted towards the anode and set up an electron current, the amount that flows depending upon the wavelength, intensity and the colour of the impinging light. From this it will be seen that the sensitivity of any cell depends greatly upon these factors; therefore, cells are designed to operate from different colours of light, this by using different photo-sensitive materials upon the cathode.

Sensitivity Terms

The sensitivity usually is stated in terms of visible radiation, although at various times it is given in micro-amperes per microwatt of radiant flux; this includes visible radiation, such as light, and invisible radiation, viz., ultra-violet and infra-red. Visible radiation is stated in micro-amperes per lumen of light flux. A lumen is a unit of luminous flux, which can be defined as the amount of light or radiant energy emitted per unit space angle per second by a source whose intensity is one international candle.
Commercial Designs

Typical designs of photo-electric cells manufactured by the G.E.C. are shown in Figs. 2 and 3. Those shown in Fig. 2 have a rectangular-shaped cathode and a rectangular wire loop for the anode. By carefully studying these cells it will be seen that the anode area is considerably smaller than that of the cathode.

Fig. 3 shows other types manufactured by the G.E.C. The KMV6 and CMV6 have a cathode in the form of a rectangular plate, centrally sealed in the bulb and brought out to the screw terminal at the top. The anode in these types is a wire mesh covering the internal surface of the bulb and brought out to the anode and grid pins of a standard four-pin base.

The Osram KG7 has a sensitised potassium cathode and is suitable for use in the blue end of the visible spectrum, particularly in the range of 4,000 to 5,000 Angstrom units. An Angstrom is the unit used for expressing the wavelength of light and ultra-violet radiation, i.e., one Angstrom equals 10^-8 centimetres.

Vacuum and Gas-filled Types

Photo-electric cells are made in two distinct groups, namely the vacuum and gas-filled types. The latter were designed originally for sound reproduction, but because of their sensitivity they now are used in many types of relay circuits.

The former type is found in such equipments as light-operated relays, photometry, colour comparison work and television. This type of cell responds to specific colours in the spectrum, whereas the gas-filled type usually covers a different part of the spectrum.

This cell, therefore, can be used for the detection or measurement of radiation from the already specified end of the spectrum. It is well to mention, however, that the sensitivity of this cell can be secured by increasing the positive potential, though extreme care must be taken not to exceed the value laid down by the manufacturer, otherwise a glow discharge will result and so ruin the cell.

Glow discharge is discussed more fully later in this article, but it is desirable to mention at this stage that if a gas discharge is allowed to pass for a few seconds the cathode surface will be destroyed.

Curves

Figs. 4 and 5 are typical curves published by photo-electric cell manufacturers. These two curves apply to the Osram KG7 and are self explanatory. The curve shown in Fig. 4 indicates the gas factor in relation to the applied potential, whereas Fig. 5 shows the average spectral sensitivity curve for an even distribution of radiated energy upon the photo-sensitive surface.

Photo-electric cell KG7 has an anode in the form of a rectangular wire loop. This is sealed centrally with respect to the cathode, which is deposited upon the interior surface of the bulb. By studying the KG7, it will be noted that the cathode covers the interior of the bulb, with the exception of a small clear window which is necessary to enable the radiated energy to reach the cathode without being obstructed by the anode.

Fig. 4.—Average voltage-current characteristic for Osram Type KG7.

Fig. 5.—Average spectral sensitivity curve.
Blue Glow

Extreme care should be taken when applying the potential to the anode, as excessive voltage will result in a gas discharge, recognizable by a definite blue glow.

This glow or discharge is detrimental to the cell and, unless the correct ratings are adhered to, permanent destruction of the cathode surface is inevitable. It is well to remember, however, that this discharge should not be confused with the ion production necessary in this type of cell.

In comparison with the vacuum type of cell, the vacuum cell is less susceptible to damage when an accidental overload of anode potential is applied for a short period. Naturally, however, it will destroy the cell if kept on for too long a period.

Applications

The applications of photo-electric cells are many and are well known to those engaged in the radio or electronic industry. Cells, to-day, are used for various purposes, such as burglar alarms, smoke detectors, alarm systems, etc. However, whatever the application of any particular cell, the principle is the same: That is, by the interruption of the impinging light that is being directed on to the cathode surface a relay comes into operation and either stops or starts the equipment that it controls.

Practical Applications

To clarify this explanation, here are a few applications in detail. In greyhound racing accurate timing to one hundredth parts of a second is essential. Osram cells are used for this purpose in conjunction with a specially-designed relay and a good-quality timing chronometer. The cell is first set into operation by the impinging light being directed across the track at the winning post and striking the cell on the opposite side of the track. The winning dog passes through the directed light beam and so interrupts it; this interruption immediately stops the emission and so causes a relay to come into operation which automatically stops the timing device and so indicates the time taken by the winning dog. The time is then recorded and the timing device reset to zero for the next race.

Sound Reproduction and Acoustics

Another application which has become extremely popular over the last few years is to sound reproduction and acoustics. A typical circuit is shown in Fig. 6, and the specific component values at the foot of col. i.

Suitable photo-electric cells for this type of circuit are the Osram CMG8, CHG22 or CMG25. These cells when operated at an anode potential of 20 volts produce photo-electric current one or two less proportional to the radiated energy being directed upon the cathode surface.

At higher voltages the ratio of the current to the radiated energy increases in respect of the voltage, due to the presence of gas in this type of cell. To prevent a gas discharge taking place in such cells it is recommended that the gas magnification should be in the order of 25. Gas magnification is the increase over the primary photo-electric current, this primary current being the amount obtained when the cathode emission is more or less proportional to the radiant energy. The excess of the gas magnification value results in a gas discharge, a phenomenon already explained.

Sensitivities

The sensitivity of the CMG8, CMG22 and CMG25 exceeds 75 microamps per lumen, the working voltage lying between 80 and 110 volts. It is a good practice when using gas type cells to incorporate a high resistance in order to try and prevent a gas discharge; this resistance will avoid any increase in working volts.

Photo-electric cell sensitivities are stated by all manufacturers, who also indicate under what conditions they are taken, as well as the anode potential applied.

Local sensitivity must always be avoided, this usually resulting from insufficient distribution of the radiated energy upon the cathode surface.

Television Cells

An application that will be coming back into great vogue is television. The cell here is an essential link in the transmission of pictures, its purpose being to convert the light impulses (radiant energy) into electric currents in such a way that, when these currents are received by the television receiver, they are reverted back into the original light impulses and so form the transmitted picture.

Gas type cells are not recommended for television transmission because they are most reluctant to change their state of rest; this will be appreciable at the very high frequencies that are found in television. It is, therefore, necessary to utilise the vacuum cell for this application, it being essential that the cell selected have a large cathode area.

Development

Photo-electric cells will play an important part in new electronic developments because of their ability to control within very fine limits of accuracy.

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Frame Aerials for Portables—2

(Concluded from page 286, June, 1946, Issue)

By M. D. H. WHITEHEAD, B.Eng.(Hons.)

If a box type aerial is to be used, and it is to be wound on the cabinet and not on a separate frame, the set will have to be designed first so that the cabinet size is known. The size cannot be decided upon, as somewhere several alterations will have to be made to the set when it is built to get maximum efficiency, it is advisable to make a rough frame aerial of any size or use a simple coil with an ordinary aerial and carry it for testing it. By doing this, the final size of the set is known before the frame aerial which is actually to be used on the cabinet is constructed.

Portable receivers are usually in a wooden case covered with rexine or leathert'cloth, the frame aerial being wound on the case underneath it. Some precautions have to be taken to make sure that the windings do not cause unsightly ridges in the rexine, and also that the medium sticking the rexine to the wood does not affect the performance of the aerial.

**M.W. Winding**

![Diagram of M.W. Winding](image)

**L.W. Winding**

![Diagram of L.W. Winding](image)

Fig. 6.—Top view of cabinet, Fig. 7.—Frame for winding showing position of aerial and carrying handle.

The first precaution is easily dealt with and is purely dependent on the gauge of the wire and thickness of insulation on it. The thicker the wire, the more efficient it will be, and also if it is close wound, the greater the winding pitch will be and consequently more turns will be required. It is advantageous to have as many turns as possible since the pick-up is proportional to the number of turns.

To keep the set neat about 34 s.w.g. copper wire is suitable for the medium-wave winding but any copper wire between 30 and 40 s.w.g. will do. If there is plenty of room it is better to arrange the windings with a space roughly equal to the diameter of the wire. For the long-wave section, if one is required, wire somewhere about 40 s.w.g. will have to be used and will have to be close wound otherwise too much room may be taken up. If there is room it is, of course, better to space the turns a little.

The efficiency depends very markedly on the condition of the wood of which the case is made and the way the rexine is stuck to it. The case must be constructed of dry wood. Before commencing to wind the aerial the case should be complete except for the rexine and should be sandpapered and have all the holes cut, etc. Otherwise, damage may be done to the aerial if these have to be done after it has been wound. It should then be thoroughly dried by leaving it in an airing cupboard or a warm room for a few days and then given a coat of shellac both inside and out. The aerial can now be wound. Small countersunk bolts coming through to the inside of the case are best for making the connections, the ends of the windings being soldered to their heads. Make sure that the medium- and long-wave windings are in the same direction and leave a space of at least 3/16 in. between them so as to reduce the effect of the long-wave winding on the medium-wave winding when the set is on medium waves. It is often useful to leave enough room for the carrying handle between the two windings (Fig. 6).

Before proceeding any further, the aerial must be tested. This should be done with the set, speaker and batteries in the case, and the aerial connected up. It will most likely be found that in order to tune the correct range a few turns will have to be taken off or put on, depending upon the effects of the various parts of the set on the inductance of the aerial. This is why the aerial must be tested with the set in the case. When the required turns have been wound, the case should be given another coat of shellac to keep them in place. The rexine is usually glued on to the case, and a good glue should be used. The glue must be kept off the aerial, and it is advisable not to let it come within 3/16 in. of each side of the windings. Also, see that the rexine coming into contact with the aerial is free from glue. A further coating of shellac on the windings and on the inside of rexine will keep it stuck down where it touches the windings, since shellac has slight gluing properties. If glue is used on the windings, the aerial will be very inefficient, even when it has dried, since glue always contains a certain amount of water.

Before fixing the set permanently, the whole cabinet will have to be dried. Usually about a week in a warm place will dry the glue and shellac under the rexine. Not too much heat must be used, otherwise the rexine will start to peel off.

If the case is not to be covered with rexine, the aerial will probably be left exposed. It is better in this case to use a thicker wire, as it gives it greater strength. About 24 s.w.g. is suitable. It is often a good idea to cover an aerial with thin plywood instead of leaving it exposed.

Having the set, speaker and batteries inside the aerial reduces its efficiency slightly. There are certain variations which the individual constructor may think of to overcome this. One of them is to wind the aerial on insulated screws projecting from the front or back of the set, but this may spoil the neat appearance of it. This type of aerial usually has to be piled wound so that it does not project too far and has, therefore, less pick-up properties, so that very little advantage can be obtained.

![Diagram of L.W. Winding](image)

Fig. 8.—Alternative form of pancake aerial.
Pancake Type

This type of frame aerial is probably not quite so efficient as the box type, but very good results can be obtained from it. The windings are usually on a piece of stiff cardboard or plywood, fastened inside the front or back of the cabinet. Slots are cut in the cardboard as shown in Fig. 7, and the wire wound in and out. The slots are each about 1 in. deep, and there must be an odd number.

The cardboard or wood on which the aerial is wound must be dry, and should be given a good coat of shellac as in the construction of the box type. The gauge of wire used is not very important, but it is easier to make a neater job if a fairly fine gauge such as 36 s.w.g. is used. The ends of the windings are best secured by piercing small holes in the cardboard and threading the wire through once or twice. A useful way of protecting the windings is to place the completed aerial in an envelope of suitable size.

Fig. 9.—Connections for external aerial and earth.

Another way of winding the aerial is to use strips of wood mounted diagonally at the corners of the front or back of the set. Saw cuts in these strips of wood hold desirable to use enamelled or s.s.c. wire when winding the windings. It will usually be necessary to put several turns in each slot. About half a dozen slots should be divided between two slots (Fig. 8).

The construction of the pancake type aerial is easier than the box aerial, but on the other hand it is harder to make a really neat job of it, although this is not essential, since it is out of sight inside the cabinet.

Pile Wound Aerials

It is possible to wind a box type aerial without taking any care about putting the turns side by side, but just putting them in a pile. This is not so efficient, since it increases its self-capacity, and those turns on the top of the winding tend to act as a screen to those underneath. These effects are more noticeable on the medium waves than on the long waves.

Usually when on the long waves, both the medium- and long-wave windings are in series. It should be noted that the whole aerial cannot be pile wound in one coil and a section tapped off for the medium wave, since the long-wave section almost entirely screens the medium-wave section when the set is on medium waves.

Ganging

Frame aerials are often used to feed an H.F. valve which is coupled to the detector valve by another tuned circuit. If a ganged tuning condenser is used, a small trimming condenser will have to be put in either tuned circuit, since the frame aerial will not have the same characteristics as the coil. This is usually done by having a variable condenser of 0.00005-0.00001 mfd. capacity in parallel with the frame aerial. A preset condenser cannot always be used, since the setting may not be the same over the whole tuning range.

External Aerial and Earth

External aerial and earth can be connected to improve selectivity and volume in out-of-the-way districts or when long-distance transmissions are being received. When insulation is taken into account the diameter of 34 s.w.g. d.c.c. wire is the same as that of 26 s.w.g. enamelled wire. Also, in wire finer than 36 s.w.g. d.c.c., the insulation accounts for more than half the diameter of the whole wire. It can be seen from these figures that in the construction of frame aerials it is desirable to use enamelled or s.s.c. wire when winding an aerial under flexing, or when the space available is limited.

Insulation of the Wire

If the windings are close wound the winding pitch will depend upon the thickness of the insulation of the wire. A table of these thicknesses is given below. These values are the increase of diameter of the wire due to the insulation (in inches).

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Conclusion

It is possible, and is very often done, to wind frame aerials without the use of formula or without reference to wire tables. The procedure is to guess the number of turns and then wind on more than this. The turns are then taken off one by one until the correct inductance is obtained. In this way the wire does not have to be joined. The snag, of course, is that if the number of turns put on initially is too small, the constructor may go on taking off turns until he realises what has happened. Considerable quantities of wire may be wasted in this way, as it is not desirable to have joins in the windings.

Finally, it must be realised that a frame aerial cannot function if wound on a metal cabinet or if enclosed in one.
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PRACTICAL WIRELESS

July, 1946
The Resistance-coupled Amplifier

Considerations in the Design of the Resistance-coupled Amplifier Stage. By S. A. Knight

The General Amplifier

Before considering the resistance-coupled amplifier proper, a few notes will be made on the equivalent circuit representation of any valve amplifier having an anode load Z (Fig. 1). The change $dI_a$ in the anode current $I_a$ of this amplifier that results from a change in $V_g$ is given by:

$$dI_a = g_m.dV_g$$

Also the change $dI_a$ produced by a small change in the anode potential $V_a$ is given by:

$$dI_a = \frac{I_a}{R_a}.dV_a$$

Thus, the change in $I_a$ due to the simultaneous changes in $V_g$ and $V_a$ is given by:

$$dI_a = g_m.dV_g + \frac{I_a}{R_a}.dV_a$$

In determining the output voltage of an amplifier we are interested only in the change in anode voltage or anode current for a change in the grid voltage. Let us replace $dV_g$ by $V_i$ and $dI_a$ by $I_a$; then, re-writing the last equation we have:

$$I_a = \frac{g_m.R_a}{R_a+Z}.V_i$$

where $\mu$ is the amplification factor of the valve ($= g_m.R_a$). We are now in a position to construct simple equivalent circuits based on this last equation which omits the steady voltages on the various electrodes and the steady anode current flow through the valve. The variations produced in the anode current by the application of an alternating voltage to the grid are exactly the same variations that would be produced if the valve were replaced by a generator whose e.m.f. was $\mu V_i$ driving a current $I_a$ through an impedance consisting of $R_a$ and $Z$ in series (Fig. 2a). By a sign convention, all voltages are measured away from the cathode, and the simple equivalent circuit is usually drawn as shown in Fig. 2b; this circuit is quite important and is the basis of all amplifier design and calculation. We define the voltage amplification factor (V.A.F.) of the stage to be $V_o/V_i$. In the circuit:

$$V_o = I_a.Z$$

But:

$$I_a = \frac{V_o}{R_a+Z}$$

$$\therefore \text{V.A.F.} = \frac{V_o}{R_a+Z}$$

The Resistance-loaded Amplifier

The object of a voltage amplifier is to obtain as much voltage output as possible, usually to pass on to the grid circuit of the following stage. In the resistance-coupled amplifier the anode load consists only of a resistive element, the output of the valve being developed across this and passed to the succeeding stage by way of a coupling condenser and grid leak.

Since the anode load is a pure resistance, the above formula for the voltage amplification factor may be written:

$$\text{V.A.F.} = \frac{\mu.R}{R_a+Z}$$

Substituting $R$ for $Z$. Consider now the effect of making $R$ a multiple of the valve impedance $R_a$. When $R=R_a$, the V.A.F. is $0.5\mu$; when $R=4R_a$ it equals $0.8\mu$; when $R=10R_a$ it equals $0.9\mu$. Thus, the voltage amplification factor of the stage becomes a larger proportion of $\mu$, the amplification factor of the valve, as $R$ increases in value, approaching the value of $\mu$ as $R$ becomes very much greater than $R_a$. In practice, $R$ cannot be too large, since the steady anode voltage on the
valve will be so small that proper working will not be obtained. Also, in the case of pentodes, increasing the anode resistance without changing the screen potential will reduce the anode voltage to a point where a virtual space-charge " cathode " forms in front of the suppressor grid, and the proper valve functions are upset. This makes it necessary to reduce the space current of pentode valves as the anode resistance is increased. The resulting decrease in the mutual conductance of the valve then partly offsets the increased amplification that would be gained as a result of the increase in the anode resistance. The outcome of this is that pentode valves are not particularly critical in the matter of the anode resistance, and values ranging from 100,000 ohms to 250,000 ohms can be employed without greatly affecting the amplification.

With triodes the choice of the anode resistance depends upon the amplification factor of the valve. With high-mu triodes, a value of from \( R_a \) to \( 2R_a \) is quite general, while for medium-mu valves it may be from three to four times the valve impedance. These proportions for the two types of valve correspond to a good compromise between conditions favourable for a maximum undistorted output and maximum amplification.

**Frequency Considerations**

The circuit of a practical resistance-coupled amplifier using a triode is shown in Fig. 3, along with the simple equivalent circuit. The coupling condenser \( C \) is for the purpose of reducing the amplified voltage appearing across the anode resistance \( R \) to the grid of the following valve and also prevent the D.C. voltage on the anode of the amplifier valve from being applied to this grid.

The insulation of \( C \) must therefore be above question. If there is a leak at this point, current will flow through the grid resistance and a positive bias will be given to the grid of the following valve. This effect can be offset by the application of an equal negative bias, but the procedure is not one to be recommended, for the leakage current through a faulty condenser is by no means steady, and erratic bias voltages are bound to be present across \( R_g \). Mica condensers are, of course, the best to use, failing which good paper condensers may be employed. Poor paper condensers and anything savouring of suspicion should never be wired in this position.

The capacity of \( C \) is a matter of considerable importance and is best considered in conjunction with an analysis of the way in which the amplification of the circuit varies with frequency. Such a characteristic is shown in Fig. 4, for a general case, and has as its distinguishing feature an amplification that is constant over a range of frequencies extending from about 80 to 5,000 cycles per second, but which falls off fairly rapidly at frequencies below or in excess of these.

- **(a)** cathode-anode capacity of the valve \( C_a \), and
- **(b)** stray capacitance of the anode load \( R, C_n \) effectively in parallel;
- **(c)** stray capacitance of the grid leak \( R_g, C_g \);
- **(d)** input capacitance of the following valve, also effectively in parallel. Since the coupling condenser \( C \) will have a fairly large capacity, \( C_p \) and \( C_n \) are also effectively in parallel with the anode load. Thus the equivalent circuit is built up on the right of the figure.

Now this circuit is quite complicated, but it can be simplified for the purpose of analysis by considering only a limited range of frequencies at a time. Consider the behaviour of the circuit over the middle range of audio-frequencies, say from 500 to 6,000 cycles per second. The reactance of the coupling condenser \( C \) in a properly designed amplifier will be small compared with the resistance of the grid leak \( R_g \), whereas the reactance of the stray capacities will be high. For example, the reactance of a 0.1 mfd. condenser, a typical coupling value, at 500 c.p.s. is about 3,300 ohms, while at 6,000 c.p.s. it falls as low as 270 ohms. Compared with a typical grid leak whose value may exceed 500,000 ohms, the coupling condenser is a short-circuit. The stray shunting capacities, on the other hand, having a value of only a few micro-microfarads, present a reactance of many megohms to this range of frequencies and are the practical equivalent of an open-circuit when compared with \( R_g \). Under such conditions the equivalent

![Equivalent circuit diagrams for the resistance-coupled amplifier for medium, high and low frequencies respectively.](image-url)
circuit takes the form shown in Fig. 5a. From this it is easily seen that the voltage amplification is given by:

\[ V_0 = \frac{R_p}{R_i} \times (R_p + R_g) \]

where \( R_p \) is the equivalent load resistance formed by the anode resistance \( R \) in parallel with the grid leak \( R_g \). Here \( V_0 \) is substantially antiphase to \( V_i \).

Now, considering the behaviour of the circuit at frequencies in excess of 6,000 c.p.s. the coupling condenser will have a negligible reactance compared with \( R_g \) and may be omitted, but the shunt capacities across the anode resistance must now be taken into account. This leads to the equivalent circuit of Fig. 5b. \( V_0 \) is no longer antiphase to \( V_i \), but lags behind \( V_i \) by an angle greater than 180 deg. As the frequency increases still further the angle by which \( V_0 \) lags \( V_i \) approaches 270 deg., which is the maximum it can have. Also the effective load impedance decreases due to the shunt effect of the capacities and thus \( V_0 \) decreases in magnitude. The extent to which the amplification falls off at high frequencies is, therefore, determined by the ratio which the equivalent resistance obtained by combining \( R_a, R \) and \( R_g \) in parallel bears to the reactance of the shunt capacities. It is possible to estimate the loss of amplification by making use of the fact that, at the frequency which makes the reactance of the shunt condenser equal to the combined resistance of \( R_a, R \) and \( R_g \) in parallel, the amplification falls to 0.707 of its value over the middle frequency range.

The equivalent circuit for frequencies below 500 c.p.s. is shown in Fig. 5c. This time the shunt capacities are neglected, but the coupling condenser \( C \) will have a reactance comparable with the resistance of the grid leak \( R_g \). This results in a falling off of the amplification due to the fact that a large percentage of the low-frequency voltage is wasted across \( C \) that would otherwise be usefully developed across \( R_g \). The extent to which the amplification falls off at low frequencies is, therefore, determined by the ratio which the combined resistance of \( R_a \) in series with \( R \) and \( R_g \) in parallel bears to the reactance of the coupling condenser. As the frequency increases still further the angle by which \( V_0 \) lags \( V_i \) approaches 270 deg., which is the maximum it can have. Also the effective load impedance decreases due to the shunt effect of the capacities and thus \( V_0 \) decreases in magnitude. The extent to which the amplification falls off at low frequencies can be estimated by the fact that, at the frequency which makes the reactance of \( C \) equal to the equivalent resistance of \( R_a, R \) and \( R_g \) combined as above, the amplification falls to 0.707 of its value over the middle range of frequencies. The output voltage \( V_0 \) lags on \( V_i \) by an angle less than 180 deg., approaching 90 deg. as the frequency is decreased more and more.

The effect of experimenting on the circuit values will be discussed in a later article.

A Single-valve Morse Practice Set

This unit uses a Mazda P220 Class B valve as two separate triodes and only one transformer is used. This component must be very carefully chosen as it is the basis of this set. The one originally used was a Cossor 5-1, and was of the type which has the primary winding between two secondary windings in series. If the two secondaries are separated and the one with the greater number of turns is used as the true secondary and connected as shown, the other is connected as the "oscillator" coil and must be out of phase. This is arranged by reversing its connections. The key makes and breaks the circuit on the grid of the first half of the double triode (referred to as \( V_1 \)). This contains the oscillator circuit (which may be adjusted for tone, etc. by a .001 pre-set condenser). \( V_2 \) acts as an amplifier with automatic bias and with a 90-volt H.T. is quite capable of good volume from a moving-coil 8in. speakers. If 'phones only are required, two 9-volt grid bias batteries are quite sufficient H.T. The L.T. is provided by a 3-volt cycle lamp battery limited by a 0-10 ohm rheostat. The class B valve has a tendency to generate parasitic oscillations and these result in a slight variation of frequency. When using 'phones better results are obtained when the H.T. on anode \( V_1 \) is about half that on anode \( V_2 \), and a 1 meg. potentiometer may be included at point X or, alternatively, a tapping on the H.T. may be utilised.

Theoretical circuit of the practice set.

The unit, batteries included, is housed in an extension speaker cabinet and a switch is provided to switch from speaker to 'phones. (Or a two-make one-break jack might be used instead.)—R. J. Amblin (Bath).

A New Handbook

NEWNES SLIDE RULE MANUAL

By F. J. CAMM

5/- or 5/6 by post from George Newnes, Ltd., Tower House, Southampton St., Strand, W.C.2
German Air-sea Rescue
Details of Construction and Operation

The German Emergency Transmitter NS.4 is a two-valve self-contained battery-operated air-sea rescue transmitter. The estimated life of the battery on intermittent use is about four hours. The aerial is a flexible copper-plated steel tape, and is wound round the box when not in use. The instrument is set in the frequency band 53.5-61.0 mc/s., and radiates an M.G.W. note of approx. 400 c.p.s. The apparatus is coloured bright yellow, is buoyant and waterproof, and a length of cord and a hook enable the instrument to be secured to a dinghy or person. The small size of the equipment makes it suitable for use with a single-seat type dinghy.

Construction
The equipment is housed in an aluminium box measuring 6½ in. by 6½ in. by 3 in., and weighs 3½ lb. The base and lid of the box are stiffened by two ribs made diagonally in the material, and the lid is secured by four screw fittings which are riveted on the outside of the box. A rubber gasket ensures a watertight joint.

The transmitter is secured in the box by means of four captive screws, one of which is used as a connector to the aerial. Two of the screws are located beneath the accumulators, which must be removed before the screws can be slackened off. The chassis is not of the usual die cast construction, but is of aluminium sheet spot-welded together. No valve holders are used, the connections being made by soldering directly to the pins of the valves.

The coils and condensers are of ceramic material, with the exception of the paper smoothing condensers in the vibrator pack.

The Aerial
The aerial is of interest and is a 3ft. 5in. strip of copper plated steel tape similar to that used in pocket rules. The base of the aerial is rim, tapering to 3½in., and has been sheathed in rubber for the last 10in. to avoid shorting due to heavy rain or spray. The aerial may be swivelled in one plane, and is wrapped round the instrument and held in position by two clips when not in use.

Two press switches fitted with rubber covers are located under one of the aerial retaining clips: when the aerial is unwound, the transmitter is automatically switched on. In the sample examined, one press stud marked K was not used, the contacts of the switch not being fitted. This is probably used to key the transmitter for sending morse and to conserve the battery life.

The Circuit
A general idea of the circuit may be obtained by examining the circuit diagram. A pentode valve LS1 is used as a master oscillator and drives a double triode valve LS2 which is arranged in push-pull.

The master oscillator is a Hartley circuit and is tuned by the preset ceramic condenser C5. The coils are grooved ceramic tubes with electro-deposited windings.
The master oscillator coil L1 is 2 in. long and \( \frac{9}{16} \) in. in diameter, nine turns are wound in \( \frac{13}{16} \) in., and the whole is mounted inside the coupling coil L2, which is \( \frac{19}{16} \) in. long and \( \frac{7}{16} \) in. in diameter. L2 has two turns wound in \( \frac{3}{16} \) in., and supplies the drive to the double triode valve LS2. Both coil formers are closed at one end and are mounted on the chassis by means of a bolt and hank bush.

The tuned circuit for the P.A. stage is supplied by the coil L3 and the preset ceramic condenser C13. The coils L3 and L4 are similar to L1 and L2, and L3 is mounted inside L4 as in the master oscillator. The double triode valve LS2 requires neutralising, and this is done by the two preset ceramic condensers C11 and C12.

The aerial is coupled to the P.A. by the coil L4, but is tapped down, only one turn being used. Both trimmer condensers C6 and C13 may be adjusted when the lid of the transmitter is removed. Two links and shorting bars (A and B) enable the performance of the transmitter to be assessed by inserting current indicators in these positions.

**Frequency Band**

The frequency band of the transmitter is 53.5-61.0 mc/s, the sample examined being set up on 54 mc/s. A very strong harmonic was emitted at 108 mc/s. The transmitter is modulated by using the "raw" A.C. direct from the vibrator without rectifying, and this modulates the transmitter at the frequency of the vibrator plus all the harmonics. The note received is rich in harmonics and appears to have maximum energy at approx. 400 c/s.

The consumption of the equipment is light, being 0.24 amps at 2 volts for the valve filaments and 0.17 amps at 8 volts for the vibrator unit. The vibrator unit gives 110 volts at 8.0 mA, of which 3.0 mA goes to the oscillator and 5.0 mA to the P.A. stage. The A.C. voltage given is not true RMS, due to distortion of the wave. The currents given are average D.C.

**Vibrator Unit**

The vibrator is of the non-synchronous variety, and is particularly interesting as the frequency is approximately 210 c.p.s. The general assembly may be seen from the photograph, and it will be noticed that the armature is of unusual design, being a light flat strip at right angles to the reed. The magnetic circuit is smaller than in the conventional vibrator although the driving coil is a good deal larger. A separate driving contact is used, and the whole contact assembly is considerably smaller than usual.

No rectifier is used, the raw A.C. being applied to the transmitter so that the carrier will be modulated at the frequency of the vibrator and its harmonics.

The two-volt lead-acid accumulators used for power supplies are 1½ in. by \( \frac{3}{16} \) in. by
1½ in., and weigh approximately 1½ oz. each. Eleven
are used in all, three in parallel for the 2 volt filament
supply and eight in series parallel for the 8 volt
vibrator supplies. These make up 1 lb. of the 3½ lb.
which is the total weight of the equipment.

These Rulag accumulators are well known in this
country, and are used by the Germans in large numbers
for their Radiosondes. Large numbers were also
exported to England before the war for use in miniature
hand torches.

A discharge test was carried out, and the two volts
fell to 1.7 volts in 2 hrs. 40 mins., and the 8 volts to 6 volts
in the same time. A captured enemy document indicated
that the accumulators last 4 hrs. if switched on for three
minutes and off for one minute.

**Operation**

A flight test was made against the equipment, which
was 10 ft. above the ground to eliminate reflections and
interference from persons moving near the aerial.
External batteries were provided.

The aircraft used a 4 ft. 6 in. vertical rod aerial in
conjunction with a receiver having a sensitivity of
5 microvolts at 50 mW. output, the signal noise ratio being
10 dB when using 400 c.p.s. modulation.

The ranges obtained were as follows:

- 9 miles at 200 ft.
- 14 ,, 1000 ft.
- 40 ,, 4000 ft.

The flight tests were carried out over land, and a slight
improvement may be expected over sea. The batteries
give a life of 4 hrs. if used intermittently, and 2½ hrs.
if left on continuously. The Rulag accumulators use
pure lead plates and have a fairly good storage life.

The equipment is well designed, its special features
being its compactness and light weight.

---

**Outdoor Listening**

**Methods of Setting Up Extension Speakers**

During the summer months an arrangement
whereby one can enjoy the radio programme
whilst in the garden is always popular and
worth while. It is also quite simple to arrange, and if a
suitable method of connection is used, the extension
listening-point may be at almost any distance from
the house.

The obvious solution is to use a portable set, but a
permanently fixed extension speaker suitably placed in
the garden is more convenient, because it is less expensive
and always there for use when wanted.

**Simple Extensions**

Fig. 1 shows the simplest system. A condenser is
connected to the negative speaker terminal on the
receiver, and an extension line goes from this to the
extension speaker. (Although shown as 2 mfd, this
condenser may be anything from .5 to 4 mfd.) At the
distant point a switch is included in circuit so that the
speaker there may be silenced when necessary. The
second terminal of the speaker is connected to a rod
pushed in the earth, thus completing the circuit via the
earth connection of the receiver.

The advantage of this method is its simplicity, and
as the extension line does not carry direct current it
may be of thin wire, even for a mains receiver. In
addition, there is no risk of shocks and cotton covered
or enamel wire is quite suitable. As shown, the receiver
speaker may be silenced by adding a switch in series
with the speech coil.

**Volume Control**

If it is intended to use the receiver speaker outside,
then an L.F. choke should be used as in Fig. 2. This
also shows how volume control at the extension point
may be arranged, a variable resistance or rheostat of
about 5 ohms being added in series with the speech coil.
This resistance will affect the quality of reproduction
slightly as it is turned towards minimum volume, but
it gives sufficient control without undue deterioration
of quality.

The primary of an output transformer is suitable for
use as the L.F. choke, but for best results it should give
a reasonably good matching to the impedance of the
output valve.

Although triodes are shown, these circuits are suitable
for pentodes also, either battery or mains operated.
Surprisingly good results are usually obtained by
connecting the extension speaker to one anode only of
the output valves, as shown in Figs. 1 and 2. But for
best results connections should be as in Fig. 3.

Two extension lines have to be used here, and if they
are of any length twin flex should not be used, or the
capacitance between the wires will make reproduction
rather muffled.
Relay Systems

The methods so far described have the disadvantage that it is necessary to go to the receiver to switch it on or off. This difficulty may be overcome by using a relay.

If, however, the extension point is at no great distance from the receiver, thick flex may be used and a switch connected in parallel with the switch in the receiver. This is quite satisfactory where the wires can be taken through a window, or otherwise arranged so that they are not long. Provided good flex is used, a mains receiver may be controlled by this method from quite a distance, but with a battery-operated receiver about 100 ft. is the maximum, or the filament voltage will be severely reduced.

Where control from a greater distance is required, a relay such as that shown in Fig. 4 is used. In this case the relay is energised during the whole of the listening time, and is of the kind which only passes 50 mA. or so. In consequence, the extension leads do not require to be of very thick wire, and may be of any reasonable length.

Such a relay may easily be made from an auto-cut-out by re-winding the coil full with 32 s.w.g. enamelled wire and slightly weakening the armature return spring.

Complete Extension Control

The best system to use is shown in Fig. 5. This not only switches on the receiver from the distant point, but also switches on the extension speaker at that point.

A three-point switch is used, and this energises the relay and at the same time completes the extension speaker circuit. In wiring such a system, the two lines connected to the relay may be twisted twin flex, but the lead from the anode coupling condenser should be kept separate from them to avoid top-cut in reproduction.

The relays are operated by a small dry battery, although by returning the extension line to the accumulator it is possible to arrange that no extra battery be required if the 2 volts available proves sufficient for the relay used.

It should be noted that some of these small relays are not suitable for direct switching of mains circuits, and their use should therefore be confined to battery receivers.

Using an Ordinary Receiver Outside

If it is desired to use a receiver without a frame aerial outside, Fig. 6 shows how an aerial may be added. A very long wire is not required, as a sensitive three- or four-valve set will give a good performance with quite a short wire.

In this case a-winding spool is fixed upon a bracket upon the inside of the cabinet. A typewriter ribbon spool is ideal, and if a small handle is added, re-winding the wire will be simplified.

The aerial consists of about 20 ft. of thin flex, and one end is fixed to the spool. At the other end a loop of string provides a means of support to some convenient object, and also insulation. A lead from the bracket to the aerial terminal completes the fitment.

A spring washer allows the spool to rotate under friction, and it is only necessary to extend the wire as convenient and hook it to some nearby object.

If local stations only are required, taking a short wire from the aerial terminal to a spike pushed in the earth will usually prove satisfactory. (This is the principle of some of the well-known "aerial-less" patent attach-ments.) But with some receivers this is not satisfactory, when a throw-out aerial, as described, should be used.

Notes and News

Wireless Receiving Licences

The following statement shows the approximate numbers issued during the year ended March 31st, 1946.

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>London Postal</td>
<td>1,999,000</td>
</tr>
<tr>
<td>Home Counties</td>
<td>1,999,000</td>
</tr>
<tr>
<td>Midland</td>
<td>1,491,000</td>
</tr>
<tr>
<td>North-Eastern</td>
<td>1,599,000</td>
</tr>
<tr>
<td>North-Western</td>
<td>1,392,000</td>
</tr>
<tr>
<td>South-Western</td>
<td>868,000</td>
</tr>
<tr>
<td>Welsh and Border</td>
<td>605,000</td>
</tr>
<tr>
<td>Total, England and Wales</td>
<td>9,226,000</td>
</tr>
<tr>
<td>Scotland</td>
<td>1,643,000</td>
</tr>
<tr>
<td>N. Ireland</td>
<td>133,000</td>
</tr>
<tr>
<td>Grand Total</td>
<td>10,392,000</td>
</tr>
</tbody>
</table>

A New RadioTel Appointment

Mr. H. V. Major has been appointed general manager of P.R.T. Laboratories, Ltd., a company member of the RadioTel Group. Mr. Major, who has for some months been acting manager of the Company, was before the war associated with Pye Radio. During the war he was assistant director of radio production at the Ministry of Aircraft Production.

P.R.T. Laboratories, Ltd., carry out the research work for Philco, Aircne and the other companies of the RadioTel Group.
In the Concluding Article Our Contributor Deals with the Once Famous Lodge “N” Circuit

The practical form of the circuit was actually commercialised in the form of a two-valve set round about the year 1926, but in spite of its popularity and the claimed ease of tuning, it seems to have been forgotten. The advantages claimed for the circuit were great amplification, one knob tuning, and—most important in those days when every other set pushed reaction to the limit—freedom from interference with other sets. The principles of operation are so interesting that I decided to devote the concluding article in this series exclusively to a consideration of the principles involved. Anyone can make up the set from the description given, since it is a particularly simple affair.

In the “N” circuit we have a closed resonator consisting of a relatively large inductance coil and a relatively small capacity. This is stimulated by impulses conveyed to it by a single wire, and builds up only those oscillations to which it is itself in tune. It is stimulated by exceedingly small amounts of energy, and these it can receive either from an aerial or from the earthed anode of a valve, or from both in combination. The aerial collects energy of any frequency, but the “N” circuit accepts only that to which it is tuned.

Referring to the circuit in Fig. 1, the inductance is about 100-120 turns, and the capacity 0.0001 mfd. The condenser in the aerial-lead is a fixed one of 0.0001 mfd. The aerial being a collector only, and out of tune with the incoming signals, cannot respond, and therefore non-radiating. This is why the “N” circuit is non-radiating.

The circuit shown in Fig. 3 has, however, one serious disadvantage. This is that strong signals of a frequency differing from that of the incoming signals may force their way through to the grid, and so mar otherwise excellent results.

Choke Coil Inserted

To remedy this, Lodge inserted a choke coil between the aerial and the earth. This amended circuit is indicated in Fig. 4. The purpose of the choke coil is to shunt the unwanted signals to earth, and it should have about 40 fewer turns than the “N” coil. This “choke” has certain other advantages which add to the novelty of the circuit; for one thing, it permits the application of vacuum.

The true explanation of regeneration in the circuit is an important point, for it appears to occur in a rather novel way. It must be of just the right value to give the necessary amount of oscillating H.F. potential on the plate when the valve is functioning at about its specified operating conditions. The inventor attached great importance to the

![Diagram of the “N” Resonator](image)

![Diagram of the Choke Inserted](image)
"load" in the anode circuit of the valve. If "phones are used, he states that the choke (i.e., the "phones") should have a resistance of 5,000 ohms. If the "N" valve is used to feed an L.F. amplifier, the primary of an L.F. transformer supplies enough choking effect. Its self-capacity seems to be an important practical feature; if this self-capacity is eliminated there will be too much regenerative energy available at the plate. It is advisable to supply this capacity as a distributed capacity choke or primary. The choke with the right amount of capacity is more easily obtained in practice, so it is not necessary to eliminate the self-capacity and then add an extra unit or capacity to replace it.

The Correct Value of Choke
Referring again to Fig. 4, it is not desirable for the "choke" between aerial and earth to be in tune with the incoming signals. On the other hand, it is necessary for it to be not too far out of tune, for it is closely bound up with the regenerative energy in the "N" circuit. A high value of choke may prevent the aerial picking up the maximum amount of energy, whilst if the choke is too small the energy will tend to go too easily to earth. The happy medium is for the choke to have a value that will make its resonant frequency (taken in conjunction with the aerial and earth constants) about 10 per cent. below that of the signals to be received. In any case, the value is not very critical, as long as there is sufficient choke to deflect some energy of the frequency required into the "N" circuit.

Fig. 5.—Showing a complete "N" circuit, with an L.F. amplifier added.

The constructor would be well advised to wind his own coil for the "N" circuit. This is because the number of turns lies between that required for the medium waves and the long waves (when the medium waves are wanted). The commercial coils are a misfit. What is needed is a coil with a little more turns than is ordinarily required for the medium waves, and a little less than that needed for the long waves. About 100-120 turns on a 2-in. former are required. This, tuned by a .0001 mfd. condenser, gives reasonable coverage. Actually, the inventor used a condenser of .00005 mfd. only, and even advised a condenser of half that capacity; but with this the tuning is somewhat restricted.

Control of Circuit Regeneration
In the original Lodge circuit regeneration was controlled by means of a filament rheostat. The writer, however, has succeeded in controlling it by means of a condenser, of which more anon. It is right to point out here, however, that whatever regeneration there is should act on the "N" circuit only. That is to say, the aerial should not be in tune with it and, moreover, it should be so little connected that it has no tendency to respond.

The aerial must have some tune of its own, since it is a conductor connecting two capacity-areas, one, the aerial and the other the earth; but of course so as to respond only to longer waves, it will be stimulated only by forced vibrations which, being of the wrong frequency, produce hardly any amplitude of vibration. There is then no effective re-radiation. If there is any self-excitation the sounds produced will be limited to the station and will not be transmitted through the aerial to other stations.

Fig. 5 indicates a two-valve version of the original circuit, and as will be seen it is very simple, though well worth studying. The inductance, L1, is the so-called choke coil of about 60 turns; whilst L2 is the "N" coil of about 100 turns. Note that the anode of the first valve is at earth potential, for the reasons already stated. The fixed condenser in series with the "N" coil is .0001 mfd., while the grid-leak is a variable one of 1 or 2 megohms. The L.F. amplifier is of quite conventional design and will not be considered further.

The aerial is aperiodic or nearly so, and consequently the coil does not have to be changed to cover the broadcast band, though it has a particular frequency of its own at which it is most efficient; this frequency depends upon the aerial and earth constants of the receiving station.

Set Oscillation
In this set oscillation is controlled by the filament rheostat, and also by the grid-leak to a certain extent—as was the custom in the old days. The leak was so set that the receiver was just off oscillation point with the filament a little "down." Then, on increasing the filament slowly, the set was brought up and over the point so that distant carriers could be picked up. Once a carrier was found the rheostat was adjusted to bring the station in clearly.

However, when the set was required for a nearby station this process had not to be gone through; hence the set earned the title of a one-knob set. The usual method was that the only remaining control was the tuning condenser. No undue capacity effects exist, and the control is not critical.

The modernised version of the "N" circuit is indicated in Fig. 6. This does away with the filament rheostat, 2-volt valves being used with a 2-volt accumulator. Reaction is controlled by means of the series aerial condenser which is made variable.

It is obvious that since the aerial coil (or choke as it is called in the original receiver) is connected to the anode, a certain amount of regenerative effect takes place through this coil, through the series condenser, and thence through the "N" circuit to the grid of the valve. So that if we make the series condenser variable we can control the regeneration.

A similar effect will be produced if we insert a variable condenser in the lead from the anode to the earth end of the coil; but the other method is to be preferred since a condenser in the anode lead might interfere with the working of the set. A .0001 mfd. variable condenser is all that is needed in the series position, and does not greatly interfere with signal strength even at low settings.

"Break-Through"

The great trouble with this circuit is a certain amount of "break-through" by a powerful local station. That is to say, the local station "peaks" in the ordinary way, and thereupon persists as a sort of ghost throughout
News from the Clubs

Bolton and District Radio Society

This society has now recommenced activities, and meetings are being held on alternate Thursdays at the old headquarters, St. Albans Church Hall, Albert Road, Bolton. A full programme of events is being arranged as rapidly as possible, including feature meetings such as junk sales, discussion evenings and lectures from the representatives of well-known organisations. Despite the fact that many old members are still in the Forces, an excellent proportion of the original members are already attending (one or two meetings have already been held), and many new members are joining. All are welcome and prospective members should communicate with the Hon. Secretary, Mr. S. E. Jones, 100, Adams Gardens Estate, London, S.E.16.

Slade Radio Society

Judging by the letters which I have received from prospective members who saw the notes in the April edition, your circulation must be very considerable and also widespread. One of the inquiries came from the Mediterranean Sea area, so it would appear that your fame has truly spread abroad.

Our current programme is as follows: June 26th: "D. R. Night. Talk on Procedure, Methods and Suggested Circuits." July 26th: "Discussion Evening."

August 23rd: "Electronics in Industry." Lecturer to be announced later.

Full details of the society may be obtained from the Hon. Secretary, Mr. G. T. F. A. Jones, 173, Welwyn Road, Sutton Coldfield, Birmingham.

Surrey Radio Contact Club

This society was recently formed to foster a practical interest in all branches of amateur radio. All local amateur constructors and anyone who is interested, are invited to write for full particulars to Mr. T. Coe, 8, New Ireland Road, Rialto, Dublin, or Mr. T. Devereux, 33, South Summer Street, Dublin.

International Short-wave Club

This club is renewing its activities again and welcomes those interested in short-waves and amateur radio. Full details may be obtained by those interested from A. E. Bear, 100, Adams Gardens Estate, London, S.E.16.
New Use for Systoflex Sleeving

A loose-fitting sleeve of Systoflex slipped on the blade of a screwdriver makes a useful tool for the insertion of screws in awkward places.

Extend the sleeving slightly and press into the end the head of the screw, so that it contacts the screwdriver. It will remain in position while placed over the hole, and when screwed home the sleeving comes off automatically.

The size is not critical and the experimenter should find that a few odd scraps of the common sizes will allow the method to be used on all normal screws and screwdrivers.—G. G. Smith (Dunfermline, Fife).

Screening Can

An efficient screening can is easily made from the zinc container of a dry cell. First the carbon rod is drawn from the “dolly” with a pair of pincers. The remaining contents of the cell can be withdrawn with the help of a penknife. The container is now sandpapered to give a smart appearance. The base is cut from a piece of tin. Two bolts secure the can to the base, as shown in the diagram. A large screening can may be made from a 1.5 volt bell battery, or, at the other extreme, an ultramidget component from a number eight battery cell.—J. N. Doobs (Bath).

Modified Morse Practice Set

I recently constructed the Morse practice set described in “Practical Hints” in your September, 1943, issue. I found, however, it suffered from three defects:

1. A loud and annoying key click both on the “make” and “break.”
2. The buzzer did not respond rapidly enough when sending at fast speeds.
3. When used with only a few pairs of headphones the volume was too great to bear with comfort.

I therefore built this modified version of the set. The buzzer is going all the time when it is in use and the secondary circuit is keyed. This eliminates faults (1) and (2). The last fault was eliminated by fitting a potentiometer as a volume control on the transformer primary (which is used in this set as the secondary). The potentiometer value is not critical. I used 50,000 ohms. A switch to disconnect the battery, and a type 800 twin cell, completes the set.—H. Stern (Herts).

Locating Device for Condensers

I think that other readers will be interested in this locating device for bandspread tuning condensers. All that is required are a small piece of sheet metal (18 s.w.g. steel or aluminium), a few nuts and screws, and one spring.

A spring-loaded lever is arranged to click into the notches on a disc that is fixed to the tuning condenser spindle. For convenience of adjustment the pivot of the lever and the spring adjustment lever are both fixed to the condenser. This allows the tension of the spring, and the angle of the lever to the notched disc, to be adjusted with ease.—P. Redman (Romford).
JOHANN STRAUSS’S waltzes seem to have perennial youth, and this month the H.M.V. company have recorded one of the most famous of them—"Roses of the South," on both sides of H.M.V. C3494. Its opus number, 398, is an interesting indication of his enormous fertility. These waltzes are something more than mere pieces for dancing; almost all of them are perfect in craftsmanship, and many of them have most attractive introductions, including "Roses of the South," whose theme is sketched lightly before the Waltz gets under way. John Barbirolli devotes great attention to this deservedly popular piece, and the Hallé Orchestra plays it with magnificent sense of swinging rhythm. These Strauss waltzes need the rich "body" of a symphony orchestra such as this to display their fine qualities.

The Boston Symphony Orchestra needs little introduction to lovers of classical music, and this month, under the able baton of Serge Koussevitzky, they have made a recording of "Harold in Italy," on both sides of DB2215-6295, on five double-sided rain. records—H.M.V. DB2651-6295.

Orchestral

SOLOMON has already shown himself to be an ideal Chopin player, and this is borne out by his new record—H.M.V. C3345—of two double-sided records—Columbia DX1247-8. They are really first class records and I have no hesitation in recommending them to readers.

H.M.V. C3491 is yet another orchestral recording, this time by the Philharmonic Orchestra under the baton of Maurice Miles. This is also a two-part record—"The Banks of the Green Willow." Chopin seems to have been represented this month by Ias Loveridge has chosen for her pianoforte solo his Op. 66 "Fantaisie—Impromptu in C Sharp Minor," on one side of Columbia DX1249. On the reverse side she records "Polonaise in A Major," Chopin’s Op. 40, No. 1.

Vocal Recordings

MERRIE England," with its brilliant pageantry and Edward German’s fine music, has earned a special place in English light opera. With a revised "book" by the late Edward Knoblock it is captivating huge audiences at the Prince’s Theatre. The lyrics have survived untouched, however, and H.M.V. C3490 offers new recordings of "One, Two, Buckle My Shoe" splendidly majestic. "O Peaceful England," which is perfect for Gladys Ripley’s lovely contralto, and the forthright "Yeoman of England," sung with great spirit by Dennis Noble, who is the Essex of the Prince’s Theatre, London, production. Both are enhanced by really fine chorus singing.

"The Bells of St. Mary’s," the film which has had such a successful run at the present moment, has as its theme song the popular song which gives the film its name. The song has been charted by the popular English tenor Webster Booth on his latest recording on H.M.V. DB9472. On the reverse side is another favourite—"Parted." Webster Booth gives a solemn and impressive performance of this song, and his beautiful tone in both pieces on this record is joy.

Other records featuring tenors are H.M.V. DA1838, with Christopher Lynch singing "Macushla," a song I shall never tire of hearing, and "Oft in the Stilly Night." The piano accompaniment in both songs is excellent. Alec Nordenson, The piano accompaniment in both songs is excellent. Alec Nordenson, with the Philharmonic Orchestra, plays the "Prelude to the Afternoon of a Faun" on H.M.V. C3490.

In the film "Lisbon Story," Richard Tauber plays the part of a world-famous tenor who is a refugee from Nazi oppression. One of the high spots in the film is his singing of "Pedro, the Fisherman," the song that was one of the outstanding successes in the stage play of the same name. On his latest record—Parlophone R520545—he features this haunting tune, together with "Never Say Good-bye," another lovely melody from the same film, and his host of admirers will find it irresistible.

Before I conclude the classical releases I must mention just two more records. They both feature well-known singers—a baritone and a soprano. The first is a recording of "Harold in Italy," Op. 16, by Berlioz, from the same film, and his host of admirers will find it irresistible.

Light Music and Variety

I START off with a recording from the film "The Bells of St. Mary’s," by Peter Yorke and his Concert Orchestra, on Columbia DB2123. The film, title theme song and the other "In the Land of Beginning Again," also from the film. The vocalist is Sam Browne. The above two song titles are also played by Archie Lewis with the Geraldo Strings, on Parlophone F3140.

Ivor Moreton and Dave Kaye continue with their "Fin Pan Alley Medley" and No. 51 in this series is featured on Parlophone F2359. These two virtuosos of the keyboard introduce "Pedro, the Fisherman," "Take me in Your Arms," "This Heart of Mine," "Kentucky," "Who could love you like me" and "If I Had a Dozen Hearts."

Frank Sinatra fans will be pleased with his latest recording on Columbia DB2124 of "Dream of You," "Someone to Watch Over Me," "Stevy Colman" and "Rancho Serenade," the last featured by Christopher Lynch singing "Macushla," a song I shall never tire of hearing, and "Oft in the Stilly Night." The piano accompaniment in both songs is excellent. Alec Nordenson, the piano accompaniment in both songs is excellent. Alec Nordenson, with the Philharmonic Orchestra, plays the "Prelude to the Afternoon of a Faun" on H.M.V. C3490.

Other releases this month include "Only a Few Steps Away" and "Song of Paradise," sung by Robert Wilson, on H.M.V. BD1123. "Love Steals Your Heart," sung by Harry Roy and his Band, on Parlophone F3451.
Unusual Push-pull Output Circuit

Details of Interest for Quality Amplifier Construction. By G. WOODWARD

When two valves are to be operated in push-pull, each grid has to be supplied with an input voltage whose phase is 180 degrees displaced from that applied to the other. The most common circuit that was developed some years ago was that known as the Duo-phase System. This had certain disadvantages and has fallen into disuse. A special output transformer was employed with an additional secondary winding to feed the second valve as shown in Fig. 1. Any distortion occurring in the output transformer is amplified by V2 and under some conditions the circuit is unstable.

The Paraphase Circuit

An alternative method of obtaining the input voltage for V2 is by fitting a potential divider across the output...
Fault Finding by Substitution

A Warning of a Pitfall in this Popular Method of Testing

By C. A. QUARRINGTON

SUBSTITUTION of components is the last desperate resource of the experienced, and usually the only hope of the novice, when endeavouring to track down an obscure fault, it is also the obvious method of verifying a suspicion however founded. When the suspected fault takes the form of an open circuit it is normal practice to connect a temporary substitute in parallel without removing the suspect component. The most convenient method of tracing for open circuit is that of employing a condenser of suitable value connected to a pair of crocodile clips, which facilitate rapid connection. This method is generally advocated in service manuals and handbooks and the practice may be observed when visiting the service departments of famous radio manufacturers.

Motor-boating

The writer's faith in this established practice recently had a severe set-back. A fault had developed in a well-known make of radiogram and took the form of a violent motor-boating which was usually isolated to the double-diode-triode circuit. All the decoupling condensers, with the exception of the electrolytic cathode bypass condenser, were eliminated by the established method, using a 1 mfd. condenser and crocodile clips. It had already been noted that a reasonable value of grid bias existed; it followed, therefore, that the electrolytic condenser, if defective, must be open-circuit and not short-circuited. A suitable electrolytic condenser was selected and its short leads connected direct to the clamping screws of a pair of crocodile clips which, incidentally, were comparatively new and of clean appearance. The new condenser was clipped in place across the suspect and made no apparent difference either to the volume or frequency of motor-boating. This caused some surprise and a new reading was taken across the bias resistance which showed correct bias voltage (the motor-boating was stopped temporarily while taking this reading by the only effective method discovered, shorting the triode grid to chassis). Wrong diagnosis was assumed and time was wasted endeavouring to trace the fault elsewhere in the electrolytic condenser, still seemed by logical deduction to be the source of trouble, however, and notwithstanding that it was obviously not short-circuited it was removed and the new one (still connected to its crocodile clips) was clipped in place; new points of attachment were selected, since the previous ones, the leads of the old condenser, had been removed; the motor-boating, however, persisted with unchanged vigour. The old condenser having been removed, replacement had to be effected before investigations could be continued elsewhere.

The original condenser being eight years old and still regarded with half-suspicion, the substitute condenser was removed from the clips and soldered in position in the normal manner, whereby the motor-boating immediately ceased. This turn of events was so surprising that it was decided to re-check; the condenser was accordingly removed, a similar one was fixed to the crocodile clips, which were clipped into position, and the motor-boating reappeared. The substitute condenser was then soldered to the crocodile clips, which were again clipped into position, but the motor-boating persisted; the ends of the crocodile clips were cleaned with carbon tetrochloride, but exhibited the properties of a rectifier to radio frequencies presumably due to oxidisation of the metal with which the devices were plated or coated. This rectification phenomenon could be stopped by thoroughly cleaning the surface with a light abrasive, but rectification properties returned within 24 hours and reached a maximum in 72 hours; unfortunately, means were not available to measure the impedance of surface contact at R.F. frequencies.

Soldered Connections

This unusual experience is retold as a warning that substitution is not 100 per cent, substitution unless a proper soldered connection is made. Ninety-nine times out of 100, or even 999 times out of 1,000 a clip connection is good enough, but it is necessary to be on the alert for the odd case. The general circumstances of the above experience also serve to show that the conclusions of systematic diagnosis should not lightly be thrown aside until proved incorrect.

Experiments with the coating elsewhere on the clips showed that the skin was an excellent D.C. conductor, but exhibited the properties of a rectifier to radio frequencies presumably due to oxidation of the metal with which the devices were plated or coated. This rectification phenomenon could be stopped by thoroughly cleaning the surface with a light abrasive, but rectification properties returned within 24 hours and reached a maximum in 72 hours; unfortunately, means were not available to measure the impedance of surface contact at R.F. frequencies.

PRACTICAL WIRELESS
SERVICE MANUAL

By F. J. CAMM

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A Study of Oscillators

Many interesting facts can be gleaned about the operation of valve oscillators without any elaborate equipment, and information obtained by experiment is often more valuable than a highly theoretical study. For the benefit of readers who have little or no knowledge of the subject, perhaps a brief outline of basic theory will be useful.

Valves are generally regarded as "amplifiers." It is seldom fully realised how the same valve can be made to function as a generator of H.F. currents, by applying positive feedback from anode to grid circuits.

Experimenter will be familiar with "unwanted" oscillations in the form of various types of instability in H.F. and L.F. amplifiers. For example, an L.F. "howl," or whistle, is an oscillation which may take place in a complicated way by positive feedback around several stages of an amplifier; at some frequencies, what is intended to be negative feedback may cause trouble by becoming "positive."

The easiest way to understand the mechanism of oscillations is to consider a single H.F. amplifying stage, Fig. 1 (a). This is shown amplifying an extraneous H.F. e.m.f. $E_g$. As indicated by the sine-waves, this becomes a larger voltage, $V$, across the anode tuned-circuit $L$ and $C$.

Suppose now, that by accident or design a portion of this output voltage $V$ is fed back to the grid exactly in phase with $E_g$, Fig. 1 (b). Then the resultant e.m.f. applied to the grid will be $(E_g + e)$, where $e$ is the feedback voltage. This is the opposite of negative feedback.

This larger grid potential is again amplified by the valve, developing a larger voltage than $V$ across the anode L.C.circuit. Since $V$ has thus increased, a larger voltage will get back to the grid, which will be amplified to give a still larger $V$, and so on.

Clearly, the process is cumulative: once started, we may remove the external signal $E_g$, because a self-maintained condition will be set up, a nearly sine-wave oscillation building up in the L.C.circuit by energy supplied from the valve and H.T. source.

In other words, the arrangement becomes a self-excited amplifier. The initial e.m.f. $E_g$ is by no means necessary to start an oscillation. By inductive action, merely switching on the H.T. will give the grid an initial "kick," and supply a little energy into the condenser $C$.

The condenser starts discharging through $L$, and an oscillation thus immediately starts at the natural frequency of the L.C.circuit. Simultaneously, feedback to the grid occurs, building up the initial oscillation in the manner described above.

An important point to realise about the mechanism is that the oscillation will go on building up until something restricts it. This "something," of course, will be failure of the valve, and given H.T., to supply more energy, caused chiefly by the rapid falling-off of the valve mutual conductance at the upper and lower "bends," Fig. 2 (a).

Nevertheless, it will be seen that the valve will finally be operating over almost the entire $E_g - V$ characteristic. Because of this, various undesirable things will occur. Possibly, a large increase in the steady anode current is one factor that should be allowed for—although it can be a decrease under certain conditions.

Then, considerable distortion of the waveform is taking place, which, in other words, means generating plenty of harmonics. In most oscillators, the second harmonic will be found particularly strong, and it is by no means difficult to pick up much higher harmonics on a sensitive receiver, e.g., a general-oscillating on medium or long waves can often be tuned as a "carrier" on the S.W. bands.

The generated frequency is also apt to be unstable under these conditions of large harmonic content.

Amplitude Control

Obviously the remedy is to find some method of restricting the final amplitude of the oscillation.

The principle required is analogous to an A.V.C. system, where the amplification can be controlled so as to operate the valve only over the straight ("linear") portion of the characteristic, as in Fig. 2 (b). The output current will then be nearly a pure sine-wave, though it is difficult to pick up any of the second and subsequent harmonics. At the other end, owing to a certain amount of curvature in the so-called "straight" portion.

One method of partially accomplishing this is by "self-bias" of the type shown in Fig. 3 (a). Owing to the large grid-swing, the valve is driven into grid-current, and this is used to charge a condenser $C_r$—the plate next to the grid becoming negative.

By employing also a leak resistance $R$, of suitable value, the bias can be given some appropriate value. It is not a very successful method of amplitude control, since quite a large oscillation can still build up before the grid-current starts to increase rapidly enough to exercise a limiting effect.

A more satisfactory method is to use a separate diode rectifier, in the manner shown in Fig. 3 (b), i.e., exactly as for A.V.C. Part of the output voltage of the oscillator is fed to the diode, giving a rectified current, and
developing an automatic bias in the condenser-resistance circuit.

This form of bias can be made to increase rapidly, and the controlling effect will be still more effective if a variable-mu valve is used as oscillator.

**Class C Operation**

The self-bias method for the oscillator valve itself can still be included, as shown. If we use a higher resistance grid-leak, the self-bias will build up to a larger value. Indeed, if no leak were connected, the change in the condenser would quickly build up to such a large value as to stop the oscillation altogether; on switching on, oscillation would just start, and be quickly damped because the valve becomes virtually "choked." This can often be observed as a symptom of a broken grid-leak in an oscillator. A milliammeter in the anode circuit "kicks" at intervals, showing start of an oscillatory condition. Also, when we adjust the tuning, inaudible, but interfering with the main oscillation to a small extent, and the grid current characteristic of the valve.

Here is a useful field for experiment. High values of leak, of the order of megohms, can give stable operation without squeggering. The operation of a heavily-biased generator should be properly understood. In particular, the bias exists only when the valve is oscillating. The steady D.C. taken from the H.T. battery then falls to a comparatively low value, being the "mean" of the pulsating current as shown by the dotted line in Fig. 5.

Now, this implies that if, for some reason, oscillation stops or does not build up when the H.T. is applied, the valve has no bias and will take a large anode current. In other words, the current falls to a low value under oscillator conditions. Also, when we adjust the tuning, maximum oscillation will be indicated by minimum anode current.

The big advantage of Class C operation is that we can get a given power output with less power from the H.T. source, i.e., improved efficiency. But against this, harder driving is necessary (more coupling between anode and grid coils), and larger harmonics generated.

There would be little point in applying amplitude control to a Class C oscillator, since the current output waveform is heavily distorted in any case. We saw earlier that the main purpose of such control is to obtain linear operation over a restricted straight portion of the characteristic, which implies biasing to about the mid-point of the straight part of the characteristic.

Experiments on "Leaks"

However, to return to Class C operation: what we require is a value of leak which will bias the valve below cut-off, as shown in Fig. 5.

Really this is the only practical way of giving an oscillator a heavy bias, i.e., by the condenser-leak method. If we used a battery, the bias would have to be momentarily removed in order to start oscillation—it being remembered that we are considering a case where the current is completely cut off under static conditions.

With the right combination of and , the bias will adjust itself under dynamic (oscillatory) conditions to give an operating point of, say, twice the cut-off bias as in Fig. 5. The valve current output will then be of a pulsating kind as indicated, though nearly sine-wave oscillations will be maintained in the LC circuit.

Using a good condenser of about or , the value of will generally be a few thousand ohms for a bias beyond cut-off, the best value depending upon the anode load to some extent, and the grid current characteristic of the valve.

![Fig. 3](image-url) (a) Self-bias by grid condenser-leak, (b) Simplified circuit diagram showing one way of using a separate diode rectifier for control bias.

![Fig. 4](image-url) Illustrating "squegger oscillations."

![Fig. 5](image-url) Class C operation: self-bias increases to about twice the current cut-off value.

Mean D.C.
Experiments on "Phasing"

The foregoing account of the theory and practical operation of this oscillator will suggest many instructive experiments. Indeed, many articles would be required to outline all the possibilities, but we may start with a consideration of phase.

In developing a simple generator from an amplifier, we saw that a voltage must be injected back into the grid circuit, in phase with that already existing there due to a hypothetical incoming signal.

Stated otherwise, this simply means that the phase relations in an oscillating stage must be exactly the same as in the corresponding amplifying stage. All we are doing is to cause the stage to drive its own grid by voltage derived from the anode circuit, instead of using an extraneous signal.

But whereas $E_g$ is derived from, it must stand in the same relationship to the voltages and currents in the anode circuit as in any other amplifier. In this article, we will not enter into a discussion of phase-angles from a vector or sine-wave standpoint, but merely observe some practical details.

We started with the magnetically-coupled oscillator Fig. 1 (b), and it is easy to see that the phase of the e.m.f. returned to the grid can be reversed 180 deg. simply by reversing the grid or anode coil connections. If the thing will not oscillate when the connections are made one way, all we have to do is to try reversing either coil.

The fact is well known in reaction circuits. But as we are setting out to "study" the why and wherefore of things, the correct connections should be noted.

If the grid and anode coils are wound in the same direction, it will be found that oscillations take place when the grid coil is connected the opposite way to the anode coil: assuming a given end of the latter connected to the anode, the opposite end of the other coil must be connected to the grid.

Why this ? Well, it is a little involved to trace out all the various phase angles, but the rule applicable to all oscillators is the same as for amplifiers.

The e.m.f. injected back to the grid must be antiphased (at 180 deg.) to the valve anode-to-cathode voltage. In other words, during a positive half-cycle of $E_g$, the voltage across the valve must fall. This is exactly what happens in an amplifying stage having a pure resistance load in the anode circuit.

The condition is fulfilled by the reversed grid coil connections above stated.

The Hartley Oscillator

Our next experiment—which, incidentally, does away with the reaction coil—will illustrate the phasing requirement more clearly.

If we employ a centre-tapped anode coil, Fig. 6 (a), and take a connection back to grid through a blocking condenser to isolate the H.T.+ (in which case a leak resistance $R$ must also be used), oscillation can be maintained without any juggling with coil connections.

Indeed, this is one of the best types of oscillators. Because the phase conditions are practically fixed at all frequencies, the Hartley oscillates very readily, and will do so at very high frequencies where phase-shifts due to stray capacitances, etc., would cause difficulties with the magnetically-coupled type.

A further advantage is a higher degree of frequency stability. In this respect, the shunt-fed Hartley, Fig. 6 (b), is considerably better than the series-fed type, and, moreover, does away with the necessity for blocking condenser in the grid circuit, if not required for bias.

The "Split-Hartley," Fig. 6 (c), is a type widely used, for short-wave work. No H.F. choke is necessary, since a large capacity condenser $C_1$ isolates the anode and cathode circuits, while offering negligible reactance to H.T., i.e., the two coils $L_1$ and $L_2$ really act as one inductance, tuned by the condenser $C$. Maintenance of oscillation is independent of any magnetic coupling between $L_1$ and $L_2$, provided they are not coupled tightly in a reversed sense.
contravene Post Office regulations, e.g., by coupling to an aerial, or radiating strongly enough to disturb neighbouring listeners.

Remember, too, that even a small battery-driven valve can radiate enough energy to be received as a "C.W. note" on a sensitive communication receiver some distance away if coupled even to a small aerial.

Considerable experimenting with different grid-leaks and H.T. values will be essential in order to get modulation reasonably free from distortion. The simplest method to start with is grid modulation, Fig. 7 (a). Here, the pick-up is coupled via a suitable transformer in series with the grid-leak so varying the bias at audio-frequencies.

Alternatively, better modulation will be got by passing the pick-up output through an L.F. amplifier first, and using the output of the amplifier to vary the H.T. on the oscillator-anode modulation, Fig. 7 (b).

Instead of a pick-up, some fascinating microphone experiments can be carried out in this way: always with the proviso that we keep within the law! It is only a question of "power" to radiate stuff that will be picked up over a wide area.

Estimating "Frequency Stability"

So much for the "entertainment value" of oscillator experiments. To go back to our more prosaic studies, we must say something about the problem of generating stable frequencies.

None of the simple generators described here have a very high order of stability. If adequately screened and kept at a constant temperature, the frequency would be constant to one part in several thousands. One cannot be much more definite than that, although for signal generators and similar purposes an accuracy of this order is quite sufficient.

It is enough to observe here that frequency changes do take place. Usually the principal change is a slow frequency drift from the value originally set, due to temperature changes, etc. If too tight couplings are used, or too much coupling between the oscillator and extraneous circuits to which a part of its output is to be fed, a frequency jump to a value different from the calibration may also occur.

The design of oscillators of a high order of frequency stability is therefore an easy job. Crystals have now simplified the matter to some extent where only one or two frequencies are required. But it will be useful to note how the stability of even the simple types we have been discussing can be compared against really high standards—available anywhere. Reference is made to the carrier frequencies of broadcast transmitters, tunable on any receiver, i.e., during intervals when there is no modulation.

The basis of all such comparisons is to beat the oscillator against the carrier, and observe how the pitch of the resulting heterodyne note changes after a period of time. This is a rather rough-and-ready method, of course, since "pitch discrimination" is a variable quantity. A more precise method would be to observe the beat on an oscilloscope or similar device.

Conclusion

This article has been something of a "ramble" over the general properties of oscillators, their operating characteristics and some of the simpler experiments which suggest themselves.

The subject is almost endless. It is hoped it may be possible later to go more fully into subjects only "mentioned" here, e.g., types of generators which give non-sine-wave oscillations, synchronisation, etc.

A CRYSTAL CALIBRATOR

The G.E.C. Crystal Calibrator, M.923B, is designed for the checking of radio receivers and wave-meters, etc., including the measurement of frequencies up to 1,000 mc/s. It comprises a crystal oscillator, which may be set by a selector switch to either 100 kc/s., 2 mc/s., or 5 mc/s. This signal is mixed with the signal under test in a hexode mixing stage so as to avoid any danger of pulling between the source under test and the standard frequency oscillator. When the signal under test is close to a harmonic of the crystal oscillator, an audio beat note is produced, which after amplification by a two-stage amplifier of the conventional type, is fed to high resistance headphones.

The G.E.C. Crystal Calibrator.
ANNOUNCE
A NEW SYSTEM OF RADIO CONSTRUCTION

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VARIABLE CONDENSERS, 35 pF. ceramic plate midget single—can be staggered. 4½, 0.005 ceramic plate, $3.50; 9, 0.001 standard, 2½gsw. $4.14. Reaction condensers, $0.005 metal diode, $3.93.

TRIMMERS, $0.003 ceramic base.air spaced, new, 2½, 0.056; one new, 40 pt. S.W. presses neutralizing condens. 0.02, $0.02; 0.03, $0.03. T.C.G. air spaced straights line. 0.056, 2½, ceramic postage stamp type, 1000. 1½.

MAINS TRANSFORMERS, 30-350 m.v. 4 5, 4 3, 8 5, 30 m.a.; also 6, 5, 18, $0.005; 9, 5, 30; 12, 3, 60; 18, 3, 90; 24, 3, 120; 30, 4, 150; 40, 3, 200; 50, 3, 250; 60, 4, 300; 70, 3, 350; 80, 3, 400; 90, 4, 450; 100, 4, 500; 120, 3, 600; 150, 4, 750; 200, 3, 1000; 300, 2, 2000. 1½.

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SMOKING CHOKES, 20 henrys 100 or 120 m.a., 1½; 30 henrys 100 or 120 m.a., 3½; 40 henrys 100 or 120 m.a., 5½; 50 henrys 120 m.a., 7½.

SWITCHES. 4 pole 3 way midget single bank, 5 0; 3 bank 2 pole 6 way, 3½; 5 gang small, 12 6. Reaction condensers, 4 3; 6 3.

MIDGET CHASSIS. The "Simplex" chassis, fully rallied for the above midget, with speaker cut-out, electro-zinc finish, 3½.

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MIDGET COPPER WIRE. 4½ × 25 k.c./s.; 2½ × 25 k.c.; 1½ × 25 k.c.; 1 × 25 k.c.; 0.75 × 25 k.c.; 0.5 × 25 k.c.; 0.375 × 25 k.c.; 0.25 × 25 k.c.; 0.125 × 25 k.c.

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MINIATURE SWITCHES. —Miniature ro- motor, 6; medium, 9; heavy, 12 6.

M&S, 100 m.a. 4 v. 4 a. 4½; 150 ma. 6 v. 5 a. 6½; 200 ma. 6 v. 5 a. 7½; 250 ma. 8 v. 5 a. 9½; 350 ma. 12 v. 5 a. 13 6; 500 ma. 16 v. 5 a. 15 6; 750 ma. 24 v. 5 a. 23 6; 1000 ma. 36 v. 5 a. 22 6; 2000 ma. 72 v. 5 a. 30 6.

MIDGET TRANSFORMERS. Types A to M. A. 120 ma. 6 v. 5 a. 6½; B. 120 ma. 8 v. 5 a. 8½; C. 120 ma. 10 v. 5 a. 10 6; D. 120 ma. 12 v. 5 a. 12 6; E. 120 ma. 15 v. 5 a. 15 6; F. 120 ma. 18 v. 5 a. 18 6; G. 120 ma. 20 v. 5 a. 20 6; H. 120 ma. 25 v. 5 a. 25 6; I. 120 ma. 30 v. 5 a. 30 6; J. 120 ma. 35 v. 5 a. 35 6; K. 120 ma. 40 v. 5 a. 40 6; L. 120 ma. 45 v. 5 a. 45 6; M. 120 ma. 50 v. 5 a. 50 6.

MAGNETIC CONSTRUCTION. All components carry Webb's unconditional guarantee of satisfaction.
A recent discussion in the Press brought home, in concise form, a point which many listeners must have frequently discussed among themselves. It was concerning Benjamin Brittain's new opera, "Peter Grimes," which was broadcast in its entirety from Sadlers Wells Theatre a few weeks back. During the playing of some of the most important music—when voices were absent—a commentator kept intervening with descriptions of the opera, and other observations. I didn't hear the performance, but I imagine it was very much like similar broadcasts that I have listened to on other occasions. Apparently, the interruptions occurred when the music was of a very engrossing character, like much of Wagner's descriptive music which accompanies the actions and not the voices of his characters. Our leading music critic in his review of the broadcast rather castigated the B.B.C. for its policy of allowing these verbal, and to him unwanted, interruptions to the music. To Mr. Newman, the music was not only performing its function of describing the action of the plot, but was also very beautiful.

However, a letter from the Director of Music, B.B.C., in a subsequent issue, must have come as a bit of a shock to Mr. Newman's critical reflections and conclusions. For Mr. Hely-Hutchinson wrote to say that the policy of having the commentary had the full approval and sanction of the composer.

Two Important Points

All of which leads me to raise two points within one discussion. Is any broadcast of an artform improved, or enhanced by such interpolation? Also, do listeners appreciate, or are listeners benefited, when works are prefaced with biographical or learned comments to the composition or the work they are about to hear. My answer, given in advance, is an unqualified and unequivocal No.

To do so with major works such as an opera seems to militate the whole reason and object of "The Radio Times." Surely that is the medium through which to tell us the story of an opera and the genesis of its existence. The whole charm and excitement of the unfolding of the opera, in the case of a play by the characters, and with an opera by the characters and the music, is spoiled by constant references to what so and so did in act one, and to what they are going to do in act 3. In presenting the play or opera, the characters speak or sing in English all foreign, operatic, or invariably translated—and providing the details of cast, scenes, etc., are clearly set out as they would be in a theatre programme, the rest should be left to the thoughts and imagination of the listener.

Ridiculous Comments

When you hear such ridiculous remarks as "When the curtain rises on act 2, Don something-or-other is striding across the stage in great wrath at having been jilted by the beautiful what's-her-name in favour of the slack and smug something-or-other. As he sings his famous aria, 'Ah, the Fickleness of Woman,' lights appear in the palace windows ..." etc., etc., don't forget that all the protagonists are grouped round the microphone,oe in band, all dressed in neat lounge suits and frocks, and that all the noises you hear of galloping horses, wind, thunder and lightning, and what-not, are only "effects" made by people, also grouped around said microphone at their appointed distances.

Another habit which annoys me intensely is the prefixing of concert programmes with "notes" or "comments" on the music about to be performed. Such remarks as "this symphony was written in ... at the height of the composer's creative genius. Some critics have likened it to a great tragedy in four acts, in which the characters experience all the joys and sorrows known to mankind," is frequently heard. Even more exasperating are the analyses of the works with references to tonics, dominants, fugues, etc.

Classical Symphonies

Music is such a personal, individual thing, and the victim of our moods and circumstances. Especially the abstract variety as exemplified in the classical symphonies, etc., where most people surely prefer to be allowed to close their thoughts to outside suggestions and form their own opinions and conclusions. To be told that "some critics consider it like a tragedy in four acts ..." etc., seems to border on the impertinent; if I wish to liken it to a comedy in four acts, why shouldn't I? It is the spoken word that jars, with no means of challenging the opinions expressed should we differ from them.

Explanations of programme music is a different matter. All harmony or tone colour being impressionistic, whether the work be an "abstract" quartet or a "programme piece," like any of Debussy's, some indication must be given of the story the composer has set out to paint. It is no good leaving us in the dark as to whether certain effects are meant to be wind or rain, sunshine or moonshine. The title of the piece is not nearly enough in a major work; Debussy's "La Mer" portrays all these things and much more. A few well-chosen sentences, like we would read in our programme notes at a concert, may make all the difference between imagining ourselves at Tintagel, in Bax's beautiful work of that name, being splashed by the waves and tossed by the wind, and sitting through weird, incomprehensible swishes and noises.

Here, again, it must not be overlooked that these works are heard time out of number by most of us, and that, no matter how useful they may be at the first hearing, such comment and explanatory remarks are apt to become tedious and commonplace when repeated time and time again. That is why the printed word is the place for them, when we can pass them by with a nod of familiarity if we do not require them.

Damper on Pleasure

But with the classical "abstract" masterpiece, no remarks or suggestions offered by the announcer in a few words prior to performance can act as anything but an intrusion into one's private thoughts and a damper on the pleasurable anticipation of the event. The knowledge of form, and kindred subjects, possessed by the expert, is only acquired after months of study; nothing can be gained under that heading from anything said by way of preface. But full, and very great enjoyment can and is obtained if we can listen with a mind clear and reposed, of quick perception and reaction, and ever alive to the rapidly changing kaleidoscope of sound and rhythm. Short of thorough study of the complex subject, we should prefer to be allowed to form our own judgements and opinions, with help and guidance from a medium such as "The Radio Times," or lectures preceding the performance.
Open to Discussion

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Overseas Readers

SIR,—It is very unfortunate that we here are unable to submit any practical hints, for the simple reason that the coupon becomes invalid after the short time lapse, so if this period can be a little extended so as to enable us to submit ours it will immediately benefit us—or can there be an exception for us?

Your journal is a real boon to us, and is greatly appreciated. Lastly, I would request you to put me into touch with a few short-wave enthusiasts.—MAHINDA WANIGASURIYA (Ceylon).

[We allow sufficient time for overseas readers to submit hints.—Ed.]

Old Circuits, Reviewed

SIR,—The article in a recent issue of Practical Wireless, "Old Circuits Reviewed," was very interesting, as I built some of these in the early days of radio and obtained very good results, for those times, with two of them, namely the "Chitos" and the "Flewelling."

I think that, if you can trace past records, the "Chitos" circuit was evolved by a gentleman named Childs, and owing to the rather badly-written signature to the letter describing the circuit, it was read as "Chitos."

The results obtained with the Flewelling one-valve set were good, again bearing in mind the quality of transistors of those days, but the desire to experiment and construct radios remains.

Now as regards to the "get-up" of Practical Wireless, I find the size ideal. The articles that interest me most are : constructional details of sets, the readers' hints page, "Open to Discussion," and test meter construction. The ones that interest me least are : radar, disc recording and any involving intricate mathematics, the latter being my weak point.

However, Practical Wireless is grand value, and 1 find was given. The wavelength of GJ KV was about 20 ft. I received this whilst listening in to the medium waves for a change—my main interest lies in the "shorts."

Like J. Leng (April issue), L also can compete for being the youngest experimenter. I started at the age of ten and am now fifteen.—D. E. SMITH (BSWL 1913).

S.W. Listeners

SIR,—I wonder whether any reader could give any details of the following two stations : GYKV and North Foreland Radio, GMF?

I heard the former repeating "This is GYKV calling North Foreland Radio—will you give me a test, please?"

for about ten minutes before a reply, which I could not make out, was given. The wavelength of GYKV was about 420 m. I received this whilst listening in to the medium waves for a change—my main interest lies in the "shorts."

Like J. Leng (April issue), L also can compete for being the youngest experimenter. I started at the age of ten and am now fifteen.—D. E. SMITH (BSWL 1913).

Details of Stations Required

SIR,—The following information may be interesting to S.W. listeners.

English broadcasts from Sweden and Czechoslovakia are as follows :—

<table>
<thead>
<tr>
<th>Station</th>
<th>Transmission Details</th>
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<tr>
<td>Motala</td>
<td>01.00-02.30, 11,730 kc/s. (every day); 19.00-20.00, 9,590 and 11,730 kc/s. (beamed to S. Africa).</td>
</tr>
<tr>
<td>Prague</td>
<td>01.00-02.30, 9,590 and 11,730 kc/s. (beamed to S. Africa).</td>
</tr>
<tr>
<td>London</td>
<td>01.00-02.00, 6,065 kc/s. (every day); 17.30-17.55, 10,780 kc/s. (week-days); 15.00-16.00, 11,705 kc/s. (Sundays and holidays).</td>
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The following are the times of transmission and the frequencies of the S.W. station at Hilversum, Holland :—

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<th>Station</th>
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<tr>
<td>PCJ</td>
<td>15,620 and 9,590 kc/s. ; power, 30 kW.</td>
</tr>
<tr>
<td>PCJ</td>
<td>17,775 and 11,730 kc/s. ; power, 15 kW.</td>
</tr>
<tr>
<td>PCJ</td>
<td>15.00-14.50, 17,775 and 11,730 kc/s. (beamed to the Far East).</td>
</tr>
<tr>
<td>PCJ</td>
<td>19.00-20.30, 9,590 and 11,730 kc/s. (beamed to S. Africa).</td>
</tr>
<tr>
<td>PCJ</td>
<td>01.00-02.30, 9,590 and 11,730 kc/s. (beamed to the D. W. Indies).</td>
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</table>

All times given in the above schedules are GMT.—A. LEVY (Belfast).

Service Engineers

SIR,—Owing to the lag in the arrival of periodicals in this area, we have just received a copy of your June, 1945, issue. We trust we are not too late in making a reply to Mr. R. Skelton—re Service Engineer. It is generally accepted by all that Signals have done, and are still doing a fine job of work, but they are not trained to carry out full servicing or to obtain "highly amplified L.F. band-passed," tone corrected, etc., etc., signal through high fidelity receivers.

Is Mr. Skelton aware of the existence of Telecommunications, within the Corps of R.E.M.E.—who, by the way, with a few exceptions have had no civilian experience? These mechanics, with their "Forces training," are required to service and use a wide range of equipment identical with, and in some cases far in advance of, the normal civilian establishments.

We, unfortunately, have not been able to follow the discussion between Mr. Firth and Mr. Levy, and have no intention of commenting on remarks passed between them. We definitely object to Mr. Skelton's phrase: "Men who have been trained in, and experience confined
Just What He Wanted!

SIR—Recently I was looking back through many of my Practical Wireless issues, and suddenly I came across something that I had previously overlooked. It was in last year’s June issue, and I now refer to the pleasure I received when I found something so very simple and yet it had never occurred to me previously. I must admit that I’m not very just how Practical Wireless is one of the finest of mags, though I would like to send thanks to T. B. Wearden (Widnlow) for his valuable hint that you so kindly printed for him on the “Practical Hints” page. Previous to being called up I had always wanted some form of simple test set for pocket use, instead of carrying about instruments, sets of a heavy nature, and here I find the idea and sample of all devices which I’m sure T. B. Wearden must have designed especially for me, and before I close this letter I would also like to thank you, the Editor, for the reply you sent me on receiving my letter dated some time last month.—C. M. BARRATT (Widnlow).

A.C. v. Universal Sets

SIR,—Mr. R. G. Harrison, of Newcastle, in a letter in the May, 1946, issue, refers to A.C. v. Universal sets. I agree with him that when A.C. becomes the standard supply in this country there will be no necessity for the Universal circuit, but I do think he gives a wrong impression by implying that the quality from a Universal set is inferior to that from an A.C. set, unless, of course, he thinks only in terms of the midget type.

To take an example. I have built an all-A.C.-D.C. amplifier which I designed and built myself, comprising a Rotherham Crystal Pick-up using thorn needles, Mullard SP13C first L.F. wired as triode, Brimar 4Dr phase-splitter, two Mullard CL13’s wired as triodes in the output stage, the whole fed into a Baker’s 12111 cabinet, and I challenge Mr. Harrison to prove that the quality is inferior to any comparable A.C. amplifier.

With reference to his statement that an A.C. set has a lower hum level, I will just remark that I have to “ get my head in the speaker ” to detect the hum in this amplifier, and that with a speaker with the finest of low-frequency responses.

As to replacements, I can obtain here any Universal component which I need. In conclusion, may I correct another statement by Mr. Harrison that it is impossible to raise the mains voltage in an A.C.-D.C. circuit, and I wonder if he has heard of the voltage-doubler circuit?—G. HOUSE (Bradford).

Amplifier Modification

SIR.—I have built the small A.C.-D.C. two-stage amplifier that was described in the January issue of Practical Wireless.

The only difference from the original layout is that I have included the speaker output transformer under the chassis as I am using the amplifier for reproducing gramophone records. I am also using two “Premier” gain and tone-indicator plates for the controls and two plates for the input sockets; these are marked Gram. and L.S. I find that these plates make the finished amplifier, look very smart and neat.

The amplifier took me three evenings to construct, and I had no trouble at all getting the various components. The chassis was made for me by a friend out of 16 s.w.g. aluminium. The gain is quite enough to load my 10in. P.M. speaker, and the tone is very good, as the speaker is mounted on a baffle 2ft. 6in. square.

My pick-up is an H.M.V. magnetic type as used on the H.M.V. pre-war record players that were priced at 39s. 6d. This I find gives more than enough input for the first stage of the amplifier, and so I have turned down a little so as not to overload the amplifier.

I am also using an A.C.-D.C. gramophone motor in the record-player. The rectifier valve is an UR46 Mullard, as the YL as stated in your components list is a side-contact base.

I am using the amplifier on 210 volt mains at present, but I am hoping to be changed over to A.C. any time now. I hope these remarks will be of use to other readers who are thinking of building the amplifier. The cost of the components, including chassis and valves (also output transformer) was £5 10s., and it is well worth it.—N. RICHARDSON (Northants).

DX Listening

SIR.—I submit an encouraging log for newcomers to the “ ham ” bands, who may think the bands are empty of DX, but who will find, with a little patient listening, that there is much to be heard. Naturally, the best way is to acquire a working knowledge of the code, but there are several DX phones available. For example the phone between 22.20-22.50 on April 26th, and a two-hour period on the 27th. CN85, 111DH (phone), ND, LA4F, 90, LU6A1, OE5RG, PY11G1, PG, 2AY (these last two on “phone,” 41E, PR4A, SM53W, 4YU, LD, 54K, OH, JS, IPERSM, WE, YS, MP, GRS, ST1CX (phone), XPA, YR8A, C, X, YV5A6, ZP1.

By far the best of C.W. DX transmissions came from LU6A1, at R.S.T. 599. I have sent reports to PY11G1, 2AY, the LU, and YV5A6, and will let you know if I have a reply from any of them. I should like to know the whereabouts and QRA. of XP1, who was working SM7XV on the 27th, also PR1AA. The RX is a t 2.-v. 2-home-built affair using the long oblique aerial. How about starting a listener’s league? A period for listening could be fixed in your journal by you, and the results of a cross section of S.W.L.s be published. I imagine this would put S.W.L.s in lively contact with each other, and also cause comparison to be made between, say, superheats and straight receivers over a given period.

Your journal has done wonders to keep the constructor’s spirits going, and when one thinks of the stream of circuits you have described in the last few months, credit must surely go to your conscientious and enthusiastic technical staff. I certainly wish you all the best for your continued success.

Hoping this letter will be of interest to all S.W.L. fans.—R. W. FINCH (Issex).

Commercial Set Design

SIR.—As radio servicing is my main interest in radio, I make the following comment on Mr. H. Hammond’s “Commercial Set Design” in the March publication of your excellent journal. Mr. Hammond apparently is unaware that A.C.-D.C. receivers, or more easily got rid of, if present. This is due to the fact that the A.C. receiver has no direct connection to the mains supply, owing to the presence of the much-criticised mains transformer, which is usually screened.

The mains is a bad source of interference, and H.F. in the mains is a not uncommon thing. With the A.C.-D.C. receiver which is directly connected to the supply, the presence of H.F. in the mains may cause modulation hum.—F. C. PALMER (Wilt’s).

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