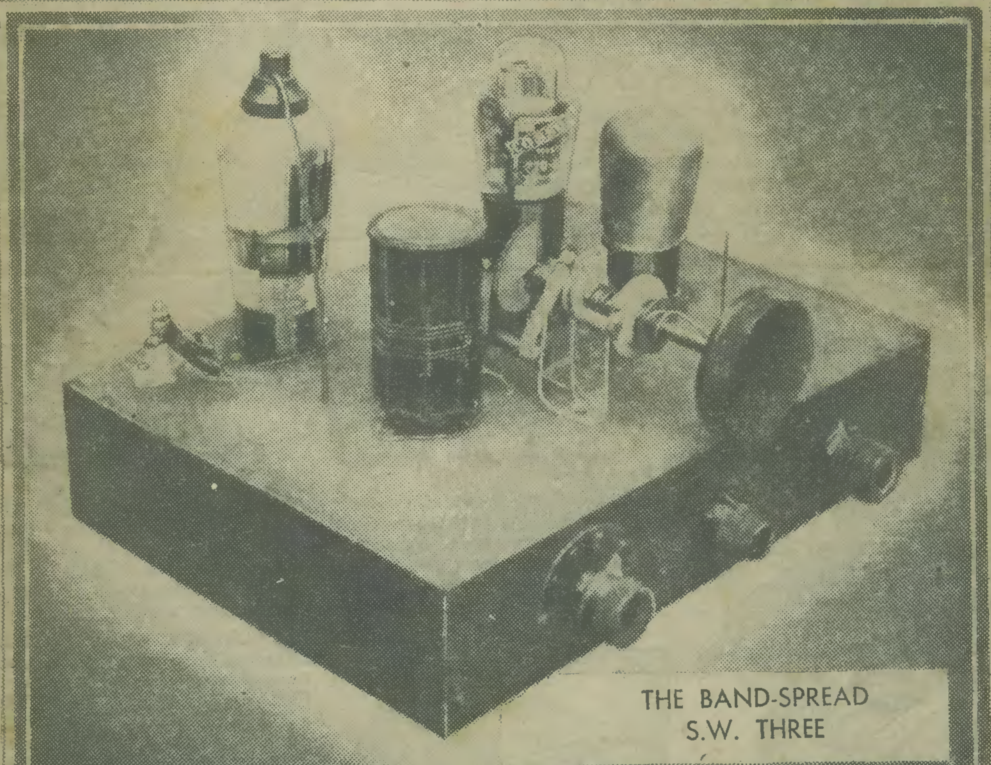
OUTDOOR LISTENING

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 22 No. 481 NEW SERIES JULY, 1946



THE BAND-SPREAD S.W. THREE

PRINCIPAL CONTENTS

Practical Wireless and PRACTICAL TELEVISION
14th YEAR OF ISSUE
VOL. XXII. EVERY MONTH No. 481. JULY, 1946
Editor F. J. CAMM

COMMENTS OF THE MONTH. BY THE EDITOR

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 Shotter.

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.

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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.

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. 6,789), are obtainable, price 9d. (by post, 11d.), 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 (W5/5) 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.

ROUND THE WORLD OF WIRELESS

Sales on Hire Purchase and Credit Terms

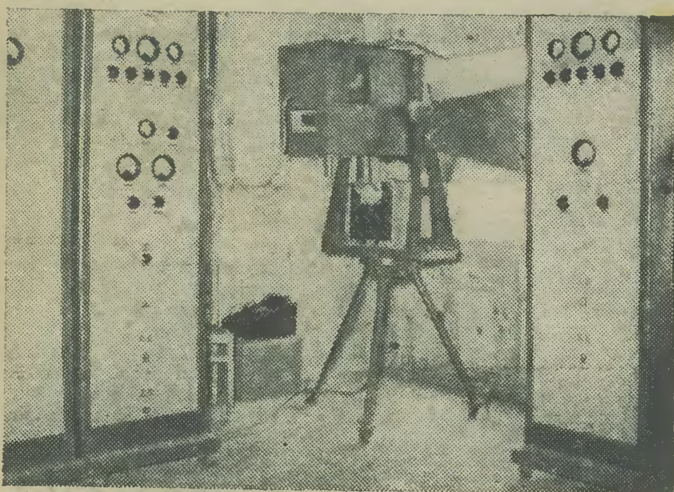
THE Board of Trade have made an Order, the Hire Purchase and Credit Sale Agreements (Control) (No. 2) Order, 1946 (S. R. & O., 1946, No. 585), adding the following goods to those which are exempt from the control exercised under the Hire Purchase and Credit Sale Agreements (Control) Order (S. R. & O., 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 Telecommunications provides 12 simultaneous telephonic lines between Paris and Enghien transmitted by waves of 9 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.



A French invention: the first hertzian cable under micro-waves was recently presented for the first time by the Centre National d'Etudes des Telecommunications at Montmorency, near Paris.

Change of Address

THE Sales Department of British Mechanical Productions, Ltd., has now removed from its wartime address at Leatherhead to 21, 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:

(1) The vast plant at Hayes, Middlesex, England.
(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. K. LYNTON-HARRIS, formerly News Editor in the News Division, Ministry of Information, has joined the Philips group of companies, of Century 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, radiolocation, 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.

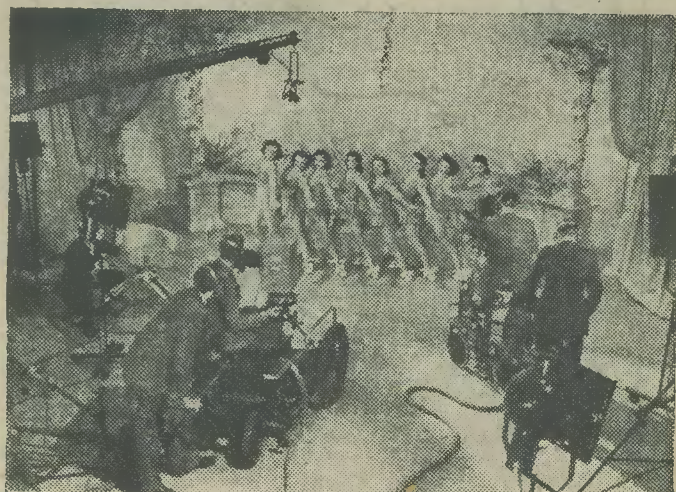
Upon completion it will be for trade transmission only and be used each morning. Many well-known stars are featured in the film.

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.



Carrying out a television test on a closed circuit to television manufacturers, dealers, etc., in preparation for the restarting of television programmes.

The Band-spread S.W. Three

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

By F. G. RAYER

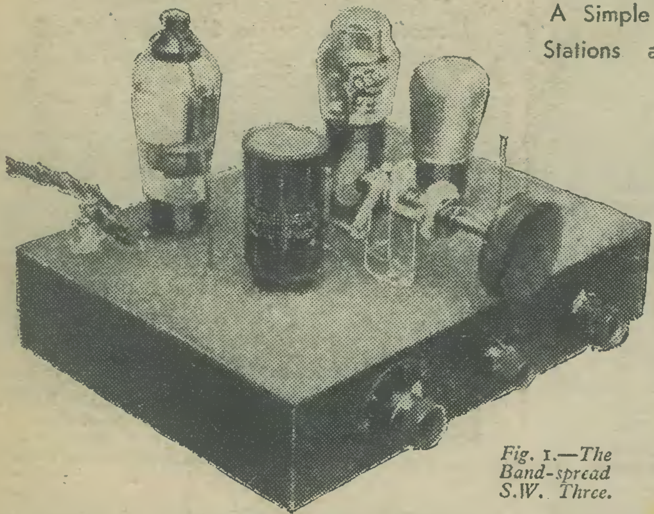


Fig. 1.—The Band-spread S.W. Three.

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 damping and obviates the necessity of ganging two circuits—a particularly difficult matter with band-spreading—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 parafeed 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-spreading 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

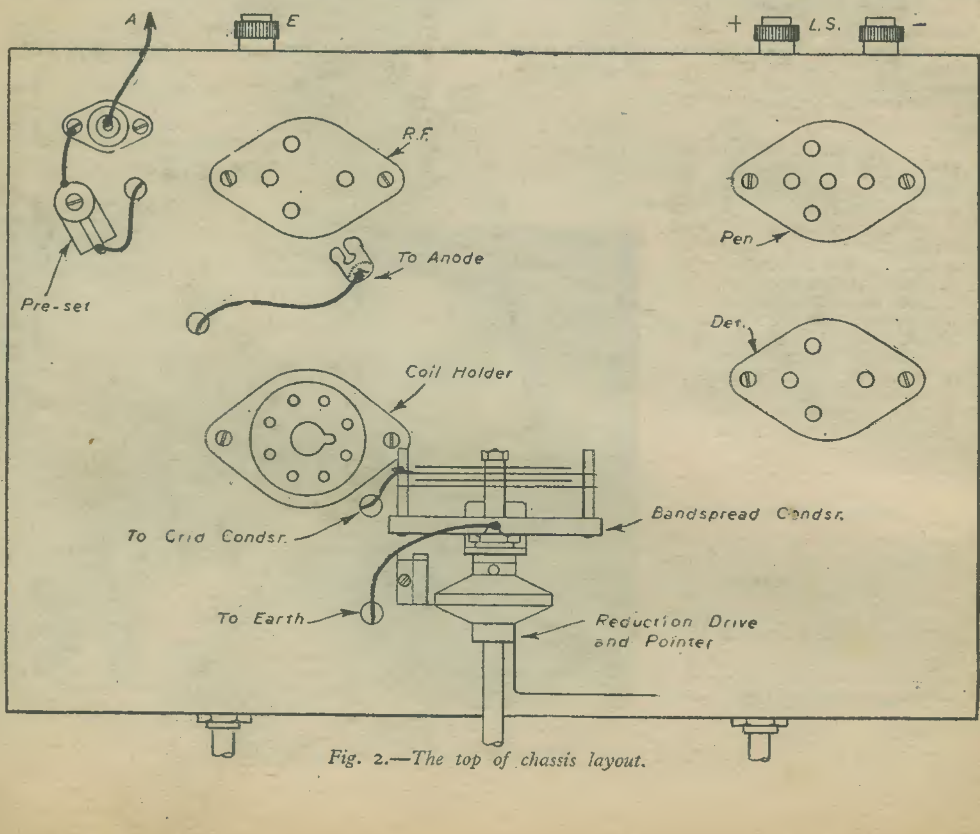


Fig. 2.—The top of chassis layout.

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 10in. by 8in. by 2½in. 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-spreader.

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

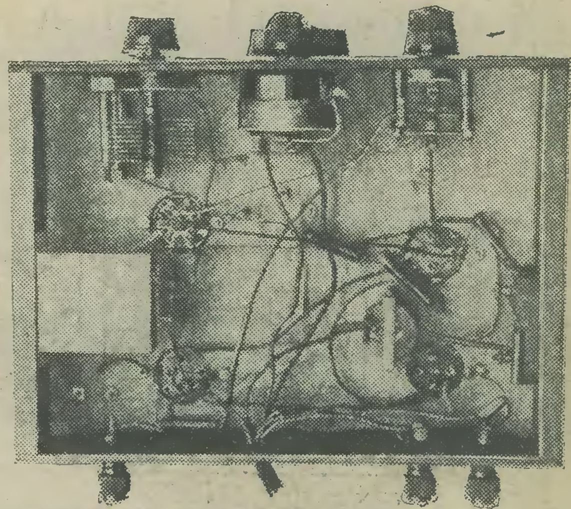


Fig. 3.—Sub-chassis view of the Band-spread S.W. Three.

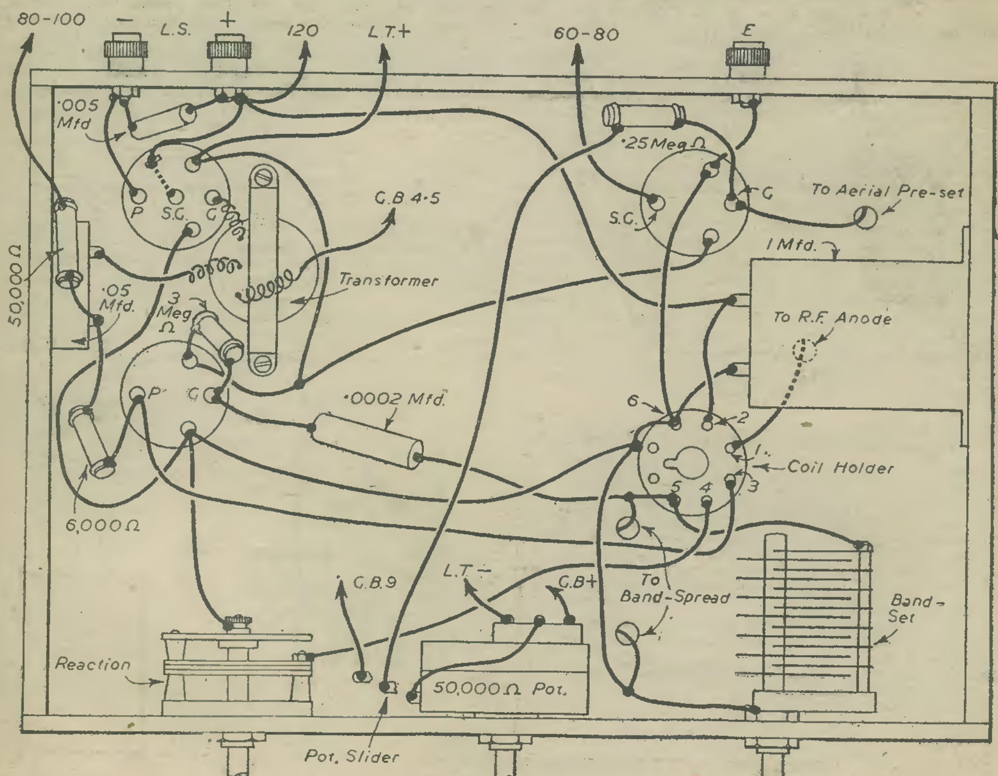
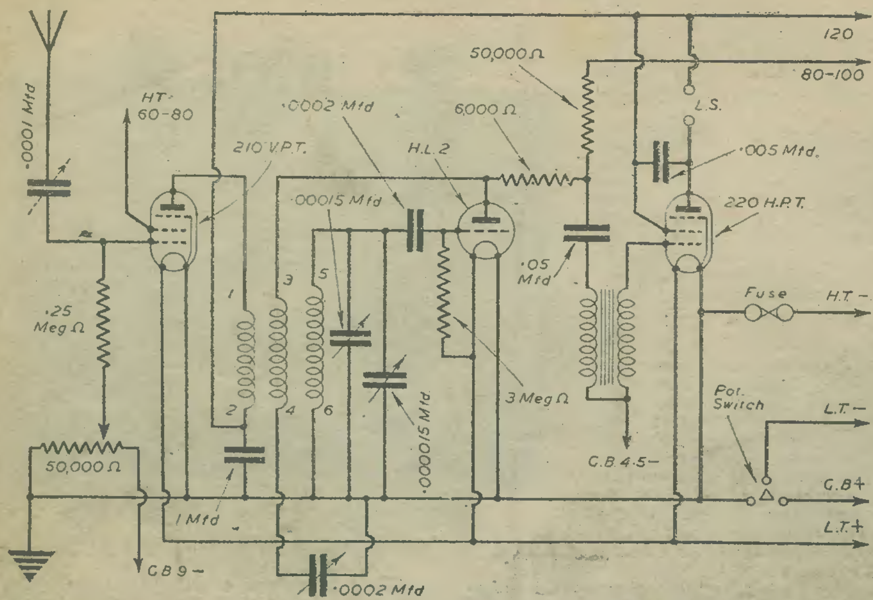


Fig. 4.—The wiring and component layout below the chassis.



which the receiver is housed, although this cannot be shown by the illustrations.

In all probability the aerial pre-set will need to be adjusted to a fairly low capacitance, and the effect of altering it should be noted upon various frequencies. H.T. 80-100 should be adjusted to obtain smooth reaction, and H.T. 60-80 should also be tried in various tappings as the voltage here influences the gain of the R.F. stage. If some slight decrease of amplification can be tolerated G.B. 4½ should be increased to 6, as this will result in quite a large decrease in anode current. If 'phones are used for DX listening 6 volts bias may be used permanently.

If to hand, a S.G. valve may be used instead of the R.F. pentode, although gain will be slightly less. A triode can also be used in the output stage, and if it is not intended to use a speaker at all with the set this modification is worth considering as a reduction in background noise will result.

Fig. 5.—The circuit diagram.

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

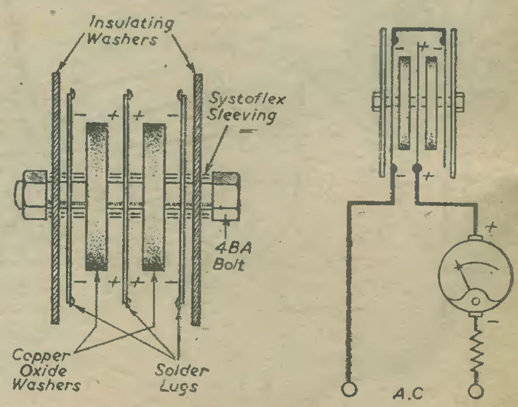
Batteries should be connected as shown for the initial trial, and the coil for 22-47 metres will probably be best for the first test. Actually, the layout enables this coil to tune down to 19.2 metres, when efficiency will be high. All tuning is done with the band-spreader, and it should, of course,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

LIST OF COMPONENTS

- 50,000 ohm potentiometer.
- 3 and .25 megohm and 6,000, 50,000 ohm resistors.
- .000015, .00015 and .0002 mfd. variable capacitors.
- .0001 mfd. pre-set.
- .0002, .005, .05 and 1 mfd. fixed capacitors.
- 4 valve holders and coil holder.
- Parafeed transformer (ratio 1 : 4).
- Fuse-plug.
- Knobs.
- Coils for 9-50 metres or as desired.
- Valves, Cossor 210VPT; Osram HL2K; Cossor 220HPT, or similar types.

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).

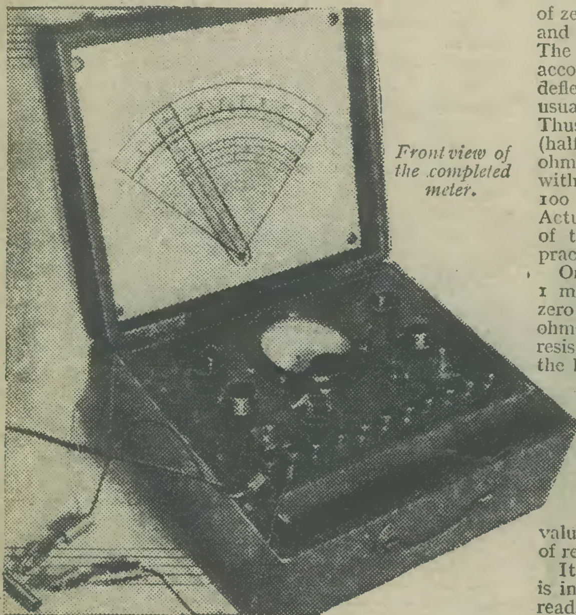


Details of the A.C. meter rectifier.

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*)



Front view of the completed meter.

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 5in. or 6in. 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 milliampere 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 resistor whose value in ohms is 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 effect 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 milliampere 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. Once again, the use of the 10-milliampere shunt divides the figures by 10, and it will be found that the readings reached by this means are low enough for all ordinary purposes. One-tenth of one ohm can very easily be calibrated and read.

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. 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 the

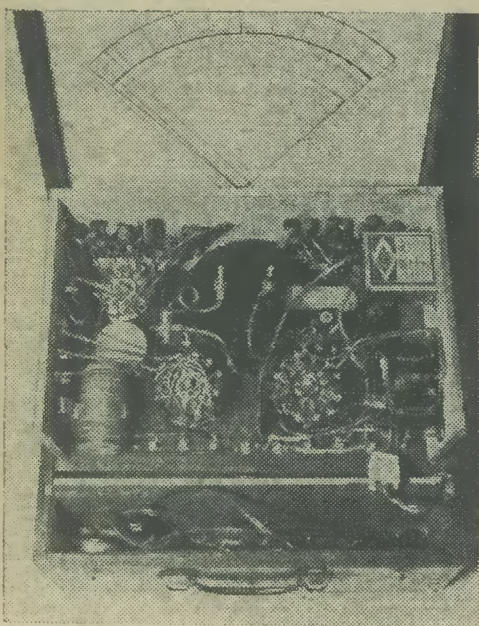
COMPONENTS LIST

Case and panel (see text).
One milliammeter 0-1 mA. (Premier).
One Westinghouse rectifier, 1 mA. (Premier).
Two switches, single-pole 11-way.
Two switches, two-bank five-way (see text).
Two on-off toggle switches.
One carbon volume control, 100,000 ohms, with switch.
One wirewound potentiometer, 2,000 ohms.
Eleven large terminals.
Two capacitors, 2 mfd. or over (one must be paper type, at least 250-volt test).
One special current transformer (Metropolitan Radio Service Co., see text).
One dry cell, type U-2.
Good quality flex for test leads, crocodile clips, prods, etc.
Flex and bayonet plug adaptor for mains inlet.
Connecting wire, soldering tags, etc.
Resistance wire for shunts (see text).
Carbon-type resistors for multipliers, as required (see text).
Four pointer-type knobs.
Two miniature round knobs.

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 should be a good hefty job, and that voltage tests should be made while the transformer is working under load.



A rear view of the completed meter.

In measuring true A.C., that is to say, where there is no D.C. element superimposed, it will be found that the reading obtained between terminals 9 and 6 will be virtually the same as that between 7 and 6.

Terminals 10 and 11, concerned with the measurement of capacity and of the higher resistances, remain to be dealt with, and while it is possible to work out the meter deflections corresponding to each value, the mathematics are rather complicated. It is suggested that these ranges should be calibrated by a method of trial and error, proceeding along the following lines :

First assemble on the test-bench as representative a collection of capacitors and resistors as possible. Then set the meter-controls as if for measuring A.C. volts on the lowest range, 0-10, and connect the first of the resistors between terminals 10 and 11. Close the switch S.2, plug into A.C. mains, and slowly turn the knob of the potentiometer P.2 until, S.3 having closed, the meter needle indicates exactly full scale. Throw open S.2 and make a note of the new reading, then close S.2, change the component under test for another, and repeat the operation. Then, having gone through all the available spare components, close S.2, move the A.C. voltage selector switch to its next higher position, re-set 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 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 0.05 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 7in., 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 arc, 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.

The "1C5" Short-wave Set

Details of an Interesting One-valve Receiver

By A. D. BROWNRIG

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.

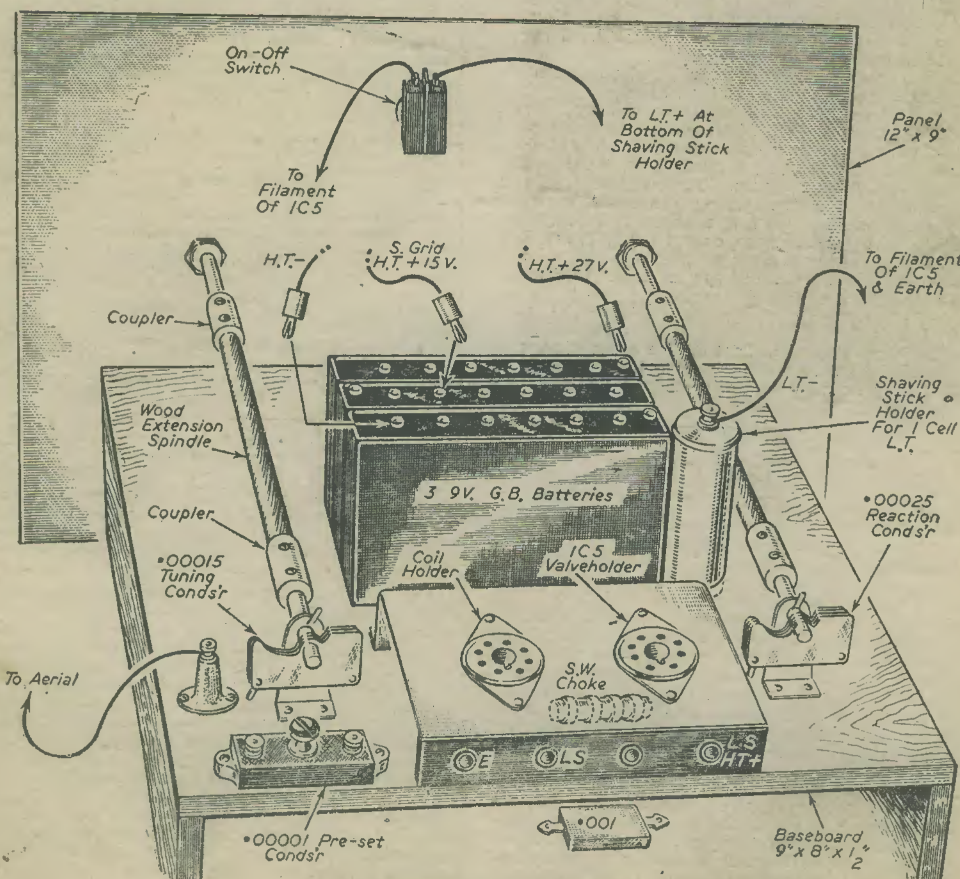
Various circuits from PRACTICAL WIRELESS were tried out, but eventually whittled down to a plain circuit using throttle-controlled reaction. The latter, however, was not so good as the normal reaction control, and so the circuit became practically the same as for the Midget Portable, using the 1C5 valve.

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.

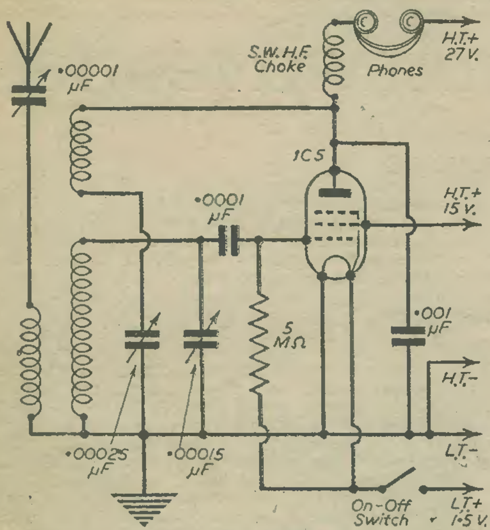
L.T. Supply

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 1½in. 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 ¼in. 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 2in. (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 1C5 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 1C5 valve produced before this? Incidentally, I've tried one or two British valves of the 1.4 type, with similar characteristics to the 1C5, but results do not seem to meet expectations. No doubt they would if I could find the right circuit and values. Meanwhile, my 1C5 0-v-0 gives me all I desire at the moment.

The set in use is connected to a short aerial, about 25ft. in length, situated in the roof attic, with down lead about 9ft. 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 1C5 SHORT WAVER

One tuning condenser, .00015 mfd. (Eddystone).
One reaction condenser, .00025 mfd. (Eddystone).
One 1C5GT 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 (Ormond).
One slow-motion dial, 100 to 1 ratio, for tuning (Utility).
One metal chassis, 6in. x 5in.
Four brass couplers for extension spindles.
Two extension spindles.
Two condenser (variable) 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 broadcasting, 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.

Eight 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 history of 1945, the work of each programme department and every section of the 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 Munchen Gladbach; the last photograph of the book is Monsieur Harold le Druillenec, the only British Channel Islander who came alive from Belsen and who broadcast before the King on Christmas Day.

Maurice Gorham, recently appointed to take charge of the Television Service, writes of the return of television.

H. Bishop, Chief Engineer of the B.B.C., tells the story of how it was possible to keep the Home Service on the air through all the enemy air raids by the use of sixty specially-constructed small transmitters. At the same time, the immense expansion of the Overseas Services was being carried out, and twice during the war B.B.C. engineers installed the largest transmitters ever erected. First, the new station near Hull, with a power of 800 kW., and again that in Cumberland, which has twelve transmitters of 100kW.

The Year Book for 1946 is priced at 2s. 6d. (2s. 10d. post free), and it may be obtained from the B.B.C. Publications Department, The Grammar School, Scarle Road, Wembley, Middlesex, or from any newsagent or bookseller.

ON YOUR WAVELENGTH

By THERMION

Nonentities at the Mike

IN order that my criticisms of programmes should be strictly impartial I always listen in to programmes which I know I am going to dislike. The past month has been particularly fruitful in rearing a crop of programmes which normally I should not listen to. Quite apart from the well-known names, or rather names which were not well known until the B.B.C. made them well known, there are quite a number of nonentities who are being helped on their way to radio stardom by the microphone. These nonentities, who come from complete obscurity, are not backed by any natural entertaining ability, and are mediocrities. I suppose they draw their modest fees in the first place from the B.B.C., gradually become better known by the simple process of name plugging over the air, and then desert broadcasting to fulfil stage contracts at about £10,000 a year.

I do not need, nor does any other listener, to have a musical programme compèred by a man who is not a musician. You will know the sort of introductory tripe: "Ladies and Gentlemen, I have very much pleasure in introducing to you a most charming and dainty little lady and I am sure you are going to enjoy her programme. (Pause for dubbed-in applause.) Ladies and Gentlemen here she is." Quite apart from the fact that listeners cannot see whether the young lady concerned is charming and dainty or not, no one is interested whether she is or not. It is purely her voice and what she sings or says which matters. Why should the B.B.C. waste money on these so-called compères who add nothing to the entertainment value of the programme, but occupy a fair amount of programme time. Of course, they give themselves a nice little boost every time they compère an item. "Hallo folks. This is Barrel Breadface speaking." The B.B.C. has a duty not to bring nonentities to the microphone especially to introduce musical programmes. It is discouraging to trained musicians, and they should not encourage this musical racket by permitting those who do not know one note of music, and cannot play any musical instrument, to broadcast.

New Amateur Wireless Station

APPLICANTS for a licence to establish an amateur wireless station and who have not previously held a licence to install wireless transmitting apparatus may now make applications. They will be required to furnish evidence of British nationality and proof that their technical knowledge and operating ability reaches a certain minimum standard. The proof normally required will be a pass in a test, conducted by the 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. Exemptions 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. These particulars will include 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 is 10s., in addition to 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/cs. 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 synchronised 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 valve bases and all the component values (including details of switch positions) are at 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"

DUE 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

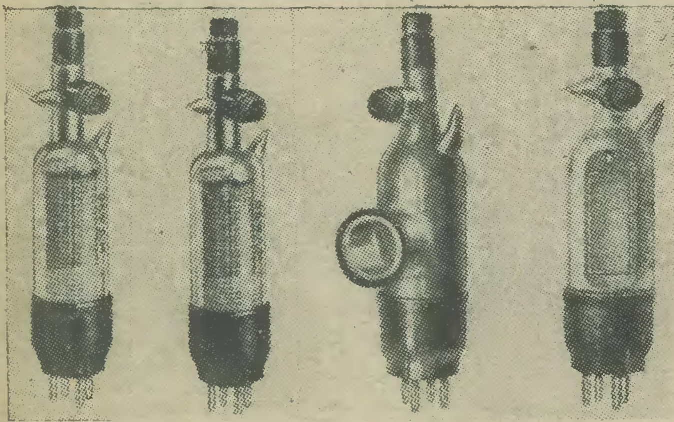


Fig. 3.—Photo-electric cells having a cathode in the form of a rectangular plate, centrally sealed in the bulb and brought out to the screw terminal at the top.

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.

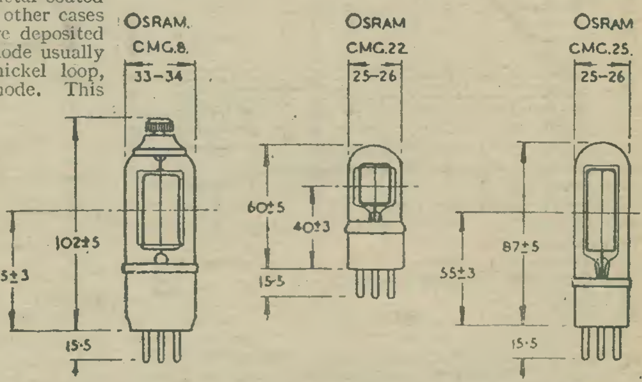


Fig. 2.—Typical designs of photo-electric cell having a rectangular-shaped cathode and rectangular wire loop for the anode.

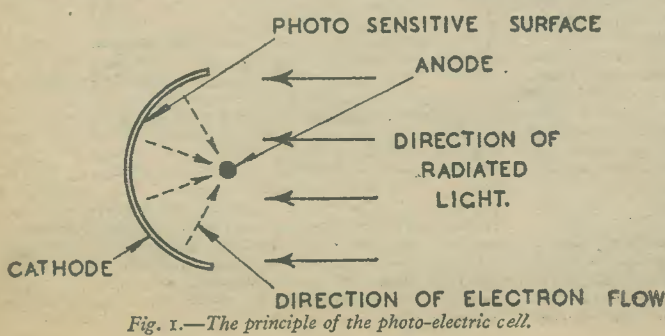


Fig. 1.—The principle of the photo-electric cell.

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. 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.

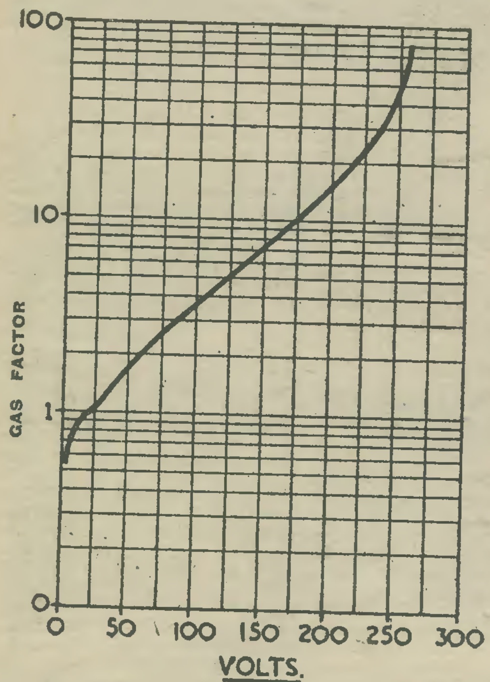


Fig. 4.—Average voltage-current characteristic for Osram Type KG7.

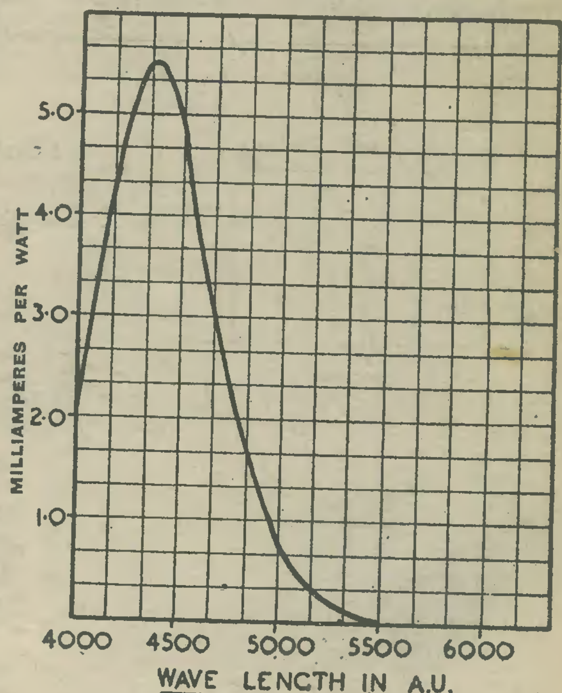


Fig. 5.—Average spectral sensitivity curve.

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.

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.

The presence of an inert gas, such as neon, argon or helium, enables the cell to pass more current for a specified amount of radiated light, thus increasing the sensitivity of the cell.

It is easier to understand why this is so by referring to radio valve practice, where is established the fact that a gas-filled rectifier passes more current than a vacuum type. The reason for this is well known and can also be attributed to the photo-electric cell, as the presence of gas results in a production of ions which cause the cathode electron emission to increase. This phenomena can be explained as the breaking down of the gas molecules by the impact of electrons, and the liberation of electrons from the gas molecules, by collision, leaves them positively charged, in which condition they act as conductors of electricity.

Blue Glow

Extreme care should be taken when applying the potential to the anode, as excessive voltage will result in a gas discharge, recognisable 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, race-track indicators, photometry, television and acoustics, 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.

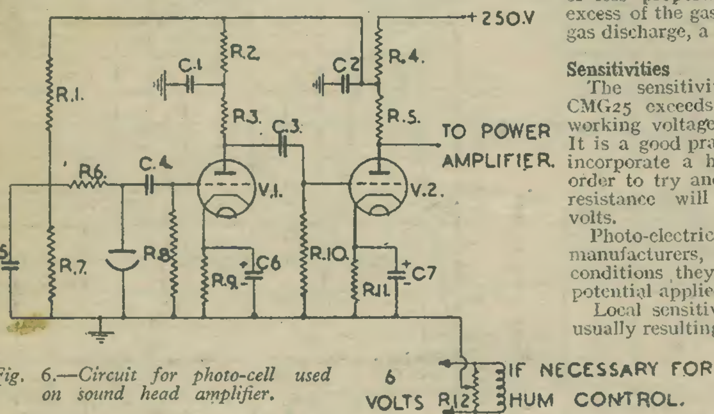


Fig. 6.—Circuit for photo-cell used on sound head amplifier.

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.

C1 & C2	=2 microfarad	V1	=Osram H63.
C3	=.01 „	V2	=Osram L63.
C4	=.002 „		
C5	=4 „		
C6 & C7	=50 „		
R1	=150,000 ohms	R7	=100,000 ohms
R2	= 50,000 „	R8	= 5 „
R3	=100,000 „	R9	= 2,000 „
R4	= 25,000 „	R10	= 1 „
R5	= 50,000 „	R11	= 2,000 „
R6	= 5 „	R12	= 50 „

Sound Reproduction and Acoustics

Another application which has become extremely popular in 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. 1.

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 more or 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 10. 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 the circuit 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 that to 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.

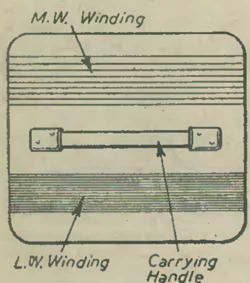
Frame Aerials for Portables—2

(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. If the size cannot be decided upon, as probably 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 earth 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 leathercloth, 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.



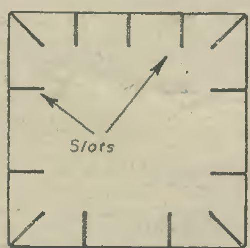


Fig. 6.—Top view of cabinet, showing position of aerial and carrying handle.

Fig. 7.—Frame for winding a pancake aerial.

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 ½in. 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 ¼in. 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 pile wound so that it does not project too far and has, therefore, less pick-up properties, so that very little advantage can be obtained.

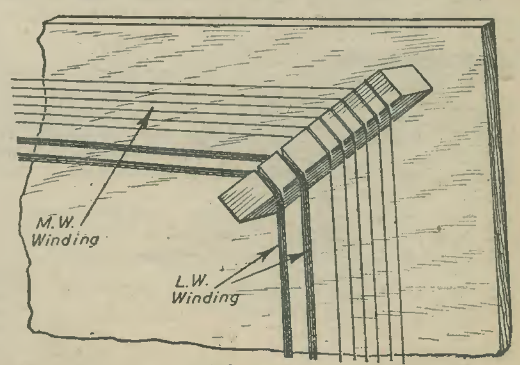


Fig. 8.—Alternative form of pancake aerial.

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 1in. 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.

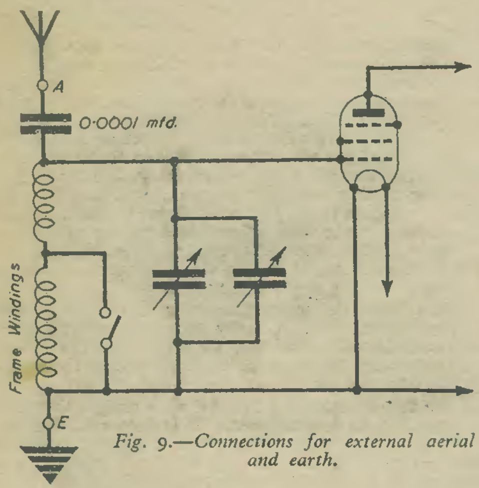


Fig. 9.—Connections for external aerial and earth.

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 the windings. It will usually be necessary to put several turns in each slot. About half a dozen slots should be enough to carry the medium-wave winding, and the long-wave winding will be quite efficient if it is only 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 most conveniently done by having a variable condenser of 0.00005-0.0001 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.

Reaction Windings

In a set using an H.F. stage, the reaction will be applied in the second tuned circuit and therefore there will be no need for an extra winding on the frame aerial. When an H.F. stage is not used, it will be necessary to apply reaction at the frame aerial. This should consist of about half the number of turns on the medium-wave winding, but if a long-wave winding also is used, more turns may be required. This reaction winding should be placed at the chassis end of the frame aerial and spaced about ¼in. from it. If a long-wave winding is used, the position of the reaction winding to work properly on both wavelengths is best determined by experiment. In this case it may be necessary to wind the medium- and long-wave sections close together.

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. The aerial should be connected by a 0.0001 mfd. mica condenser to the grid end of the frame aerial and the earth to the other end (Fig. 9).

With superhet circuits, or where very good selectivity is required with a straight set, the external aerial and earth can be coupled to the frame aerial by a further winding on the frame.

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).

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 rexine, or when the space available is limited.

Conclusion

It is possible, and is very often done, to wind frame aerials without the use of formulæ 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 turn after turn 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.

s.w.g.	Diam. of bare wire	Thickness of Insulation				
		Enamel covered	s.s.c.	d.s.c.	s.c.c.	d.c.c.
24	.022	.0018	.0018	.0030	.0060	.0140
28	.0148	.0014	.0015	.0027	.0056	.0100
32	.0108	.0013	.0015	.0025	.0050	.0090
36	.0076	.0010	.0015	.0022	.0042	.0080
40	.0048	.0008	.0014	.0022	.0039	.0079
44	.0032	.0007	.0012	.0020	—	—

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 to (V_g+dV_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:

$$dI_a = \frac{1}{R_a}dV_a$$

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

$$dI_a = g_m.dV_g + \frac{1}{R_a}.dV_a$$

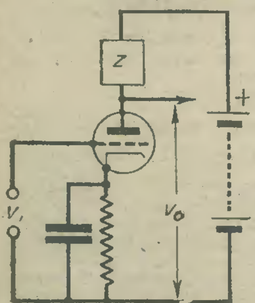


Fig. 1.—A valve amplifier with anode impedance.

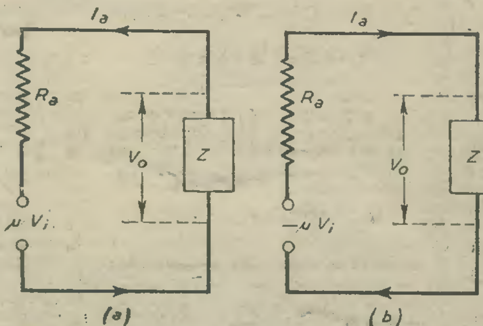


Fig. 2.—The simple equivalent circuit of the valve amplifier of Fig. 1.

Suppose that the grid is made positive by an amount dV_g, then there is an increased volts drop across the anode load impedance equal to $Z.dI_a$, which reduces the anode potential, so that dV_a is negative for a positive dI_a. Then we have:

$$dV_a = -Z.dI_a$$

Substituting this value of dV_a into the equation derived before, we get:

$$dI_a = g_m.dV_g - \frac{1}{R_a}.Z.dI_a$$

$$\therefore\ dI_a\left\{1+\frac{Z}{R_a}\right\} = g_m.dV_g$$

$$dI_a\left\{\frac{R_a+Z}{R_a}\right\} = g_m.dV_g$$

$$\therefore\ dI_a = \frac{g_m.R_a}{R_a+Z}.dV_g$$

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:

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

where μ 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 flowing 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

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

$$\therefore\ \text{V.A.F.} = \frac{\mu.Z}{Ra+Z}$$

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:

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

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.$=0.5\mu$; when $R=4R_a$ it equals 0.8μ; when $R=10R_a$ it equals 0.9μ. Thus, the voltage amplification factor of the stage becomes a larger proportion of μ, the amplification factor of the valve, as R increases in value, approaching the value of μ as R becomes very much greater than R_a. In practice, R cannot be too large, since the steady anode voltage on the

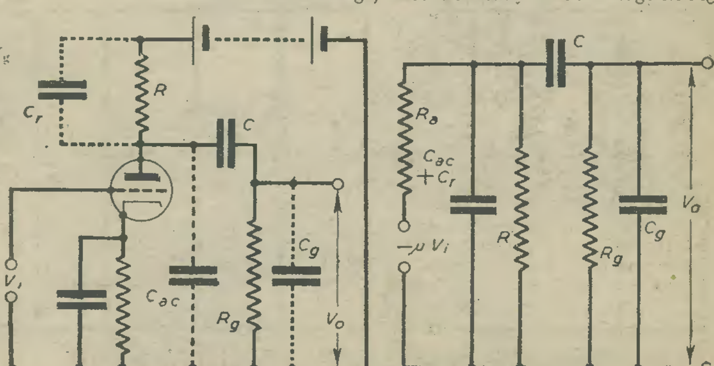


Fig. 3.—The practical resistance-coupled amplifier and its equivalent circuit.

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 passing 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 R_g, 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.

The reason for this behaviour will become apparent when the simple equivalent circuit of Fig. 3 is studied again. The full circuit on the left indicates the presence of stray capacitances due to:

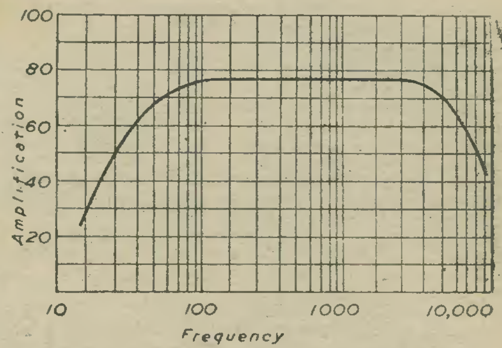


Fig. 4.—Frequency response curve of a typical amplifier.

(a) cathode-anode capacity of the valve C_{ak}, 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) and (d) 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

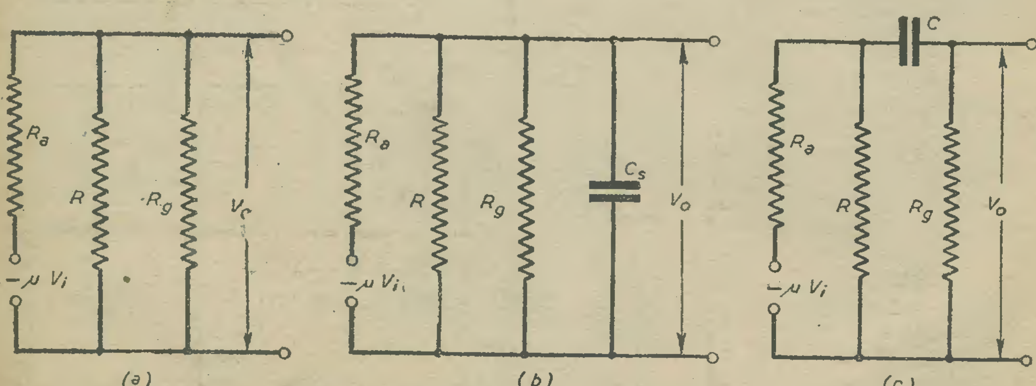


Fig. 5.—Equivalent circuit diagrams for the resistance-coupled amplifier for medium, high and low frequencies respectively.

circuit takes the form shown in Fig. 5a. From this it is easily seen that the voltage amplification is given by:

$$\frac{V_o}{V_i} = \mu \cdot \frac{R_p}{R_p + R_a}$$

where R_p is the equivalent load resistance formed by the anode resistance R in parallel with the grid leak $R_g \left\{ = \frac{R.R_g}{R + R_g} \right\}$. Here V_o 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_o 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_o 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_o 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.

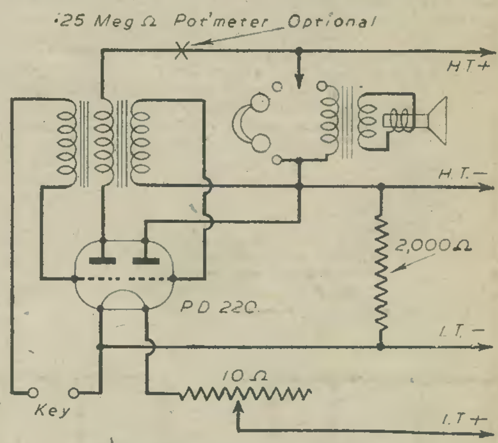
The equivalent circuit for frequencies below 500 c.p.s. is shown in Fig. 5c. This time the shunt capacities are neglected, but the coupling condenser C will have a reactance comparable with the resistance of the grid leak R_g. This results in a falling off of the amplification due to the fact that a 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_g in series with R_a and R in parallel bears to the reactance of the coupling condenser. As for the high-frequency case, the loss of amplification 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_o 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.

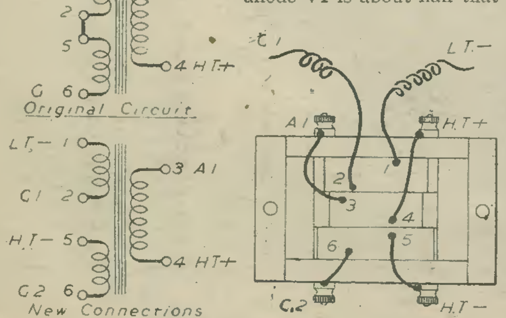
A Single-valve Morse Practice Set

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 V1). This contains the oscillator circuit (which may be adjusted for tone, etc. by a .001 pre-set condenser). V2 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 V1 is about half that on anode V2, and a ¼ 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.

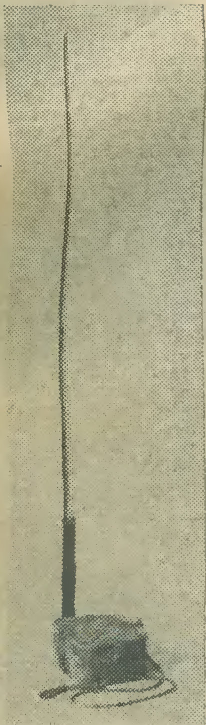


Details of the transformer and its modifications.

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).

German Air-sea Rescue

Details of Construction and Operati



The complete equipment with aerial erected.

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 preset in the frequency band 53.5-61.0 mc/s., and radiates an M.C.W. note of approx. 400 c.p.s. The apparatus is coloured bright yellow, is buoyant and watertight, 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 6¼in. by 6¼in. by 3in., and weighs 3.5lb, 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.

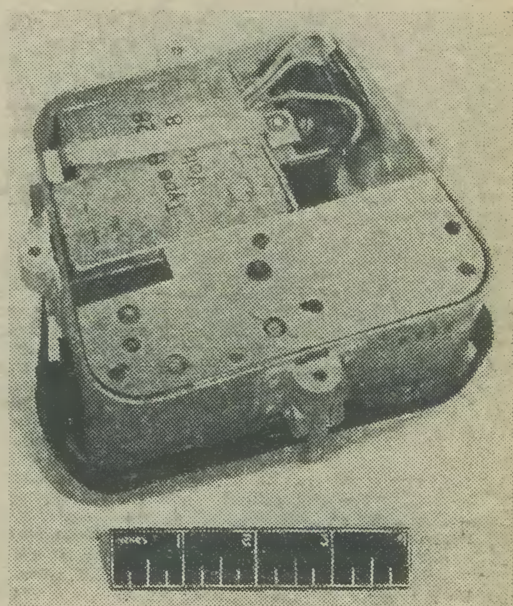
The transmitter is secured in the box by means of four captive screws, one of which is used as a connector to the aerial. Two of the screws are located beneath the accumulators, which must be removed before the screws can be slackened off. The chassis is not of the usual die cast construction, but is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

Covers removed showing P.A. stage.

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 1in. tapering to 3/16in., 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.



Aerial folded and lid removed.

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 C6. The coils are grooved ceramic tubes with electro-deposited windings.

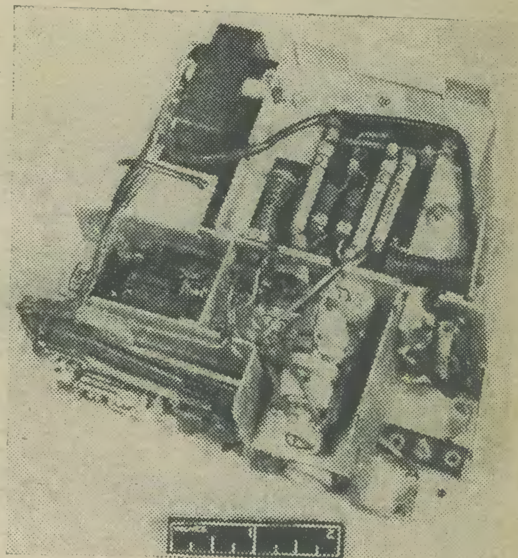
ue Transmitter

eration

The master oscillator coil L1 is 2in. long and 9/16in. in diameter, nine turns are wound in 1⅜in., and the whole is mounted inside the coupling coil L2, which is 1 9/16in. long and ¾in. in diameter. L2 has two turns wound in ⅛in., 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 C15.

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.

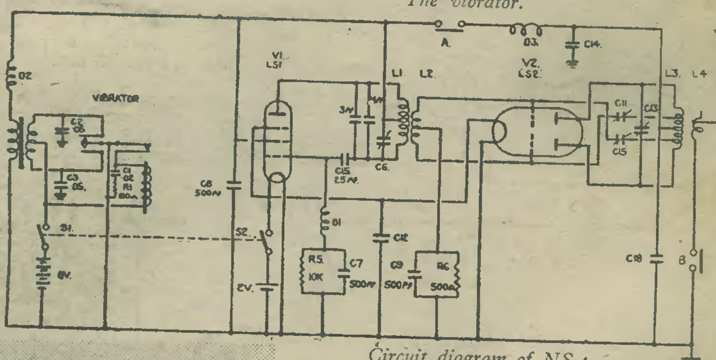


The vibrator.

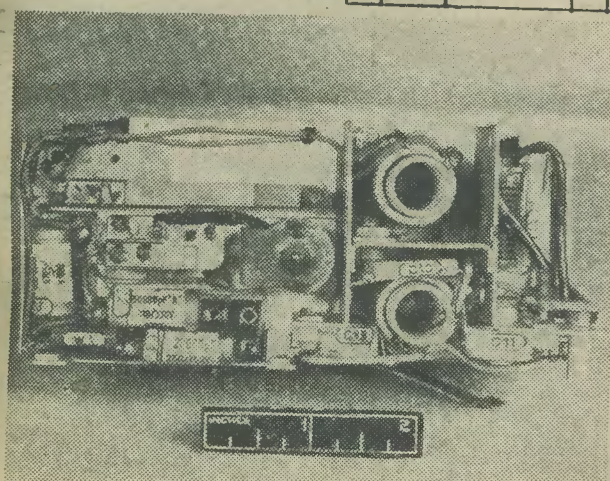
Frequency Band

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.



Circuit diagram of NS.4.



Showing the master oscillator.

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 1¼in. by ½in. by

1¾in., and weigh approximately 1½oz. 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 1lb. of the 3½lb. 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 10ft. above the ground to eliminate reflections and interference from persons moving near the aerial. External batteries were provided.

The aircraft used a 4ft. 6in. vertical rod aerial in conjunction with a receiver having a sensitivity of 5μ volts 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 200ft.
14 ,, ,, 1,000ft.
40 ,, ,, 4,000ft.

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.

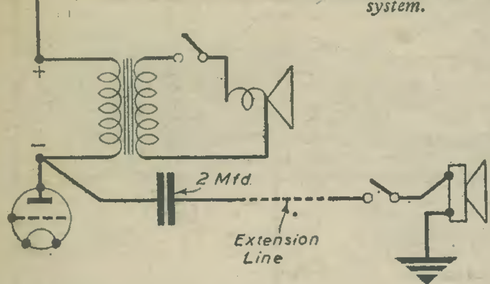


Fig. 1.—A simple extension speaker system.

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.

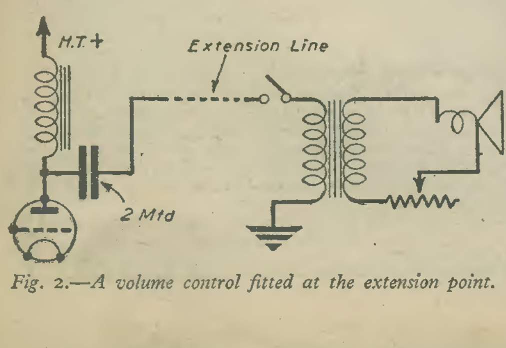


Fig. 2.—A volume control fitted at the extension point.

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.

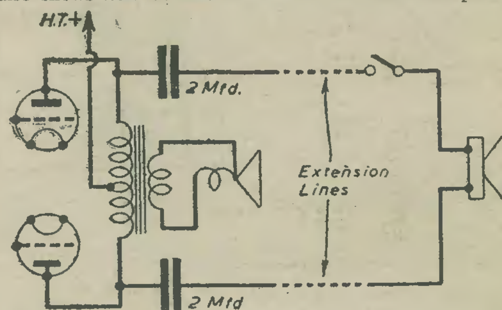


Fig. 3.—Excellent results are obtained with this circuit.

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.

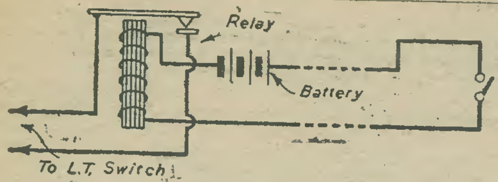


Fig. 4.—Where control at a distant point is required, a relay such as this should be used.

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 20ft. 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 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

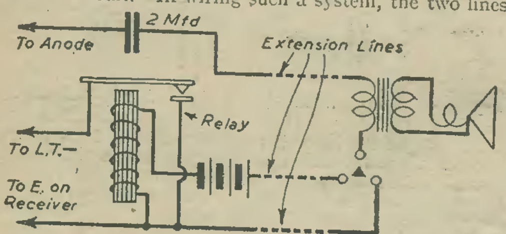


Fig. 5.—Complete extension control is obtained by this system.

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 20ft. 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

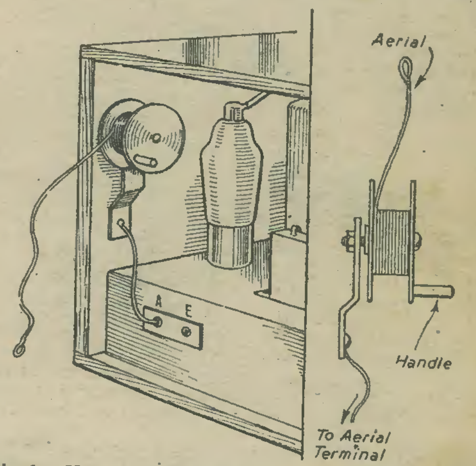


Fig. 6.—How a frame aerial may be added to an ordinary receiver.

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 attachments.) 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.

Region	Number
London Postal	1,969,000
Home Counties	1,299,000
Midland	1,494,000
North-Eastern	1,599,000
North-Western	1,392,000
South-Western	868,000
Welsh and Border	605,000
Total, England and Wales	9,226,000
Scotland	1,013,000
N. Ireland	153,000
Grand Total ..	10,392,000

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, Airmec and the other companies of the RadioTel Group.

Old Circuits Reviewed—4

In the Concluding Article Our Contributor Deals with the Once Famous Lodge "N" Circuit

OF all the circuits which from time to time have appeared on the horizon of the constructor's world, none created a greater furore than the Lodge "N" circuit. This was the invention of Sir Oliver Lodge, that great pioneer of wireless telegraphy. The practical form of the circuit was actually commercialised in the form of a two-valve set round about

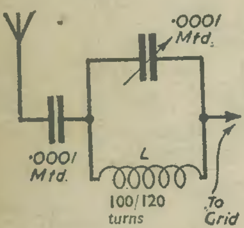


Fig. 1.—The "N" resonator.

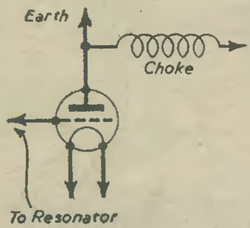


Fig. 2.—In this circuit the anode resonates at the frequency of the grid.

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 .0001 mfd. The condenser in the aerial lead is a fixed one of .0001 mfd. We have the aerial at one end of the resonator and the grid at the other; this, of course, is contrary to ordinary practice, where the build-up is between grid and filament.

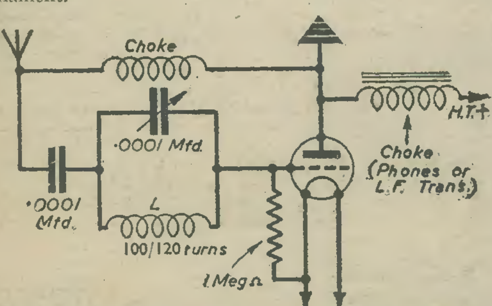


Fig. 4.—The choke connected between aerial and earth in this circuit is to prevent the break-through of strong signals.

The resonator is to be left almost free from the aerial. It must be connected to it in some degree, or it would not respond at all, but the slighter the connection the better. The aerial should have no tune of its own; it is a mere collector, the "N" circuit being the responder.

The "N" Frequency

The frequency to which the resonator is tuned is called the "N" frequency.

Now, if a suitable choke is placed in the anode circuit of the valve (Fig. 2), and if the grid has alternating potentials of a frequency "N" applied to it, and if the plate is also earthed, then the earthed plate will pulse gently at that frequency.

Further, if these two circuits are now combined (Fig. 3), the "N" circuit will build up energy both from the aerial by collection and from the capacity effect between the aerial and the earth. This feeble regenerative tendency is just what is needed to overcome the resistance and damping in wires, etc.

Now, suppose this limit is overstepped, so as to give true regeneration, and suppose the "N" circuit is tuned to a frequency different from that of the incoming signals. If the difference is great, the circuit can only oscillate at the natural frequency of the "N" circuit, and therefore it will not respond. But if the difference

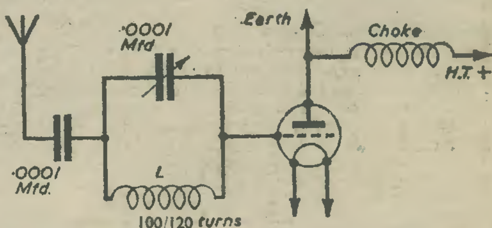


Fig. 3.—Correctly handled, this circuit is non-radiating.

is very slight the incoming signals will build up to an amount in accordance with the energy curve of a tuned circuit, and heterodyning will take place in the circuit. The aerial being a collector only, and out of tune with the incoming signals, cannot respond, and therefore cannot re-radiate. 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 "N" circuit 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 reaction.

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 "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 8,000 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, and not as an added capacity across a low-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.

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 if it is out of tune 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 howls 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.

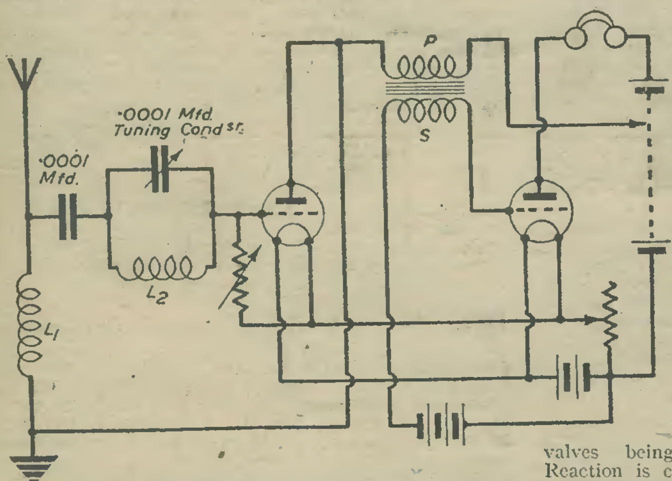


Fig. 5.—Showing a complete "N" circuit, with an L.F. amplifier added.

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 set so 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, since 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.

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) and 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 2in. 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

"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 thereafter persists as a sort of ghost throughout

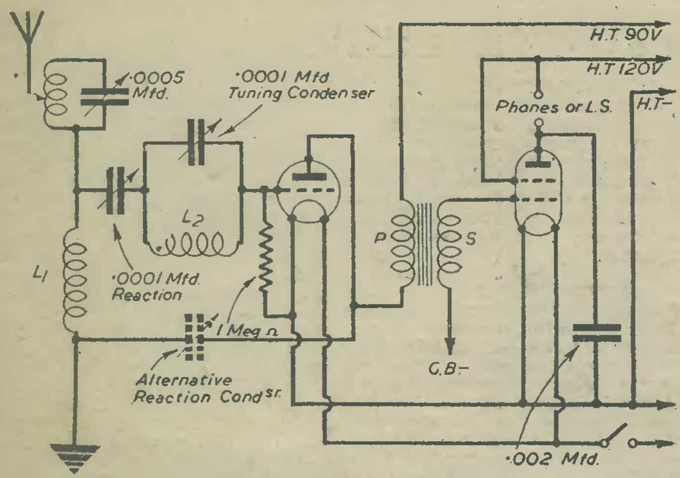


Fig. 6.—Fig. 5 modernised; care should be exercised that L1 and L2 are kept at right-angles.

the tuning scale; this makes the reception of distant stations difficult.

The cure the writer found for this was to insert a wavetrap in the aerial lead. An ordinary rejector wavetrap was used, but the aerial was tapped two-thirds of the way down the coil. The coil should preferably be wound with fairly thick wire, and is of the usual type to cut out a station on the 200-550 metres band.

The "N" circuit is followed by a pentode, or a beam tetrode, and the precise valve employed is not material. The detector valve should be one of fairly high impedance, around 20,000 ohms, otherwise reaction will be jumpy and overlap a little. Note that the grid-leak is returned to L.T. negative. Too jumpy reaction can be cured by reducing the H.T. to the valve, but for best results this should be fairly high, say around 80-90 volts. The output valve can be given the full 120 volts.

No H.F. Choke

Note also that there is no H.F. choke in the anode circuit of the detector valve. This follows from the explanation given in regard to the working of the circuit; and, in fact, with the primary of some transformers it will be necessary to include a small condenser of, say, .0002 or .0003 mfd. across the primary to shunt away some of the H.F. energy.

I will end by quoting Sir Oliver Lodge's remarks about the "N" coil. He says that the essential theoretical factor is that this coil must be able to build up energy. Not every type of coil will do this. The fact that not every type of coil will function in no way interferes with the theory of the circuit, nor does it prove that the circuit is tricky. It merely indicates that the method of winding an inductance coil introduces a factor—perhaps quite new—which does not allow the energy to build up by syntony. It seems that this factor is not a function of inductance, capacity or resistance. In spite of this a solenoid coil works quite well.

News from the Clubs

Bolton and District Radio Society

THE above society has now resumed its activities after a quiescent spell during the war years.

A meeting was recently held at Gaskell House, 7a, Churchgate, Bolton, when Mr. S. Bayliss (G4IA) demonstrated various modern communication receivers. Subsequent meetings will be held at the same address on the first Tuesday of each month.

Details of the society will be gladly given by the Hon. Secretary, Mr. N. Moorcroft, 3, Beaconsfield Street, Bolton.

Ilford 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, Ilford. 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. C. E. Largen, 44, Trelawney Road, Barkingside.

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 28th: "D. F. 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. L. Griffiths, 47, Welwyndale Road, Sutton Coldfield, Birmingham.

Surrey Radio Contact Club

THE above club has now commenced post-war activities, and the following officers have been elected. Chairman (Mr. N. Guy, G2DN), Vice-chairman (Mr. C. W. Crook, G5BT), Secretary (Mr. L. C. B. Blanchard, BRS 3003), Treasurer (Mr. R. M. Herbert, C2KU), Committee (Mr. J. H. Boyce, G4NI, and Mr. S. E. Jones, C2FWA), with two more elections pending.

Thanks are due to Mr. S. A. Morley who, as secretary, kept the club's flag flying during the early months of the war. Accommodation has been found difficult, but, thanks to Mr. Drummond, future meetings will be held on the second Tuesday of each month at 7.30 p.m. in a room at the "Blacksmith's Arms, South End, Croydon (at the end of the High Street). Newcomers will be welcomed and details of membership may be obtained from the Hon. Secretary, "Montcalm," 122, St. Andrew's Road, Coulsdon, Surrey.

The Practical Amateur Radio Constructors' Club

THE above club 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. Keogh, 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.

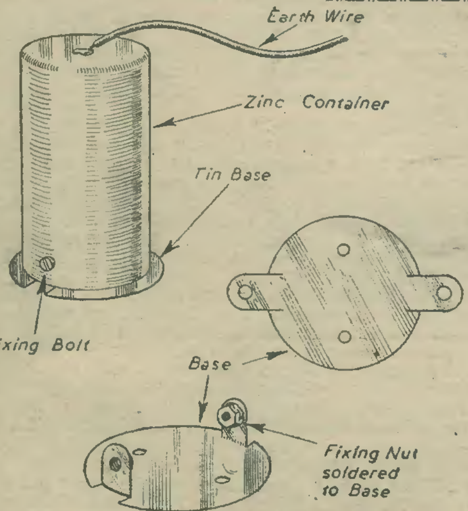
Practical Hints

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).



Mr. Dobbs's suggestion for making screening cans from dry cell containers.

Screening Can

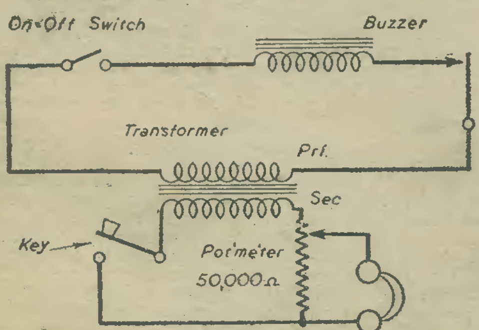
AN efficient screening can is easily made from the zinc container of a dry cell. First the carbon rod is drawn from the "dolly" with a pair of pincers. The remaining contents of the cell can be withdrawn with the help of a penknife. The container is now sandpapered to give a smart appearance. The base 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 ultra-midget component from a number eight battery cell.—J. N. DOBBS (Bath).

Modified Morse Practice Set

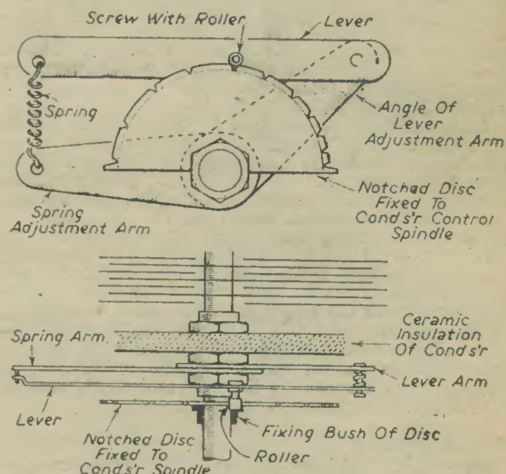
I RECENTLY constructed the morse practice set described in "Practical Hints" in your September, 1943, issue. I found, however, it suffered from three defects:

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).



The circuit diagram of the modified morse practice set as suggested by Mr. Stern.



A locating device for bandspread tuning condensers (Mr. P. Redman).

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).

Impressions on the Wax

Review of the Latest Gramophone Records

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. C*3408. Its opus number, 388, 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," where the main 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, Op. 16," by Berlioz, on five double-sided 12in. records—*H.M.V. DB*6261-6265.

Orchestral

SOLOMON has already shown himself to be an ideal Chopin player, and his record *H.M.V. C*3345 will give great pleasure to those who consider that technique is only part of the story. The apparent easiness of the famous "Nocturne in E Flat" and its many transcriptions have made it one of the most familiar, if not the best known, of Chopin's works. Hear Solomon play it and you will realise what a perfect little work it is, and how much it demands from the soloist. He has also made a recording on *H.M.V. C*3494 of Haydn's "Sonata in D Major." The three charming movements have been recorded on both sides of the record and yield some really beautiful piano playing.

I have a decided weakness for ballet music and it gave me a great pleasure to listen to the City of Birmingham Orchestra conducted by George Weldon, in their recording of Gounod's "Faust" on two double-sided 12in. records—*Columbia DX*1247-8. They are really first class records and I have no hesitation in recommending them to readers.

*H.M.V. C*3491 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 be well represented this month for Iris Loveridge has chosen for her pianoforte solo his Op. 66 "Fantasie—Impromptu in C Sharp Minor," on one side of *Columbia DX*1239. 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. C*3490 offers new recordings of Queen Bess's 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 is having such a successful run at the present moment, has as its theme song the popular song which gives the film its name. This song has been chosen by the popular English tenor Webster Booth for his latest recording on *H.M.V. B*9472. 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 a joy to hear.

Other records featuring tenors are *H.M.V. DA*1858, 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 by Gerald Moore. The other is Archie Grant's recording of "Gillean Uidhist" and "Tiugainn Do Scalpaidh," on *Parlophone F*3360.

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 RO*20545—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.

"Romeo and Juliet" needs little introduction and "'Tis Love! Ah, 'Tis Love!" the well-known aria from Act II, is featured on *H.M.V. C*3492. Once again the singer is a tenor, this time none other than Heddle Nash, and the record is further enhanced by the Philharmonia Orchestra, conducted by Walter Susskind, who supply the accompaniment. On the reverse side he sings "Down her Pale Cheek," from Act II of "L'Elisir D'Amore."

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 two famous arias from Wagner's "Tannhauser"—"Wolfram's Entry" and "O Star of Eve," beautifully recorded by Herbert Janssen—*Columbia LX*948 and the other "Lakme—Bell Song (Act II)," Parts 1 and 2, sung by none other than Lily Pons—*Columbia LX*940.

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 DB*2215. On one side is the film title theme song and on 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 F*2140.

Ivor Moreton and Dave Kaye continue with their "Tin Pan Alley Medley" and No. 71 in this series is featured on *Parlophone F*2139. 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 DB*2214 of "I Dream of You" and "Someone to Watch over Me." Steve Conway steals one of Sinatra's songs he featured in the film "Anchors Aweigh," "I Fall in Love too Easily," on *Columbia FB*3213. The coupling is "Along the Navajo Trail."

Other releases this month include "Only a Few Steps Away" and "Song of Paradise," sung by Robert Wilson, on *H.M.V. BD*1123. "Love Steals Your Heart," and "Sweet Dreams to You," played by Billy Thorburn with Organ and vocalist on *Parlophone F*2145. "Waitin' for the Train to Come in" and "Rancho Serenade," by the Jack Simpson Sextet, on *Parlophone F*2138. "Martelette Polka" and "Jacqueline Waltz," two accordion solos by William Starr, on *Parlophone F*3361. And finally, "Kiss Me Hello" and "When the Gang Meet Again," played by Harry Roy and his Band, on *Parlophone F*2141.

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 method of obtaining these anti-phase voltages is by using a centre-tapped transformer.

Various schemes have been devised to dispense with the input transformer, such as the use of a valve as a phase-splitter and also the paraphase circuit. Another 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.

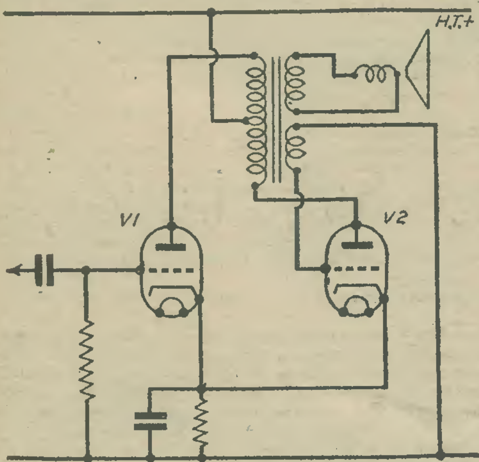


Fig. 1.—The output transformer with additional secondary winding to feed the second valve.

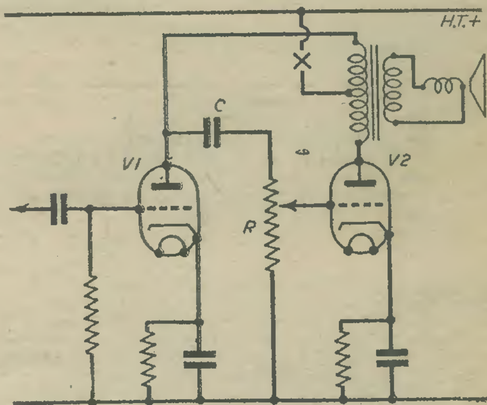
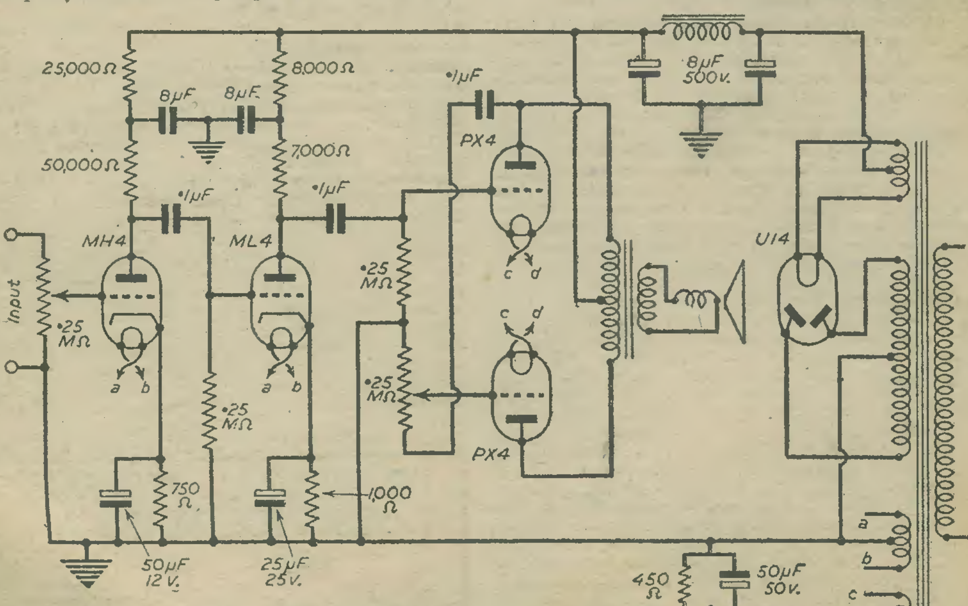


Fig. 2.—Modification of circuit shown in Fig. 1.

The Paraphase Circuit

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



A circuit of an amplifier incorporating push-pull output as described in this article.

of V1 and thus providing a voltage of opposite phase to that of the input to the stage. Fig. 2 shows this modified circuit. The position of the slider on R is adjusted until the input to both valves is equal. To find the balance point the following method can be adopted. Place a 50 ohm resistance at the point X in Fig. 2 and across it connect a pair of phones or a C.R.O. if one is available. Apply a steady signal at about 400 c.p.s. to the input and adjust R until there is no response in the detector used, indicating that the alternating components of the anode currents are cancelling each other.

The circuit as shown in Fig. 2 could also be regarded as an adaptation of the paraphase system of phase-splitting applied directly to the output valves. It will be obvious from the diagram that for full output from the two valves the signal voltage will be the same as that for a single valve of the same type. Two indirectly-heated triode valves are shown but directly-heated valves could be substituted and a common bias resistance and condenser utilised for both valves if desired.

The circuit of a complete amplifier using this output system is given in Fig. 3. The undistorted output using PX4 valves with 300 volts on the anodes would be approximately eight watts. The first two stages are quite conventional employing resistance-capacity-coupled triodes.

The advantage of this circuit is that the input transformer and any distortion it may introduce are eliminated without having to use a complicated paraphase or phase-splitting system employing valves that do not add to the amplification. The usual advantages of push-pull, such as avoidance of saturation in the output transformer are, however, retained.

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 trace 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 condensers, for example, is by 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 really violent motor-boating which was quickly isolated to the double-diode-triode circuit. All the de-coupling 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-circuited 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 to either 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; 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 into 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, whereupon 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 *new* 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 the motor-boating persisted with unabated violence; the serrated edges were then filed bright, the clips again put into position, and the motor-boating ceased.

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 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.

A Study of Oscillators

A Brief Survey of the Properties of Oscillatory Circuits and their Application

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.

Experimenters 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. "signal" E_g. As indicated by the sine-waves, this becomes a larger voltage, V, across the anode tuned-circuit LC.

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 fed-back voltage. This is the opposite of negative feedback.

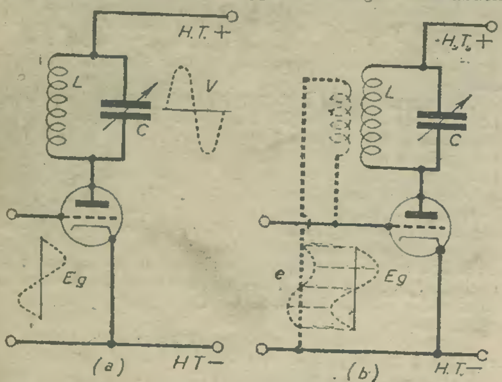


Fig. 1.—Showing how an H.F. amplifier can be "kept going" as an oscillator (b) if an e.m.f. e is injected back from anode to grid circuits in phase with Eg.

This larger grid potential is again amplified by the valve, developing a larger voltage than V across the anode LC-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 LC-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 LC-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 I_a-E_g 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 generator 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 reduce sufficiently harmonics such as the second, owing to a certain amount of curvature in the so-called "straight" portion.

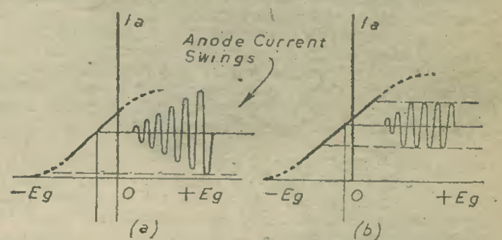


Fig. 2.—An oscillation will usually grow until the amplitude is restricted by the bends in the valve characteristic (a). "Linear operation" (b) can be accomplished by amplitude control.

One method of partially accomplishing this is by "self-bias" of the type shown in Fig. 3 (a). Owing to the large grid-swings, the valve is driven into grid-current, and this is used to charge a condenser C1—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 C2R2.

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.

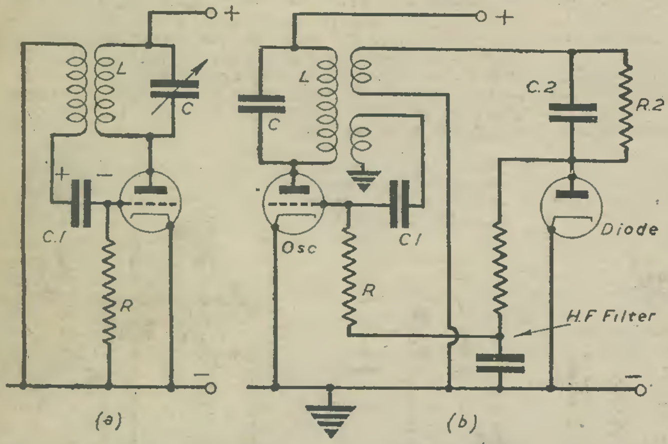


Fig. 3.—(a) Self-bias by grid condenser-leak. (b) Simplified circuit diagram showing one way of using a separate diode rectifier for control bias.

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 charge 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 oscillation, but the bias quickly rises enough to stop it. Generally, there will be stray leakage paths across C to cause some leakage of the charge.

"Squegger" Oscillation

The fact just stated suggests another possibility. If the grid-leak is given an appropriate (or wrong) value, the condenser can be made to charge and discharge *at an audio-frequency rate.*

The oscillation itself is at radio-frequency, but will be "modulated," i.e., rise and fall somewhat in the manner shown in Fig. 4 (a), or, more likely, start and stop like interrupted C.W., Fig. 4 (b).

Since an oscillator valve inevitably gives appreciable rectification if biased to cut-off, or below, we shall get an audible howl or whistle from our H.F. generator. Incidentally, this gives a clue to one cause of reaction troubles, such as threshold and superimposed howls, etc.

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 practicable 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 C and R, 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 0.001 or 0.002 mfd., the value of R 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.

Here is a useful field for experiment. High values of leak, of the order of megohms, should first be tried, which will cause "squegging." The pitch of the A.F. note will become lower as the resistance is increased. Then, using successively lower values, a resistance can be found which will give stable operation without squeggering.

At least, in theory it looks easy to get at the best leak value. But it must not be forgotten that a squegger oscillation can take place at a *high-frequency*, i.e., itself inaudible, but interfering with the main oscillation to give beats, or other complicated effects—then heterodyning of two high-frequencies can cause an audible note.

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 relatively 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 oscillatory 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.

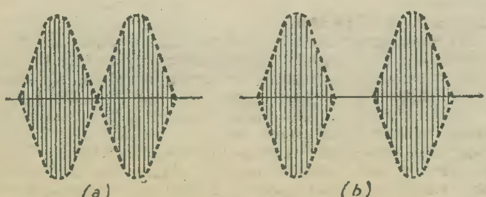


Fig. 4.—Illustrating "squegger oscillations."

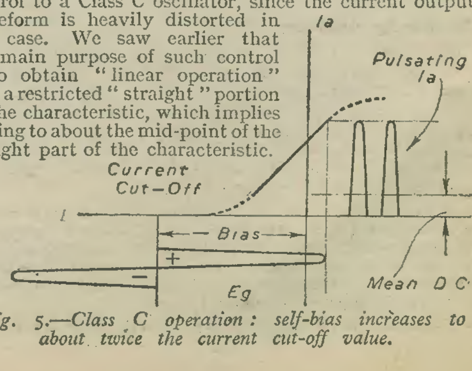


Fig. 5.—Class C operation: self-bias increases to about twice the current cut-off value.

Experiments on "Phasing"

The foregoing account of the theory and practical operation of oscillators 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 wherever 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 is 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 does happen 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 a 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 C1 isolates the anode and cathode circuits, while offering negligible reactance to H.T., i.e., the two coils L1 and L2 really act as one inductance, tuned by the condenser C. Maintenance of oscillation is independent of any magnetic coupling between L1 and L2, provided they are not coupled tightly in a *reversed* sense.

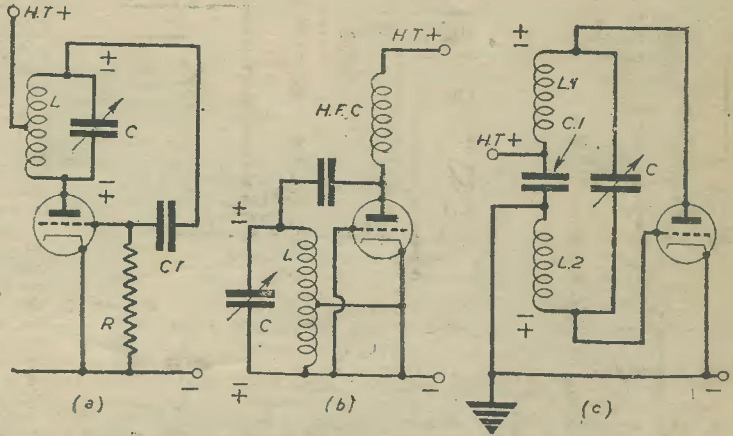


Fig. 6.—Forms of Hartley Oscillator, which show clearly how the e.m.f. returned to the grid is of opposite phase to the anode voltage.

All these Hartley types show fairly clearly that an e.m.f. is fed-back to the grid of opposite phase to the valve voltage. In each case, we have an "earthy" point at the coil tap. Then, one end of the coil goes to anode, and the opposite end to the grid.

Obviously, the alternating potentials at these opposite ends will be of opposite signs (+− or −+) at every instant, and so the sign of the potential returned to the grid is reversed with respect to that at the anode.

Along with these experiments on "phase," the question of automatic bias and amplitude control may be studied on the lines previously outlined. Harmonic content in the output can be tested, roughly, by inserting various tuned circuits in series with the one generating the fundamental oscillation. It is not a difficult matter to arrange an oscillator to generate several frequencies simultaneously, though most of the power will, of course, be in the fundamental oscillation.

In any case, the harmonics can generally be picked up easily on a sensitive receiver without tuning them to maximum amplitude in the oscillator, which, incidentally, is also a good method of arriving accurately at the frequency of the fundamental oscillation—assuming the receiver fairly accurately calibrated.

This brings us to questions of frequency-multiplication and division, the synchronisation of oscillations, etc., which must be deferred for future consideration.

Modulating an Oscillator

One experiment that is always interesting is modulation of the H.F. output of an oscillator.

For example, instead of connecting a gramophone pick-up directly to the "Gram." sockets of a receiver, its L.F. output may be used to modulate a Class C oscillator placed somewhere near the receiver. We can adjust the "transmitter" to oscillate at some convenient wavelength, and hence "tune-in" our gramophone at some reasonably quiet spot on the receiver wavebands; care is necessary in such experiments, of course, not to 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 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

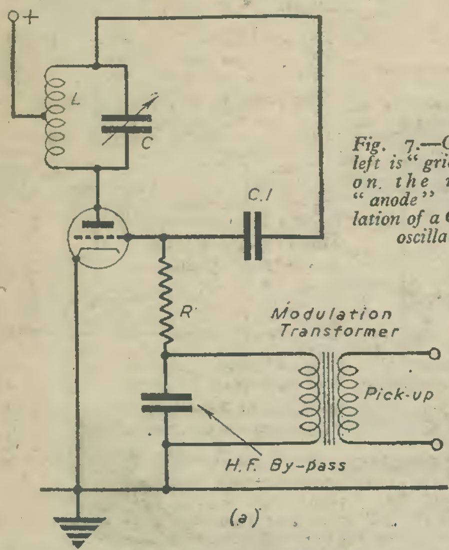
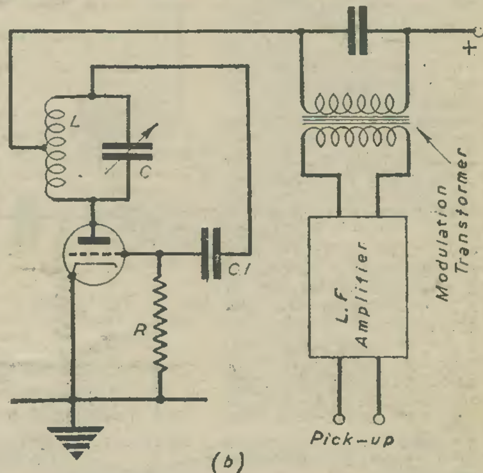


Fig. 7.—On the left is "grid," and on the right, "anode" modulation of a Class C oscillator.



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 serious 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 not 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.

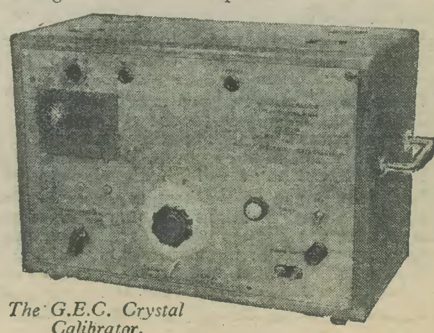
Conclusion

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.928B, 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., 1 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.

Programme Pointers

A Criticism of a Recent B.B.C. Broadcast by MAURICE REEVE

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 on the composer 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 nullify 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 plot, 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 operas are 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 sleek 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, scores in hand, 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.

Explanation of programme music is a different matter. All harmony or tone colour being impressionistic, whether the work be an "absolute" 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 judgments 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 transmission and reception of those times. When working properly it gave quite respectable volume and on 2LO's transmission a loudspeaker could be used.

This would be about 1925 when I was resident at Tooting, London.

It is a far cry from those days to the present ones, 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 I look forward to the time when it will be issued weekly once more.—E. J. WALKER (Braughing, Herts.).

"How the Wheels Go Round"

SIR,—Now that the time for revision of the B.B.C.'s Charter draws near, you could do licence holders a great service if you would give them the "low down" on the management and the control of the B.B.C. What are the exact functions of the Director-General, and what exactly do the Governors do for their £1,250 a year salaries?

Who makes these appointments and what qualifications are necessary? Have they any real authority, and, if so, how is it exercised? What (if any at all) control is or can be exercised by the ordinary licence holder, who provides the whole cost of the B.B.C.? Has the ordinary licence holder any voice in the appointment of the Governors? None whatever! With a very few possible exceptions, none of the past or present Governors had or has any expert knowledge of Radio or Entertainment worlds, and these nice little appointments seem to be awarded entirely "by favour" and as a reward for alleged "political services."

We should know by now, if never before, the extreme folly of placing unrestricted power in the hands of any public authority and the surrender of all effective control by those who have to foot the bill, and how this invariably results in their own exploitation and the falling off of the services rendered to them. The B.B.C. seems to be rapidly becoming little more than a propaganda department for the Government, with as many plums as possible for those who support it. The salaries of the present bloated B.B.C. staff, and of its Governors, its contributions to the Post Office and the Treasury, and its whole conduct and administration are in urgent need of close scrutiny and criticism before its Charter is renewed for another ten years.—K. T. HARDMAN (Birkenhead).

Details of Stations Required

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 find, 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), I also can compete for being the youngest experimenter. I started at the age of ten and am now fifteen.—D. E. SMITH (BSWL 1991).

S.W. Listeners

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

English broadcasts from Sweden and Czechoslovakia are as follows:—

Motala: 15.00-16.00, 15,155 kc/s.; 01.00-02.00, 6,065 kc/s., 9,535 kc/s. (every day); 17.30-17.55, 10,780 kc/s., 15,155 kc/s. (week-days); 15.00-16.00, 11,705 kc/s. (Sundays and holidays).

Prague: 20.00-20.30, 49.92 m. (daily).

The following are the times of transmission and the frequencies of the S.W. station at Hilversum, Holland: PCJ, 15,220 and 9,590 kc/s.,; power, 30 kW. PCI, 17,775 and 11,730 kc/s.; power, 5 kW. 13.00-14.30, 15,220 and 17,775 kc/s. (beamed to the Far East). 19.00-20.30, 9,590 and 11,730 kc/s. (beamed to S. Africa). 01.00-02.30, 9,590 and 11,730 kc/s. (beamed to the D. W. Indies). All times given in the above schedules are G.M.T.—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 to, Forces personnel and equipment." Incidentally, one of us was a radio service man in civilian life—the other an ardent amateur.—SERGT. F. A. HINTON, SERGT. J. B. WATSON (Tele. Comm. Mechanics), R.E.M.E. (S.E.A.C.).

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 rapid in coming to the point, but I cannot express just how PRACTICAL WIRELESS is one of the finest of mags., though I would like to send thanks to T. B. Wearden (Wilmslow) 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 of a heavy nature, and here I find the most simple 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 (B.A.O.R.).

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 a 4-6 watt A.C.-D.C. amplifier which I designed and built myself, comprising a Rothermel Crystal Pick-up using thorn needles, Mullard SP13C first L.F. wired as triode, Brimar 4D1 phase-splitter, two Mullard CL33's wired as triodes in the output stage, the whole feeding into a Baker's 12in. Auditorium Speaker, mounted in an infinite baffle cabinet, and I challenge Mr. Harrison to prove that the quality is inferior to any comparative 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. set; 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 smaller plates for the input and output sockets; these are marked Gram. and L.S. I find that these plates make the finished amplifier look very smart and neat. The amplifier only 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 to the first stage of the amplifier, and so I keep the gain control 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 UR1C Mullard, as the CY1 as stated in your components list is a side-contact base.

I am using the amplifier on 210 volt mains at present but 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 also to be heard.

Log on 14 mc/s. between 22.20-22.50 on April 26th, and a two-hour period on the 27th. CN8S, I1BH ('phone), ND, LA4F, 90, LU6AJ, OE5RG, PY1GJ, FG, 2AY (these last two on 'phone), 41E, PR1AA ('phone), SM3MW, 4YU, LB, 5ZK, OH, JS, LK, KM, WE, YS, MP, 6RS, SU1CX ('phone), XP1, YR5A, C, X, YV5AE, ZP1L.

By far the best of C.W. DX transmissions came from LU6AJ, at R.S.T. 589. I have sent reports to PY1FG, GJ, 2AY, the LU, and YV5AE, 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 1-v.-2 home-built affair using an experimental 30ft. 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, superhets 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 past 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. fans.—R. W. FINCH (Essex).

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. sets are usually freer from most types of hum than the A.C.-D.C. receiver, 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 (Wilts).

CLASSIFIED ADVERTISEMENTS

LITERATURE, MAPS, etc.

RADIO SOCIETY OF GREAT BRITAIN invites all keen experimenters to apply for membership. Current issue " R.S.G.B. Bulletin " and details, 1/- below.
AMATEUR RADIO HANDBOOK (300 pages), paper cover, 4/- ; cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9 ; cloth, 5/-.—R.S.G.B., 28-30, Little Russell Street, London, W.C.1.

BRITISH SHORT-WAVE LEAGUE.—S.A.E. for membership details and sample " Review." " Amateur Radio Simply Explained," 1/6 post free. Write NOW to H.Q., 17, Bedford Road, London, N.22.

WEBB'S Radio Map of the World. Locates any station heard. Size 40in. by 30in., 4/6, post 6d. On linen, 10/6, post 6d.—Webb's Radio, 14, Soho Street, London, W.1. GERard 2089.

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MORSE Practice equipment for class-room or individual tuition. Keys, audio oscillators for both battery and main operation.—Webb's Radio, 14, Soho Street, London, W.1. Phone : GERard 2089.

" H.A.C." Short-wave Receivers. Famous for over ten years. Improved one-valve model now available Complete kit of components, accessories, with full instructions, now 19/3, postage 9d. Easily assembled in one hour. S.A.E. for free catalogue.—A. L. Bacchus, 109, Hartington Road, London, S.W.8.

RECEIVERS & COMPONENTS

AMATEUR ENTHUSIASTS !—What offers for 1942 RCA Frequency modulated radio, 14 valves, 6 waveband, a.v.c., etc. Less speaker and cabinet. Pre-war list price £100. Consumption only 100 watts. Box 126, " Practical Wireless," Tower House, Southampton St., W.C.2.

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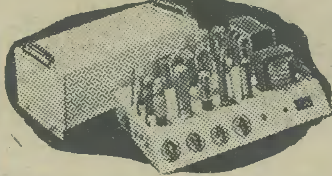

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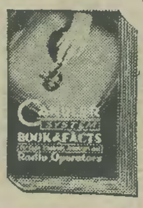

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Nucleon Class B Four (SG, D (SG), LF, Cl. B) .. .. — PW34B*
Fury Four Super (SG, SG, D, Pen) — PW34C*
Battery Hall-Mark 4 (HF, Pen, D, Push-Pull) .. .. — PW46*
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B) .. .. — PW83*
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC)) .. .. — PW90*
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P) .. — PW67*

Mains Operated

Two-valve : Blueprints, 1s. each.
A.C. Twin (D (Pen), Pen) .. — PW18*
Selectone A.C. Radiogram Two (D, Pow) .. .. — PW19*

Three-valve : Blueprints, 1s. each.
Double-Diode-Triode Three (HF Pen, DDT, Pen) .. .. — PW23*
D.C. Ace (SG, D, Pen) .. .. — PW25*
A.C. Three (SG, D, Pen) .. .. — PW29*
A.C. Leader (HF Pen, D, Pow) .. — PW35C*
D.C. Premier (HF Pen, D, Pen) .. — PW35B*
Ubique (HF Pen, D, Pen), Pen) .. — PW36A*
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen) — PW50*
"All-Wave" A.C. Three (D, 2 LF (RC)) .. .. .. — PW54*
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen) .. .. — PW56*
Mains Record All-Wave 3 (HF Pen, D, Pen) .. .. .. — PW70*

Four-valve : Blueprints, 1s. each.
A.C. Fury Four (SG, SG, D, Pen) — PW20*
A.C. Fury Four Super (SG, SG, D, Pen) .. .. .. — PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull) .. .. .. — PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull) .. .. .. — PW47*

SUPERHETS

Battery Sets : Blueprints, 1s. each.
£5 Superhet (three-valve) .. — PW40*
F. J. Camm's 2-valve Superhet .. — PW52*

Mains Sets : Blueprints, 1s. each.
A.C. £5 Superhet (Three-valve) .. — PW43*
D.C. £5 Superhet (Three-valve) .. — PW42*

F. J. Camm's A.C. Superhet 4 .. — PW59*
F. J. Camm's Universal £4 Superhet 4 .. .. — PW60
"Qualitone" Universal Four .. — PW73*

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprint, 1s.
Simple S.W. One-valver .. — PW88*

Two-valve : Blueprints, 1s. each.
Midget Short-wave Two (D, Pen) — PW38A*
The "Fleet" Short-wave Two (D (HF Pen), Pen) .. .. — PW91*

Three-valve : Blueprints, 1s. each.
Experimenter's Short-wave Three (SG, D, Pow) .. .. .. — PW30A*
The Prefect 3 (D, 2 LF (RC and Trans)) .. .. .. — PW63*
The Band-spread S.W. Three (HF Pen, D (Pen), Pen) .. — PW68*

PORTABLES

Three-valve : Blueprints, 1s. each.
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Parvo Flyweight Midget Portable (SG, D, Pen) .. .. .. — PW77*

Four-valve : Blueprint, 1s.
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MISCELLANEOUS

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AMATEUR WIRELESS AND WIRELESS MAGAZINE

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Lucerne Tuning Coil for A.W.427*, 6d.
1934 Crystal Set .. .. .. — AW444
150-mile Crystal Set .. .. — AW450*

STRAIGHT SETS. Battery Operated.

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B.B.C. Special One-valver .. — AW387*

Two-valve : Blueprints, 1s. each.
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Full-volume Two (SG det, Pen) .. — AW392*
A modern Two-valver .. .. — WM409*

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Lucerne Ranger (SG, D, Trans) . — AW422*
£5 5s. Three De Luxe Version (SG, D, Trans) .. .. .. — AW435*
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Simple-Tune Three (SG, D, Pen) .. — WM327*
Economy Pentode Three (SG, D, Pen) .. .. — WM337
"W.M." (1934 Standard Three (SG, D, Pen) .. .. .. — WM351*
£3 3s. Three (SG, D, Trans) .. — WM354
1935 £6 6s. Battery Three (SG, D, Pen) .. .. — WM371
PTP Three (Pen, D, Pen) .. — WM389*
Certainty Three (SG, D, Pen) .. — WM393
Minitube Three (SG, D, Trans) .. — WM396*
All-wave Winning Three (SG, D, Pen) .. .. — WM400

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Self-contained Four (SG, D, LF, Cl. B) .. .. — WM331
Lucerne Straight Four (SG, D, LF, Trans) .. .. .. — WM350
£5 5s. Battery Four (HF, D, 2LF) . — WM381*
The H.K. Four (SG, SG, D, Pen) .. — WM384
The Auto Straight Four (HF, Pen, HF, Pen, DDT, Pen) .. — WM404*

Five-valve : Blueprints, 1s. 6d. each.
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Class B Quadradyne (2 SG, D, LF, Class B) .. .. .. — WM344
New Class B Five (2 SG, D, LF Class B) .. .. — WM340

Mains Operated

Two-valve : Blueprints, 1s. each.
Consoelectric Two (D, Pen) A.C. . — AW403*
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Three-valve : Blueprints, 1s. each.
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Harris' Jubilee Radiogram (HF, Pen, D, LF, P) .. .. .. — WM386*

SPECIAL NOTICE

THESE blueprints are drawn full size. The issues containing descriptions of these sets are now out of print, but an asterisk beside the blueprint number denotes that constructional details are available, free with the blueprint.

The index letters which precede the Blueprint Number indicate the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

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The Request All-Waver .. .. — WM407

Main Sets : Blueprints, 1s. each.
Heptode Super Three A.C. .. — WM359*

PORTABLES

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Holiday Portable (SG, D, LF, Class B) .. .. — AW393*
Family Portable (HF, D, RC, Trans) .. .. — AW447*
Tyers Portable (SG, D, 2 Trans.) — WM367*

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprints, 1s. each.
S.W. One-valver for America .. — AW429*
Roma Short-Waver .. .. — AW452*

Two-valve : Blueprints, 1s. each.
Ultra-short Battery Two (SG, det Pen) .. .. — WM402*
Home-made Coil Two (D, Pen) .. — AW440

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The Carrier Short-waver (SG, D, P) .. .. — WM390*

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MISCELLANEOUS

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