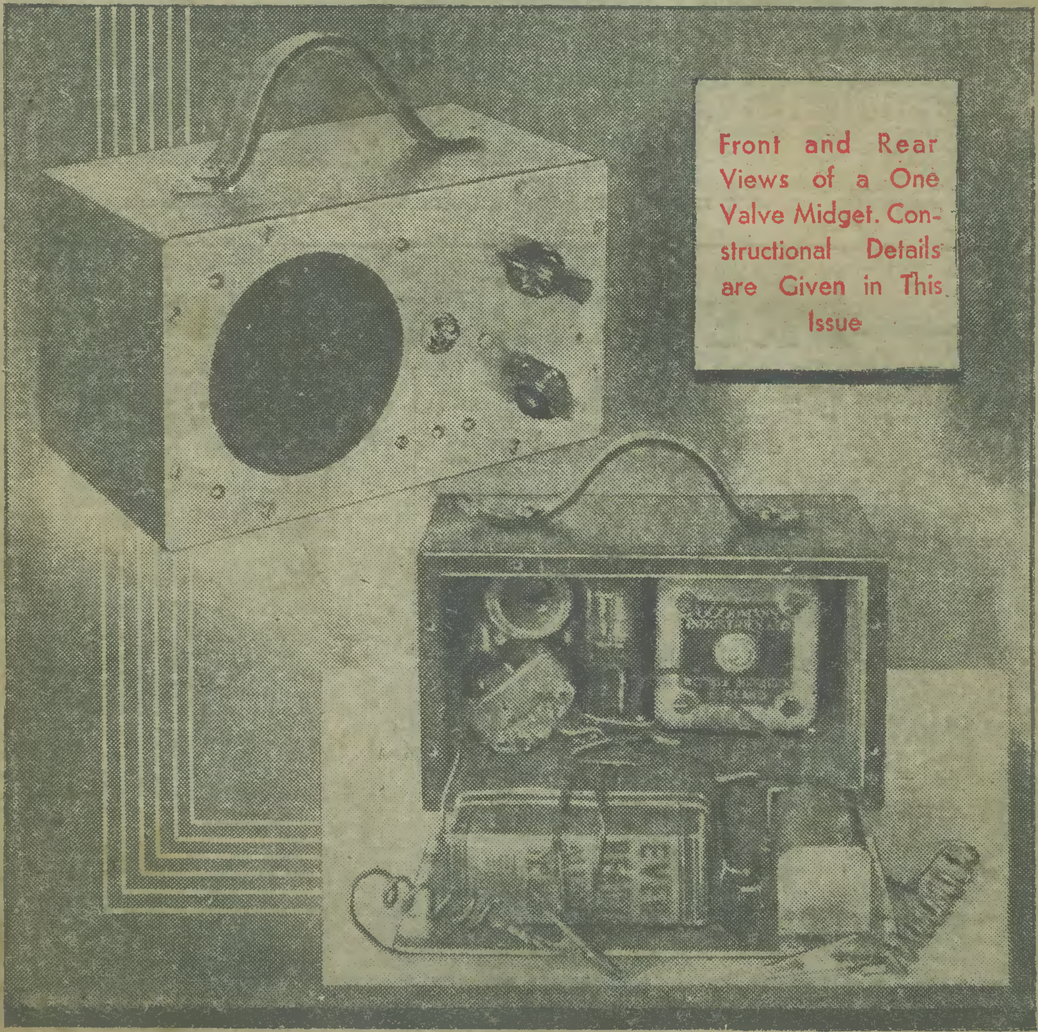
# A VALVE ANALYSER


# Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 20 No. 459 NEW SERIES SEPTEMBER, 1944

Practical Wireless
and PRACTICAL TELEVISION
12th YEAR OF ISSUE
EVERY MONTH.
Vol. XX. No. 459. SEPTEMBER, 1944.
Editor F. J. CAMM

# Comments of the Month

By F. J. C.

## Wartime Civilian Receivers

THE annual peacetime output of the radio industry was in the neighbourhood of 1,250,000 sets, but few have been made since the war, and up to the end of 1943 the numbers being made did not provide for the replacement demands.

The wartime civilian receivers intended for members of the public without means of listening, and not for those who already have a set in working order, are, as from July 1st, controlled by The Wireless Receiving Sets (Control of Supply) Order, 1944, which relates to the sale, hire purchase and renting of wireless sets marked with the words "Wartime Civilian Receiver." The substance of the Order is as follows:

The sets may not be sold at prices in excess of those shown below:

| | A.C. Mains Set | Battery Set (exclusive of battery and accumulator) |
|---|---|---|
| | £ s. d. | £ s. d. |
| To Wholesalers .. .. .. | 5 13 4 | 5 2 0 |
| To Retailers .. .. .. | 6 13 4 | 6 0 0 |
| To Retail Customers (price *including Purchase Tax*) | 12 3 4 | 10 19 0 |

These prices must include delivery charges, but in the case of sales to wholesalers and retailers, are subject to a cash discount of not less than 2½ per cent. where payment is made by the end of the calendar month following that in which the sets are despatched. Hire purchase and similar agreements for which a maximum service charge is fixed under the second schedule of the Order must provide for an initial payment of not less than £2, and must be for a term of not less than six nor more than 24 calendar months. The first instalment must not become payable until delivery of the set, and the service charge must not exceed 20 per cent. of the balance of the maximum cash sale price, exclusive of purchase tax, after deducting the initial payment. If the agreement is for a period of 18 months or less, or the final instalment is tendered before the due date, the service charge must be adjusted, if necessary by a refund so as not to exceed the appropriate percentage shown below:

| Period between date of agreement and date of accrual or payment of last instalment | Percentage |
|---|---|
| Not exceeding 12 months | 12½ |
| Exceeding 12 months, but not exceeding 18 months | 15 |

No adjustment, however, need be made if the customer at any time after delivery of the set becomes more than one month in arrear in payment of the instalments due. Battery sets may not be rented. Renting agreements for A.C. mains sets must provide terms not less favourable to the customer than the following:

The customer must be at liberty to terminate the agreement at any time on giving one month's notice or paying one month's rent in lieu thereof. The trader must not terminate the agreement before the end of six years unless the customer fails to pay the monthly rent when it becomes due or to observe reasonable conditions as to the use and care of the set.

The trader must maintain the set in proper working order at his own expense, and the customer must give him all reasonable facilities for this purpose.

Any deposit required from the customer must not exceed £2, and must not be forfeited to the trader if the customer pays the monthly rent for 30 consecutive months and returns the set at the end of the agreement in good condition (fair wear and tear excepted).

The monthly rent must not exceed:

| | |
|---|---|
| for any of the first 30 months .. | 13s. 6d. |
| for any of the next 42 months .. | 7s. 6d. |
| for any month thereafter .. .. | 5s. 0d. |

and the total amount paid or payable by the customer (including any deposit which has been forfeited or remains liable to forfeiture for non-payment of rent) must not at any time exceed

| | |
|---|---|
| for the first 30 months .. .. .. | £16 |
| for the next 42 months .. .. .. | £12 |

By the terms of the Musical Instruments and Wireless Order, 1944, it is unlawful for any person to remove the words "Wartime Civilian Receiver" from any set on which they have been marked, or to mark those words on any set except by licence of the Board of Trade.

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*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.*



## Index for Volume 19

INDEXES for Volume 19 are now ready, and may be obtained for 10d. by post from The Publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Indexes for all volumes from 10 to 18 are available at the same price.

## Our Mathematical Handbooks

THOSE anxious to study the mathematical side of radio may need to brush up their mathematics, and we therefore draw their attention to three books published from this office:

"Refresher Course in Mathematics" (8s. 6d., by post 9s.); The "Slide Rule Manual" (5s., by post 5s. 6d.); and "Mathematical Tables and Formulæ" (3s. 6d., by post 3s. 9d.). This latter is similar in style to our "Radio Engineers' Vest Pocket Book."

# ROUND THE WORLD OF WIRELESS

## Rail Radio Network

IT is reported that a complete radio network has been built up by British railways as a safeguard against a breakdown of other means of communication. Forty-two fixed radio stations and forty mobile stations have been fully equipped. It will also be possible, after the war, for passengers to speak to office or home during a train journey. Recent tests carried out by the L.N.E.R. with radio-telephones show that the idea is practicable.

This is the first time the radio-telephone has been operated from trains in motion in this country, although experiments have been made on the Continent and in Canada and the U.S.A.

## Long-distance F.M.

A STATION on Mount Royal, Montreal, operated by the C.B.C., is reported to be receiving F.M. transmissions from a transmitter at Mount Washington, New Hampshire, 170 miles distant.

## Underground Radio H.Q.

TUNNELLED into the face of a hill somewhere in England, 90ft. below ground level, is the communications headquarters for keeping in touch with our invasion troops in France. The equipment was installed by the Royal Corps of Signals, and from this underground H.Q. messages are sent out directing convoys, the supplies on the beaches of Normandy, the men in the assault area, and the aircraft squadrons. Messages have been sent by radio, telephone, cable and teleprinter.

Long ago preparations were perfected so that a battle in France could be completely directed by wireless. In the naval control room an officer has a huge map by which he can tell at a glance the position of every ship. Elsewhere another man moves units in the field, and another directs aerial fleets.

## From Dusk to Dawn

TIMING has from the first been a major problem in programme planning. Town and country got up at different times, fed at different times and the country went to bed when the town considered the night yet young. Distinctions between country and town hardly exist in wartime, but the next difficulty was less psychological, more physical: it concerned the Forces abroad who see sunrise and sunset at different times whether their watches register local time, G.M.T., B.S.T., or D.B.S.T.

Now comes news of a third difficulty and the country is Burma. No radio can be played in camps from dusk to dawn, for the wily Jap hears the strains of Lillibulero and tracks down the camp. Therefore it appears that radio, like the Englishmen in the song, must go "out in the midday sun."

## "Bandstand"

"BANDSTAND" provides every shade of light orchestral music from popular to light symphonic. The singers give well-known operatic arias, ballads and new songs, and a novelty artist is frequently included in the bill. The aim of conductor Charles Groves and producer Michael North is to present this programme as a two-man affair with the closest collaboration between them, in order that the show may be put over as brightly and smoothly as possible. "Bandstand" uses the B.B.C. Revue Orchestra augmented by 15 extra players, "the same every time," says Groves, "so that they understand my way of putting things."

In addition to "Bandstand," Charles Groves conducts the B.B.C. Revue Orchestra in such shows as "Sitting on the Fence," "Songs from the Shows," "Travellers' Tales," and concerts and recordings for Overseas programmes.

## New Argentine S.W. Transmitter

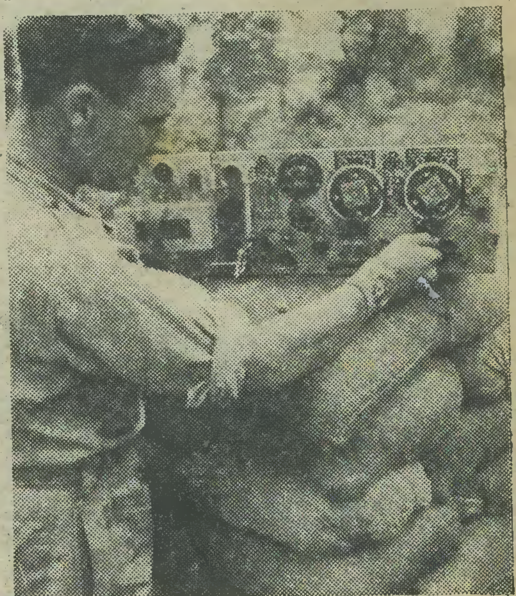
THE new short-wave transmitter Radio-Belgrano, in the Argentine, has a power of 135 kW. The transmitter is equipped with directional aerials, and has a frequency coverage of 6 to 15 mc/s.

## Broadcasting from Eire

OWING to shortage of fuel, broadcasting from Radio Eireann has been curtailed by half an hour each evening.

## The Technical Side of War Reporting

ACCORDING to the chief engineer of the B.B.C., war reporting, as it has developed during the course of the war, presents two problems. The first of these is to provide a medium by which war correspondents can record their impressions whilst actually at



*A tank radio, captured from the Germans on the Anzio bridgehead and now in use in a British tank. It is British made, was sent to Russia under revenue lease-lend and has Russian figures and instructions on it. Captured by the Germans on the Eastern front, it was used by them until its recapture in Italy.*

the scene of military operations. The second problem is to transmit that impression or recording back to Broadcasting House for inclusion in the various programme services. So far as technical equipment is concerned, therefore, the problem becomes the design and supply of suitable recording equipment and a system of transmitting those records from the correspondents in the field to Broadcasting House.

## Mobile Recording Cars

AT the time of the outbreak of war the B.B.C. had designed and put into service a small number of mobile recording cars. These took the form of a standard saloon car in which was placed a single turntable recording equipment. This recording equipment obviously had to be independent of a mains supply and consisted of three main units:

(a) The power supply unit, deriving its current supply from batteries carried in the boot of the car.

(b) The recording amplifier with a separate microphone mixer for combining the outputs of up to three microphones.

(c) The recording turntable unit.

It was the only truly mobile recording equipment then in existence and gave excellent service in peacetime.

When war broke out, this equipment was used in France but was found somewhat cumbersome for many of the war reporting jobs which it was called upon to perform. Its total weight was 450 lbs. and, therefore, it could not easily be carried by correspondents to points to which the car could not be driven. It required a recording engineer to operate it. One of these B.B.C. sets was in fact captured by the Germans in France in 1940. Later designs of this equipment made it more robust but did not succeed in making it appreciably lighter or capable of being operated by the correspondent singlehanded. None the less, this type of equipment gave excellent service in the period 1940-1944 whilst in constant use throughout the Libyan, Tunisian and Italian campaigns.

Equipment of this type is now installed in four-wheel-drive Humber vehicles which are operating in all theatres of war. These vehicles have been fitted up with all the necessities to enable the correspondents and engineers to live in them for comparatively long periods.

This equipment has also been used for reporting the war at sea, and has been installed in bombers for recording raids on Berlin, and also Denis Johnston's remarkable visit to the Yugoslav patriots with his recording engineer Bob Wade.

## Portable Recorders

IT was realised in 1940 that lighter equipment should be designed which could not only be carried by the war correspondent but be sufficiently simple in design for him to operate himself. A search produced two kinds of portable recorders, neither of which was found entirely suitable or available in sufficiently large quantities. The B.B.C. Research Department then gave its attention to the development of a small disc recorder. In a few weeks the B.B.C. research engineers produced what is now known as the Midget Recorder, and it is this recorder which has done such excellent service in reporting the battle news of the campaign in Normandy. Its weight is 35 lbs., its size little larger than a portable gramophone, and its operation is confined to one knob. To save battery weight, the motor is clockwork driven and the microphone-cum-recording amplifier, with its dry batteries, are all inside the box. The battery unit has been built on the cassette-loading principle and is capable of running the amplifier for a period of about an hour. The recorder will run for 3½ minutes without changing the disc, and a warning light shines 15 seconds before the end of each disc.

*Members of a shore fire control party set up shop in an old shell hole and immediately proceed to direct the fire of Naval guns against targets on the beach, somewhere in France.*

## War Reporting Transmitters

DURING the last two or three years, the B.B.C. has been preparing war reporting transmitters, and these are being installed behind the battle fronts for the transmission back to this country of war correspondents' material. One of these is a low-power transmitter capable of working on medium or short waves, complete with its own engine generator set, aerial, masts, communication receiver and microphone equipment, all installed in a 3-ton four-wheel-drive Army lorry. This transmitter is now transmitting the bulk of the despatches back to this country for recording or inclusion "live" in the nightly War Reports.

## B.B.C. Tests Reaction to G.F.P.

TO test the reaction of Service men and women overseas to the General Forces Programme, the B.B.C. has organised a panel which is distributed throughout the overseas Commands, each of which is represented on it. It was recruited by announcements in Service newspapers and from a selection of those writing to the Corporation.

From three to four hundred correspondents are concerned in each inquiry made, though some of these are lost for a variety of reasons, such as battle casualties and transfers from one area to another, but the panel is continually augmented through the efforts of Army and R.A.F. Welfare Officers. In the panel at present operating, the proportion of officers is 30 per cent., the remaining 70 per cent. made up of other ranks. There is also a special panel of a hundred or more correspondents from the Royal Navy.

## Suitability for Overseas Listening

EACH correspondent undertakes to report the views of his colleagues, usually some six to 10 men, but in the case of officers and Welfare Officers the number goes up to more than a hundred. Since the correspondents are geographically widespread and each represents a number of men, the panel is considered to be a satisfactory sample of men serving overseas.

Inquiries have been made to test the general characteristics of the G.F.P. for its suitability for overseas listening conditions. Questions on peak listening times, and programme contents as a whole have been put.

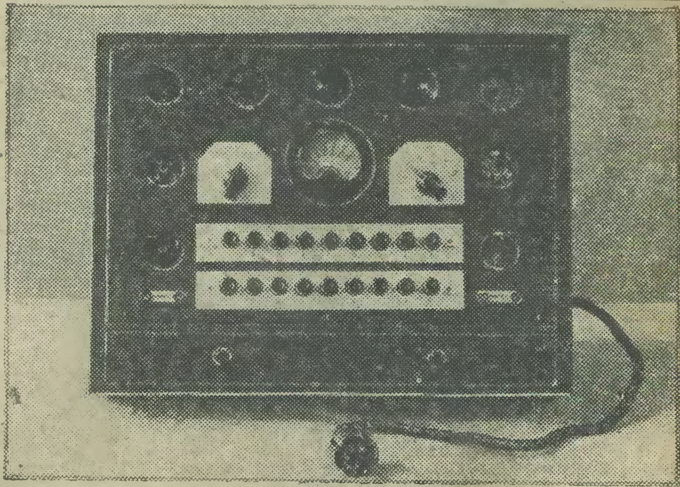
In replies just to hand from the last questionnaire, a number of correspondents spontaneously mention how much the fact that the programme is shared with their people at home is appreciated by men whose views they have sounded.

So keen are those correspondents on this work that after receiving a postal order covering their postal charges, many of them in their next letter to the B.B.C. ask that this money should be donated to a named charity for, as they put it, "the job is so interesting that we are only too pleased to have the opportunity of doing it."

YOUR SERVICE WORKSHOP

# A Valve Analyser

**An Instrument Enabling a Wide Variety of Valve Tests to be Made Without Disturbing Permanent Connections**



*The complete instrument.*

It was mentioned in recent articles on "Servicing" that having localised a fault to a certain stage, it is necessary to check, among other things, voltages and currents relating to the valve. It is easy enough to say this, but to actually carry out the operation may sometimes be quite inconvenient. For instance, to measure the anode current of most valves it is necessary to remove the chassis from the cabinet, break or unsolder the appropriate lead (which incidentally may mean removing temporarily some other component) and connecting a meter in circuit. After which connections must be restored.

The instrument here described is known as a Valve Analyser and with its aid it is possible to carry out innumerable measurements without disturbing any permanent connections in the receiver. It is quite distinct from a valve tester, which, of course, tests valves under specified conditions quite apart from the receiver. Such an instrument was described in this series in issues Nos. 446, 447 and 448.

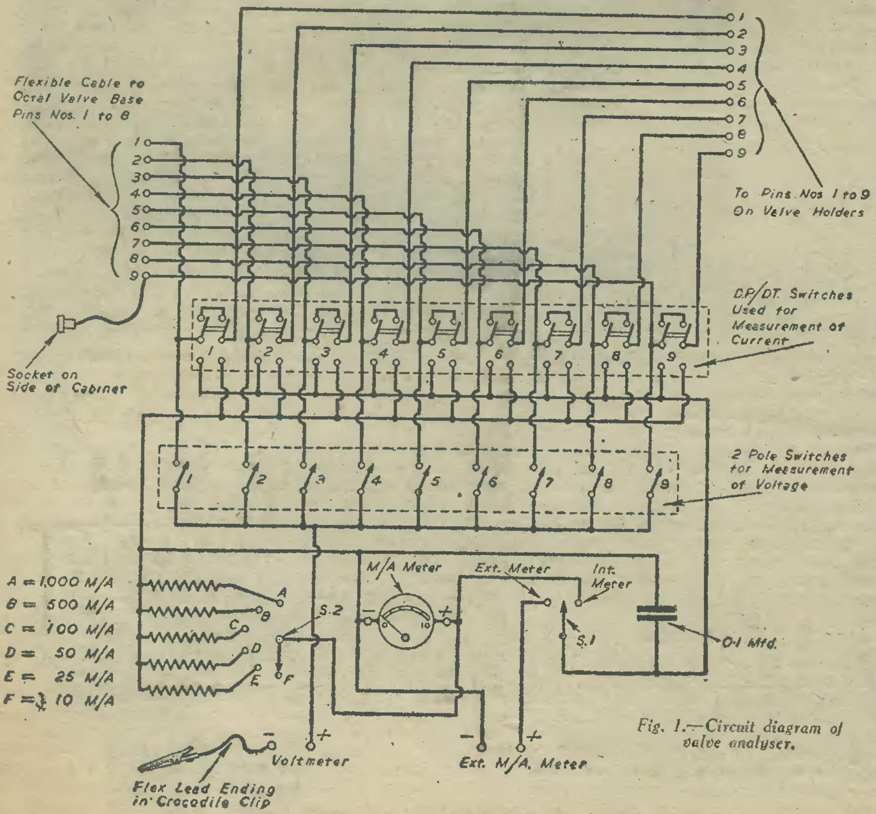



*Fig. 1.—Circuit diagram of valve analyser.*

### The Circuit

The circuit diagram of the valve analyser is shown in Fig. 1, while from the panel layout of Fig. 2 it will be seen that valve holders are provided for British 4-, 5-, 7- and 9-pin valves, octal, side contact, and American U.X. 4-, 5-, 6- and 7-pin. This covers practically all valves met in servicing, but the constructor may, of course, add any additional ones should he think fit. The V. type side contact holder is not included because it was impossible to obtain one, but anyway it is not

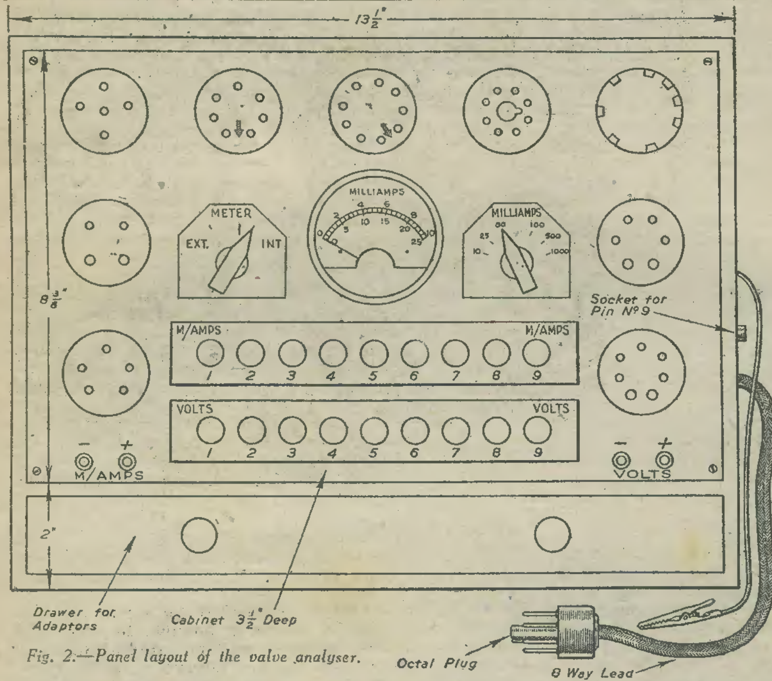



*Fig. 2.—Panel layout of the valve analyser.*

a type that one comes across very often. Switches are arranged so that a milliammeter may be joined in series with any number pin of any valve holder and so that voltage measurements may be made between chassis and any pin. This means that one is able to take readings of any type of valve for which a holder is provided, including rectifiers, as follows:

| Current | Voltage |
| --- | --- |
| Anode .. .. | Anode .. .. } To chassis or cathode |
| Screen .. .. | Screen .. .. } To chassis or cathode |
| Grid .. .. .. | Grid .. .. } To chassis or cathode |
| Cathode .. .. | Filament or heater } To chassis or cathode |
| Filament or heater .. | Cathode to chassis, voltage between electrodes may also be checked. |

For convenience a moving coil milliammeter is included in the instrument, but this is purely optional so that it may be omitted without detracting from the usefulness of the apparatus which, indeed, is intended to be used in conjunction with a universal test meter. For this reason a switch S.1 is used so that when set to external meter the required range of a universal meter may be connected to the socket marked "milliamps." For instance, it may be required to take a measurement of A.C. current, such as from rectifier anode or valve heater. Nevertheless, it is particularly helpful to incorporate a D.C. milliammeter if possible as it will cover most requirements without using the universal meter, which can then be used for voltage tests. The meter incorporated reads 0-10 m/a and the switch S.2 is used to increase the range to 25, 50, 100, 500 and 1,000 m/a. Voltage and current tests may be taken at the same time either on the same or on different electrodes, providing, of course, that two meters are available. However, full operational details will be given later.

## Layout

A good idea of the general appearance and layout of the completed Valve Analyser may be gained from the photograph and drawings. Construction is not difficult and all parts are reasonably easy to obtain. If the original method of construction is carried out a very neat and professional appearance may be obtained. The panel is of 1/4in. plywood and is therefore easy to work. It should be cut and drilled to comply with the layout given in Fig. 2. It is as well to make sure that the size of the hole for the octal holder is made large enough for a valve to seat down into it, as this type has rather short pins. The round holes are drilled with wood bits or an adjustable cutter and long slots for the press-button units cut out with a fretsaw. When prepared the edges of the round holes (for the valve holders) are given a liberal coating of shellac varnish or "knotting," which is allowed to dry. Then the panel is covered with black rexine, using good Scotch glue and making sure that it is really stuck around the edges of the holes. After giving time for the glue to dry, the rexine is cut away from all holes with the aid of a fine blade of a penknife. If the knife is very sharp it will be possible to cut a nice clean edge free of any fraying, which is necessary to preserve the appearance of the finished instrument. The valve holders are next mounted centrally under their respective holes and fixed with 1/4in. round head wood screws passing up into the panel from the underside. Then with a fine brush, the valve holders and the edges of the holes are given a coat of black enamel. Thus a neat finish is obtained.

The switch S.1 is a single-pole double throw and in the original

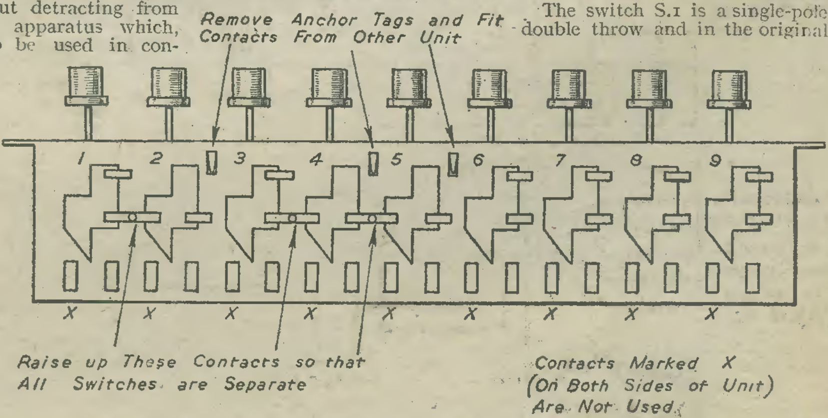



*Fig. 3.—View of one side of press button unit, showing alteration necessary.*

is a rotary switch of the Yaxley type. S.2 is similar but needs to be of the single-pole 6-way variety. They are mounted as shown in Figs. 2 and 4. For various reasons the electrode switching is carried out by means of two 9-way press-button units. They are readily obtainable and are cheaper than 18 separate switches. Also, because one switch automatically cuts out when another is depressed, it affords a safeguard against damage to valves when operating. One unit is used for milliammeter switching and one for voltmeter switching. Before mounting it is necessary to shorten the shafts so that they are all ¾in. long. The units are then set back from the panel to the extent of ½in. This may be done by slipping ½in. lengths of metal tubing over the fixing screws between the panel and the unit. No escutcheons are available, so the ones shown were made from ivorine sheet. The holes need to be at least ½in. diameter and ¾in. apart. Indicator plates for S.1 and S.2 are made from the same material.

Apart from the meter (which must be left to the constructor) the only other part to mount are the sockets for voltmeter and external milliammeter. The socket on the right of the instrument—not shown on the photograph—is for connection to No. 9 pin and its use will be described later. In connection with the press-button units some explanation is necessary. One side of these will be seen to consist essentially of separate S.P.D.T. switches operated by each button. There *are* other contacts but these may be ignored. On the other side, however, a slightly different arrangement is used, for it will be seen that on buttons Nos. 2, 4 and 5 from one end the switch is not S.P.D.T. but of a type where, when the button is depressed, one contact connects with two others. Also it will be noted that from the same end switches Nos. 1, 2 and 3, 4, 5 interconnect.

### Switching

A glance at the circuit diagram of Fig. 1 will show that for the milliammeter tests 9 D.P.D.T. switches are required, while for the voltage tests the same number of two-pole on/off switches are needed. On this latter unit, therefore, many spare contacts will be available and some can be removed and fitted to the other unit so that it fulfils our requirements of a D.P.D.T. switch operated by each button. This operation is not at all difficult and the procedure is as follows: First take either unit, and on one particular side it will be seen to compare with Fig. 3. Note where switches 1, 2 and 3, 4, 5 interconnect and raise up the contacts as shown so that each switch is electrically separate. Next remove the anchor tags indicated. These are held by rivets, and to release them it is a simple matter to drill off the top flange of the rivet and the tag can be lifted out with a penknife, afterwards pushing through the remainder of the rivet. Now take the other unit and remove three contacts from the side which is similar to Fig. 3. Note that the contacts vary in shape and it is necessary to select the type that will fit into the positions from which the tags were removed on the other unit. When removing the contacts, care should be taken not to distort them. Only light pressure is needed to drill off the top part of the rivet and then, as mentioned before, the contact may be gently lifted off with some fine instrument. Finally, the removed contacts are fixed into position on the other unit with 8 B.A bolts and nuts. The whole alteration can be done in a few minutes since all necessary holes and slots, etc., are already prepared.

The unit to which the contacts have been added now consists of a D.P.D.T. switch operated by each button (i.e., one S.P.D.T. on each side) and is therefore used for the milliamp tests, and the unaltered side of the other unit for the voltage tests.

### Wiring

When commencing the wiring of the instrument it will be found convenient to wire up the contacts of the press-button units as much as possible before the latter are finally fitted to the panel. Although there is quite a lot of wiring to be done it is straightforward providing a methodical system is employed. First wire up the P.B. units together with the leads to the 9-way anchorage plate shown in the wiring diagram, Fig. 4. It should be noted that the standard B.V.A. pin numbering has been adopted for all valve holders so that when wiring these it is advisable to have the information at hand. The data may be obtained from many text-books in the PRACTICAL WIRELESS series. By studying the wiring diagram it will be seen that a wire runs to pin No. 1 on all valve holders and to a point on the "milliamps" switch operated by No. 1 button. Next from all number 2 valve holder pins to the switch worked by No. 2 button and so on up to No. 9. After this, the meter and its switching may be wired up and finally the 8-way cable attached to the anchorage plate shown. To the other end of this cable an octal valve base is fitted. Incidentally, make sure that it *has* 8 pins. It is, of course, essential that the correct numbering should also be observed here. The lead from No. 9 on the anchor plate connects to a socket attached to the side of the cabinet and a flexible lead from the "volts neg." socket goes through the cabinet and terminates in a crocodile clip.

The values of meter shunts have been omitted since they depend on the resistance of the meter used. The information may be found from the formula:

$$\text{Resistance of Shunt} = \frac{\text{Resistance of meter}}{N-1}$$

where N = number of times the full-scale reading is to be increased.

### Valve Adaptors

When the instrument itself has been finished it is necessary to make a set of valve adaptors. Nine are required and they are naturally all designed to take the octal plug on top and to fit valve holders as follows: British 4, 5, 7, 9, side contact, American U.X. 4, 5, 6, 7. Here again it is essential to observe the B.V.A. pin numbers. For instance, when making, say, the 5-pin one, first solder a length of about 22 S.W.G. wire (longer than is needed) to contacts 1, 2, 3, 4 and 5 of an octal holder, slipping about ½in. of sleeving over each. Then having cleared the solder from the pins of a 5-pin valve base, pass the wires through so that No. 1 on the octal holder goes to No. 1 on the base and so on. The wires are now pulled taut and soldered at the tip of the pins and the excess nipped off. Finally check for short circuits. A little adhesive applied between the junction of the holder and base is an advantage. In the case of the 9-pin adaptor a small terminal is fitted to the side of the valve base and connected to pin No. 9. Then when this adaptor is needed a wire from the terminal is joined to the socket on the side of the cabinet which, as already explained, connects to the 9th pin of the holder in the instrument. If this method had not been adopted it would have been necessary to use 9-pin holders, which are not easy to obtain, for all adaptors, in conjunction with a 9-pin plug.

It will be seen from the illustrations that a drawer or space has been provided in the cabinet to keep all adaptors handy, yet out of the way.

### Operation

To use the valve analyser it is only necessary to remove the valves from the receiver and plug it into the corresponding holder of the instrument. Then the octal plug is inserted into the appropriate adaptor and this is plugged into the holder on the receiver. The flexible lead is clipped on to any convenient part of the chassis.

Now, if it is desired to know the anode current a milliammeter is joined to "milliamps"—unless the internal meter is used—and the button on the "milliamps" unit is depressed whose number corresponds with the number of the anode pin of the valve. Similarly, screen, filament, or cathode, current, etc., may be checked by pressing the appropriate button. With a voltmeter connected to "volts" any electrode may be checked by pressing the required button on the "volts" unit. Obviously, no two voltages or currents may be

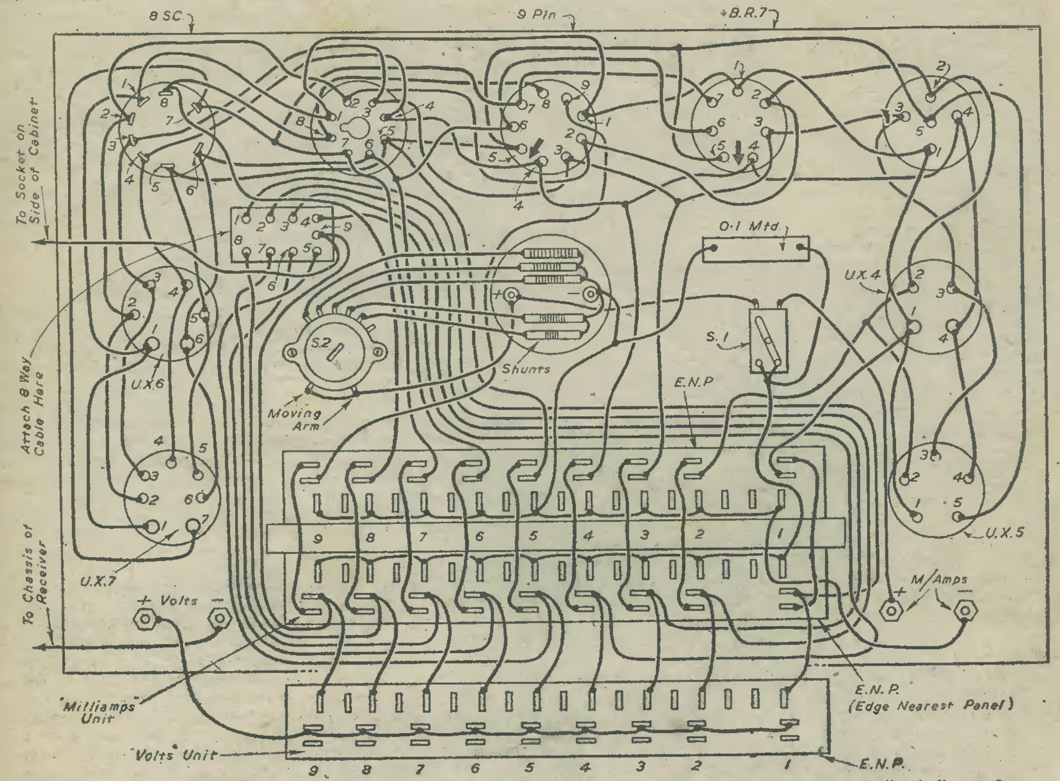



*Fig. 4.—Wiring diagram of the valve analyser. For clarity the "m/amp" unit is shown opened out and the "volts" unit flat (one side only.)*

measured at the same time, but voltage may be measured simultaneously with current even on the same electrode if two meters are available. When checking a valve having a top cap on side terminal, a flexible lead is joined between it and the T.C. or S.T. lead in the receiver. A couple of leads for this purpose are kept handy in the adaptor drawer. Voltage and current may be checked in the usual manner, but in any case measurements such as this may be carried out with the valve inserted in the receiver. Voltage across electrodes, such as heater or filament, may be checked by plugging the voltmeter leads into the appropriate pins of an adjacent valve holder.

Care should be taken not to press two buttons at once on the same unit, otherwise the advantage of the safety action of the switches will be lost. A button which is already depressed may be restored to normal by a slight pressure on any other one, so that none of the switches are in operation, which is sometimes convenient.

## LIST OF COMPONENTS

- Two 9-way press-button units with knobs.
- Ten octal valve holders.
- Four American U.X. holders, 4, 5, 6 and 7-pin.
- Three British holders, 5, 7 and 9-pin.
- One side-contact (8 contacts) holder.

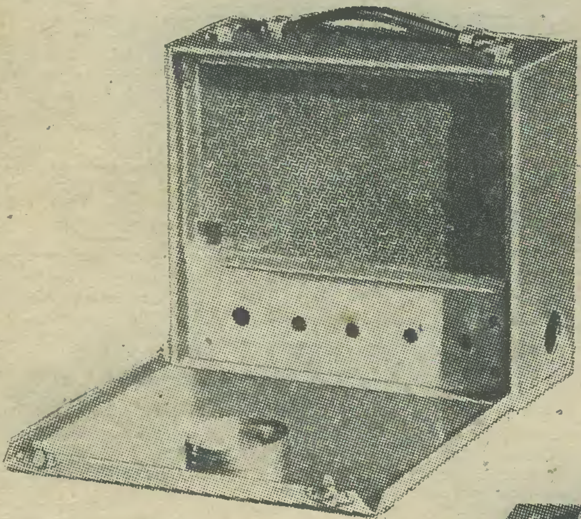
(Fred's Radio Cabin)

- Two instrument pointer knobs.
- One 0.1 mfd. fixed condenser 350 v.w.
- Tinned copper wire and sleeving.
- One single-pole 2-way switch. (S1)
- One single-pole 6-way switch. (S2).
- One milliammeter 0–10 (if required).
- Nine valve bases for adaptors (see text).
- 18ins. of 8-way cable.
- One octal valve plug.
- Five sockets, one crocodile clip.
- Wood for panel and cabinet, rexine, ivorine, etc.
- Screws, flex, etc.

# Sound Amplifying Equipment—I

## Complete Constructional Details of a High-efficiency Unit for Use Between Microphones and Pick-up and the Main Amplifier

THE purpose of this new series of articles is to provide constructors with comprehensive constructional details of well designed and well tested L.F. amplifiers and associated equipment. It is not proposed to devote a great deal of space to technical matters, other than that required to cover fully individual circuit considerations, as that part of the subject has been ably dealt with in a recent series entitled "L.F. Amplifier Design" (October, 1943-March, 1944). On the constructional side, every endeavour has been made to utilise those components which are still available, but if difficulties are experienced readers should bear in mind that it is quite permissible to substitute other makes *provided* values, ratings and characteristics are the same as those specified. On the other hand, catering for those who have to secure components from the somewhat restricted supply of to-day, the designs have been shorn of some super features which would have been embodied in more normal times. Fortunately, however, this enforced austerity does not affect the overall efficiency of the pieces of apparatus about to be described, but rather the case of operation, connection and so forth. A word about metal work. It is possible that some constructors may not have had much experience of making metal cases, etc., such as the one used for the unit described below, and may feel rather dubious about tackling such work. Without wishing to decry in any way the skill required for *real* sheet-metal work, it can be said that fairly simple designs are not beyond the capabilities of the average amateur possessing a vice, a couple of stout iron bars, a steel rule, a pair of tinsnips and the ability to do a decent spot of soldering. For proof of this it can be stated that the example illustrating this article was made throughout by one without any experience of metal-work, other than bending up a normal type of chassis.

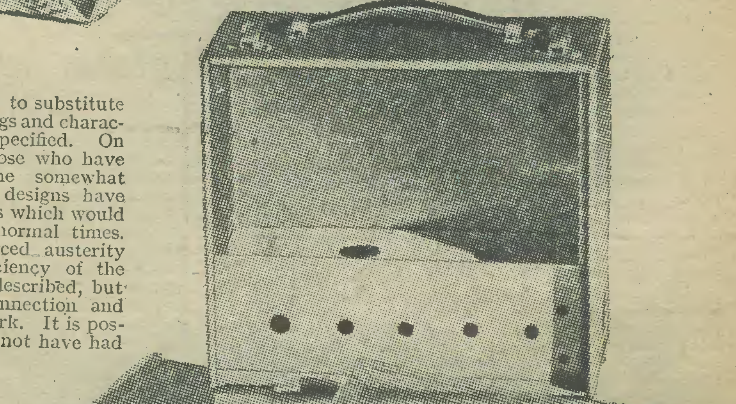


### Pre-amplification

It may seem strange commencing a series with the details of a pre-amplifier before describing a main amplifier with which it can be used. The reasons for this rather unorthodox procedure are (1) that the subject is being dealt with from the input end, and (2) that it is better for those who wish to build up a complete sound amplifying installation to start their activities by building one of the most important sections in the system, rather than make a power L.F. amplifier and then experience troubles and dissatisfaction so often due to input lines, insufficient voltage amplification, hum and valve hiss, etc.

As its name implies, a pre-amplifier is solely intended for use between the source of the input signal—microphone or P.U.—and the main or power amplifier. The former provides *voltage* amplification, and it is not concerned with a high wattage output, whereas the latter—a power amplifier—is designed to supply a certain amount of power at its output terminals (for a given input) to feed the speaker(s) system with the required wattage for satisfactory reproduction of a greatly amplified version of the input signal.

In addition to the above, pre-amplification is, more often than not, really essential for microphone work, and, in particular, when long lines have to be used between the "mike" location and the power amplifier and speakers. Apart from more important technical considerations, the use of a pre-amplifier



*Two illustrations of the metal cabinet.*

offers many practical advantages, not the least of which is that it does allow the operator to maintain a constant control over the input signal at or very near the "mike" location, and it also enables satisfactory monitoring at an important point in the system.

**Specification**

The theoretical circuit is not given in this issue, but here is a general specification of the unit about to be described. It is designed for A.C. operation, but it does not incorporate its own mains gear, for reasons which will be more obvious as this series progresses. Two valves are used—British standard triodes—and it is primarily intended for use with two transverse current microphones and one pick-up, a fader change-over being provided for the former, and a normal potentiometer control for the latter, which, incidentally, is fed into the second valve only; therefore a nice degree of "mixing" can be obtained. The "mike" energising battery is contained in the amplifier housing; an output jack is incorporated—in addition to the output sockets proper, for headphone monitoring. A small transverse current microphone is fitted to the lid of the case to enable the operator to test out line and communicate with main amplifier operator, etc. It is an easy matter to modify the inputs to suit other types of microphone. The metal case is compact and fitted with a carrying handle and a detachable hinged lid; the valves and "mike" battery are protected by a removable metal grill. Owing to the simplicity of the circuit, it would not be a difficult matter to adapt it to battery operation if so desired.

**Construction**

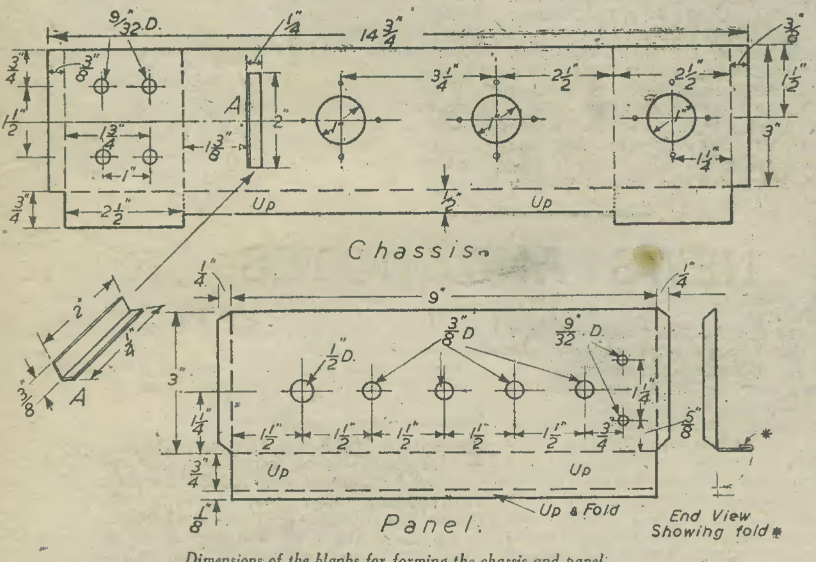
For the construction of the case and chassis, a sheet, approximately 28in. by 20in., of tinplate will be required or, of course, several smaller pieces capable of satisfying the dimensions shown for the individual parts. A local ironmonger was able to supply the material for the original model, therefore it is not thought that any difficulty will be experienced in obtaining such a small quantity. The gauge of the metal used was 24, the measured thickness being 0.024in. but heavier gauge could be utilised and greater rigidity obtained, though the 24 gauge is perfectly satisfactory and easier to work than thicker plate. As regards tools, a steel rule, a scriber, a good pair of tinsnips, a set-square, one or two twist (or preferably fluted) drills and a reasonably heavy soldering iron are the chief requirements. For bending, it is a great advantage to have the use of a vice and a couple of, say, 9in. lengths of stout iron or steel bars, or angle-iron.

**The Chassis**

As the case is built around the chassis, the latter should be the first part to be made. After squaring off the plate, mark out with the steel rule and scriber the shape shown in Fig. 1, and strike the centres and fix clearly with a centre-punch all holes ready for drilling, but do not drill. Cut the plate to the specified shape, taking care to keep perfectly straight edges and to avoid distorting or buckling the metal. The front of the chassis is the bottom of the diagram, and it will be noted that the ½in. strip is marked "Up." This is to indicate that it is bent UP along its broken line, whereas the other sections are bent DOWN along their broken lines. Don't attempt to cut the ½in. strip while the plate is flat: leave it the same width as the small rectangles on each side of it, namely, ¾in., and reduce it to ½in. after it has been bent upwards. Note, the *dotted* lines indicate a *cut*, whereas the *broken lines* denote a *bend*.

The first bending operations should be the two ¾in. wide pieces on each end of the chassis. Hold the plate firmly in a vertical position in a vice by the ¾in. deep portion—with a metal bar each side of the plate if the jaws of the vice are too narrow—so that the scribed line is just flush with the upper surface of the vice or bars. With a piece of wood pressed up against the back of the plate and resting on the top of the jaws, apply good pressure and bend the free part of the plate towards you. The complete bend need not be produced in one sweep; in fact, it seems better to do it in two or three stages, provided care is taken to see that the final movement does produce a good right-angle bend. Do not be tempted to beat the metal down with an ordinary hammer; it is best for the amateur to avoid any beating, otherwise the metal is almost bound to be distorted and a warped surface or crinkled edge will result. If any tapping down has to be done, always use a good block of wood up against the surface of the metal and a mallet rather than a hammer. The next bends, those 2½in. in from the previous ones, may be rather awkward to make in the vice, therefore, the bending bars must be used, one end of which can be held in the vice, and the other in a small clamp, or, if this is not feasible, try and clamp the plate between the bars on the bench. There are various ways of doing this, and each constructor may devise ideas of his own according to the facilities available, but the essential requirement is that the plate must be held firmly between two straight-edged surfaces, otherwise a sharp bend along the scribed line will not be obtained. In all of this metal work, it must be remembered that if the bends take a curve having an appreciable radius, the finished dimensions will differ from those anticipated.

The two ¾in. by 2½in. portions along the front edge can now be bent inwards—these can be done in the vice—and then the remaining centre portion of the front can be bent in the *opposite* direction, i.e., outwards or upwards,




*Dimensions of the blanks for forming the chassis and panel.*

and the flange thus formed can afterwards be cut down with the snips to the specified ½in. in height.

All drilling can now be done, and the work then given a cleaning up with a file to remove sharp edges, corners and burrs. If a 1in. drill or an expanding bit is not available, the holes for the valve holders can be cut out by drilling a series of holes round the *inside* of the scribed circles with a ⅛in. twist drill, and removing the metal by cutting through the walls between adjacent holes and finally smoothing up with a half-round file.

The short length of right-angle plate "A" should be made from an odd piece, and soldered in the position indicated on Fig. 1. Its purpose is to form a retaining bracket for the microphone battery.

### The Panel

A metal worker would, no doubt, have made the chassis and panel from one piece of plate, but for simplicity it is made in two parts in this instance. The dimensions are shown in Fig. 2. Reasonable care must be taken with the marking off, especially the centring, etc., of the holes, and it is very advisable to check overall dimensions against the recently made chassis. For example, owing to the reasons already given about bends affecting measurements, etc., and bearing in mind the thickness of the plate, it is safer to see if the distance between the two side flanges on the front of the chassis *is* 9ins. before actually marking off and cutting the panel. This may sound very amateurish, but assuming that amateurs without metal work experience are making the item, then it is wiser to play for safety by taking such precautions. This advice applies throughout the construction of the case, especially as some may use thicker metal than others and so on.

Once the panel has been cut out, the seven holes can be drilled, as there is very little bending to be done in this instance. If fluted drills are available they are much better for thin metal work, as they do not tend to wander so much as an ordinary twist-drill. If possible, clamp the plate on to a stout piece of wood before drilling, as this will not only hold the work firm but it will also help to act as a guide for the drill and thus help to prevent the weird shapes sometimes produced when drilling thin metal. Remove all burrs with a larger drill or file, and then proceed wtih the bending, the first being the ⅛in. *fold over* along the bottom front edge. This is a complete fold, as shown by the side view of the panel, its object being to provide a nice smooth edge and give greater rigidity. The ⅜in. front strip can then be bent upwards, and the two side flanges in the *opposite* direction. When completed, the panel should be a nice fit as shown by the illustration Fig. 3. It is held in position by soldering the flanges to the inside of the side supports of the chassis, care being taken to see that *all* bottom edges are flush. A small quantity of solder should also be run between the bottom turned-up portion of the panel and the sides. All soldering should be executed as neatly as possible, and to do this the plate must be kept at the correct temperature, otherwise the iron will cool off and the solder refuse to flow evenly. The plate can be pre-heated over the gas, and if a fairly heavy well-shaped iron is used no trouble should be experienced. A small spirit blowlamp can be most useful for such work.

When finished, the job should be washed in strong soda water—hot—to remove all trace of grease and flux, rinsed off in clean water and then dried thoroughly. Don't attempt at this stage to give the metal work a coat of paint.

(*To be continued*)

# NEWS AND NOTES

### £1,000 In Prizes for Writers

TO promote closer interest in Australia and its people among other English-speaking countries, the Australian Broadcasting Commission announces a number of competitions for writers, with prizes totalling £1,000.

Novels, plays, documentary features, short stories, poems and discussions are called for. Entries must deal with Australian life, history or characters.

It is with the object of securing the best talent available for the projection of Australian subjects, as well as to foster better understanding overseas of Australian life and ways, that the competitions are open to the nationals of all English-speaking countries. The A.B.C. wants the material to be of a quality that will be readily acceptable for broadcasting overseas as well as in Australia. The Commission feels that many people abroad who were either born in Australia, have visited that country, or taken a keen interest in its history, or some special aspect of its life, will wish to enter one or more of the competitions. Australians, the Commission says, will welcome an opportunity of pitting their talent against overseas competitors, particularly on subjects relating to their own country.

### New Talent for Radio

NEW competitions provide scope for almost all forms of writing, and may be expected to attract new as well as established, writers. To encourage new talent for radio, a special bonus is being offered, in all six categories, for the best work purchased from a non prize-winning writer who has had none of his work either published or broadcast.

The following is a list of the awards:

Novel: First prize, £150; second, £75. Minimum length, 50,000 words.

Play: First prize, £100; second, £70; third, £40 Plays can be from 30 to 60 minutes' duration.

Documentary Feature: First prize, £60; second, £40. Features of not more than 30 minutes' duration.

Short Story: First prize, £50; second, £30. Stories of 1,500–1,700 words, which should not take more than 14 minutes to read.

Poem: First prize, £25; second, £10. Poems of not less than five minutes' reading time.

### Post-war Developments

POSSIBILITIES of after-war developments in film reproduction of sound with new emulsions having improved resolution were indicated as being on the way. A frequency range even exceeding 15,000 or 16,000 cycles was mentioned in this connection.

An interesting story was told of the manner in which some of the early difficulties with processing films had been overcome, especially in regard to taking copies of the negatives owing to shrinkage during development.

Although some people doubted the necessity of raising the frequency range to 12,000 cycles, the opposite view prevailed that it is essential to take the frequency range as high as possible for an adequate reproduction of music, particularly in securing fidelity of "attack."

### I.E.E. Wireless Section Commemoration

THE wireless section of the I.E.E. was formed in 1919, and to mark the occasion of its 25th birthday a commemoration meeting and dinner was held on May 3rd. Short addresses were delivered comprising a view of wireless progress by the following past men of the section: Col. Sir A. Stanley Angwin, D.S.O., M.C., T.D., B.Sc.(Eng.), president; Dr. W. H. Eccles, F.R.S.; Professor G. W. O. Howe, D.Sc.; Admiral Sir Charles E. Kennedy-Purvis, K.C.B., R.N.; Mr. H. Bishop, C.B.E., B.Sc.(Eng.); and Dr. R. L. Smith-Rose.

In addition to the addresses, there was a short gramophone recital dealing with important events in wireless development. There was also an exhibition of apparatus of historical interest loaned to the exhibition by the B.B.C., Marconi's Wireless Telegraph Co. and others.

# Short-wave Radio—1

The First Article of a New Series Dealing With S.W. Technique, and the Construction of S.W. Receivers and Equipment. By 2CHW

WHEN the memorable Radio Exhibition of 1939 prematurely closed its doors, short-wave radio—the keystone of the amateur radio movement whose activities extend over the whole world—was enjoying a popularity far exceeding the most optimistic hopes of the pioneers of 1923. Many veterans will, no doubt, point out that amateur radio dates back to the years immediately preceding the Great War of 1914-18, when a small but very enthusiastic body of experimenters were setting the foundation stones of the gigantic movement we know to-day. They will be quite correct, but it was not until 1923 that the amateurs turned their attention to the short-waves, and, strange as it may seem in the light of present knowledge, even then it was not by their own choice. It must be remembered that transmitting was the king-pin of the amateur structure in the early days, and when this was made illegal in 1914 (as in 1939) the first amateur transmission did not come on the air again until the latter part of 1920, and then only after many wordy battles between the amateur and the P.M.G.

Two wave-lengths were allocated to them, 1,000 metres and 180 metres, but after further agitation, these were altered to 440 metres and 150-220 metres. In 1923, the Post Office did away with the 440 metre band, and forced the amateurs down on to the short-waves, which, apparently, the P.O. thought were pretty useless and/or because no one else had any use for them. This, as it then seemed, drastic step, has since turned out to be a blessing in disguise, and it may well be recorded as forming one of the milestones along the path of progress of radio development. By their great enthusiasm, untiring efforts and splendid achievements, the amateurs

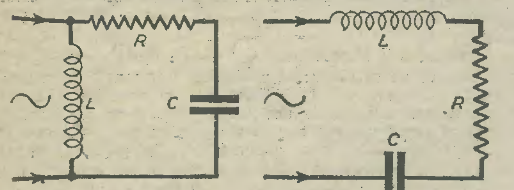



*Fig. 1 (Left).—Simple parallel-tuned circuit. Fig. 2 Right).—Series-tuned circuit.*

undoubtedly forced the pace of official progress, and to a large extent made possible many of the numerous applications of short- and ultra-short radiations which are playing such a vital part in the satisfactory prosecution of the war of to-day.

**Co-operation**

Although the transmitting amateurs still form the backbone of the movement, it must not be overlooked that for every transmitter there are many hundreds of equally enthusiastic amateurs who confine—not always through their own choice—their activities to listening to S.W. transmissions from all over the globe. It is through their splendid co-operation with the transmitting stations, and the valuable work they perform in checking and reporting, etc., that the amateur radio movement has grown to what it is to-day, a vast body of enthusiasts of all nationalities having one common interest, namely, the progress of radio.

**S.W. Technique**

There must be a surprising number of constructors having varied and long experience with the construction and operation of broadcast (long- and medium-wave) receivers, who fail to achieve anything like success when they try their hands on the short-waves.

Although each case appeared to present its own individual problems, the answer is failure to understand that what will do for the frequencies of the long- and medium-wave bands, will most certainly not do for the very high frequencies with which we are concerned on the short-waves. This is hardly a text-book description, and it is rather sweeping, but, speaking in a general sense, it is a fact.

**Frequency**

When dealing with alternating current, circuits, components and their values or characteristics, depend on the frequency of the source of the A.C. The normal electricity supply in this country has a frequency of 50 cycles per second; the sounds audible to the human ear cover a frequency band of 30 to 15,000 c/s; the usual broadcast long-wave band is concerned with frequencies in the region of 300,000 c/s (300 kc/s) to 150,000 c/s or 150 kc/s. The medium-waves embrace a frequency band from 1,500 kc/s to 550 kc/s, while the short-waves are concerned with A.C. currents and voltages having frequencies as high as 3,000 kc/s to 20,000 kc/s, when thinking in wavelengths of 100 to 15 metres.

**H.F. Considerations**

Alternating currents can produce many peculiar effects, and it should be noted that the higher the frequency the more pronounced become the peculiarities, as compared with conductors carrying only direct current. For example, insulators, which might be quite satisfactory for D.C. work, can often prove the reverse when used in S.W. circuits owing to high-frequency—in addition to possible leakage—losses. Thus, we endeavour to use components constructed from materials having the greatest insulation against H.F. currents, and utilising the minimum amount of material consistent with strength, for S.W. work.

Any electric current produces a magnetic field, and, in the case of alternating current, its associated field also alternates. Conversely, if an alternating magnetic field is allowed to influence any other conductors, alternating currents will be induced in those conductors, and losses will be experienced. This is particularly so with high-frequency currents, therefore this introduces another feature to be considered when designing S.W. receivers, as it is naturally desirable to avoid such losses, but keeping metal parts outside the fields produced by any conductor or component carrying H.F.

**Conductors**

When a conductor is carrying direct current (or A.C. of *low* frequency) the current is carried by the whole conductor; with A.C., however, and especially at high frequencies, the current tends to travel more on the surface layer, or "skin," of the conductor, and we speak of the "skin effect." To avoid introducing resistance the conductors or wires carrying H.F. should be of heavier gauge than that used for normal work, in fact, tubing is often used in equipment designed for ultra short-waves, so that the maximum "skin" surface can be obtained with the minimum amount of material.

**Self-capacity**

We know that a condenser inserted in a direct current circuit will block the flow of current; we also know that the same component in an A.C. circuit will allow energy to be transferred or passed through it. In the latter case, the condenser will offer a certain opposition to the A.C. current, in much the same manner as resistance does in a D.C. circuit, but the amount of opposition will depend on the value of the condenser and the *frequency* of the A.C. Although the opposition is measured in ohms, it is not known as resistance, but as reactance, the symbol for which is Xc.

$Xc=\frac{10^6}{6.28fC}$ when f equals the frequency; and C is the capacity of the condenser in microfarads, $10^6$ being 1,000,000.

From this it will be seen that the higher the frequency the lower will be the reactance of the condenser, and this not only helps us in selecting suitable values for the condensers in a S.W. circuit, but it also stresses the importance of all components to possess a very low minimum *self-capacity*. To quote one example, if a S.W. choke had a comparatively high self-capacity the windings forming the choke would have little or no effect, as the H.F. currents would simply by-pass it through its self-capacity.

These elementary items are mentioned to stress the original statement about paying attention to frequencies, and to show—in a general manner—the reasons why the H.F. currents flowing in a S.W. receiver impose certain demands on design and components, and that unless these are satisfied efficiency will never be obtained.

### Essential Features

To use our broadcast receiver comparison again, the aerial of such an installation often receives a signal having an E.M.F. in the region of .001 volt. A short-wave receiving station is, more often than not, called upon to detect a signal having a strength 500 to 1,000 times weaker than that, therefore one of the first essentials of any S.W. receiver is high-sensitivity. Against this it must be remembered that the broadcast receiver usually reproduces its signals via a loudspeaker, whereas the short-waver is chiefly concerned with feeding into a pair of headphones which would give a very good signal on 5 to 6 milli-watts, compared with several hundred needed for the loudspeaker.

Closely linked with sensitivity is selectivity. It is useless to design a S.W. receiver to give a very high degree of sensitivity if it is not capable of selecting the weak signal from others on adjacent frequency bands.

### Proportional Band Width

A normal wireless telephony transmission occupies a frequency band width of approximately 10 kc/s, *irrespective* of the frequency of the carrier wave. On, say, 2,000 metres, this represents 6.6 per cent. of the carrier frequency; on 400 metres, 1.33 per cent.; at 100 metres 0.3 per cent.; and at 15 metres, 0.05 per cent. This percentage is known as the *proportional band width*, and it is closely related to the selectivity of tuned circuits.

From the above it will be obvious that a very far greater number of transmissions can be accommodated on the S.W. band than on the medium or long-waves. An examination of a list giving the frequencies of some of the commercial S.W. stations will reveal how many are separated by only fractions of a metre. For example WCRC is on 25.36 metres or 11.830 mc/s; WGEA is on 25.32 metres or 11.847 mc/s. This gives a separation of .04 metres, or 17 kc/s, therefore the 10 kc/s telephony frequency band is provided for, but the example also gives an illustration of the need for selective circuits and tuning controls which will provide delicate yet consistent adjustment.

### Selective Circuits

To secure the desired selectivity and high-efficiency tuning circuits, particular attention must again be paid to the elimination of losses, resistance, and to the L/C ratio.

Consider the simple parallel-tuned circuit shown in Fig. 1. To select the station on the required frequency, the circuit must be capable of resonating at that frequency, which is determined from the formula

$$f=\frac{10^6}{6.28\sqrt{LC}}$$

when f is the frequency in kc/s; L the inductance of the coil in micro-henrys, and C the capacity of the condenser in micro-microfarads.

The circuit must also be capable of passing on to the grid of the first valve, the highest possible voltage at the desired signal frequency, and the lowest voltage at any other frequency. If these two values can be written as maximum and zero, then perfect selectivity would be achieved. To secure high signal voltage, the circuit must present to the incoming signal a high parallel impedance—as distinct from a low impedance of a series-tuned circuit—and the H.F. resistance must be kept as low as possible. This resistance is shown in Fig. 1 as a separate item, but it is intended to represent the resistance due to the coil, etc.

### L/C Ratio

From the formula for the resonant frequency, it can be seen that the values of L. and C. can be varied, provided that their product is constant for a given frequency. The capacity C could be high and the value of L low, or vice versa, and this introduces a ratio which is known as the L/C ratio. In a series-tuned circuit, Fig. 2, this ratio does not play an important part as the impedance at resonance is equal to R. With a parallel tuned arrangement, however, the L/C ratio becomes a major consideration, as it directly affects the impedance offered to the applied signal. In view of what has been said above, it is usually desirable for the ratio to be high. This will be more obvious, if one considers the "dynamic resistance" or the impedance of the circuit at resonance which is given by:

$$\frac{L}{CR}$$

At resonance, the parallel-tuned circuit acts as a resistance.

### "Goodness" Factor or "Q"

The value of R varies with the frequency, *increasing* as the frequency gets higher, and in practice, the coil will be responsible for the major portion of it. Another fact of great importance is the reactance of the coil or inductance, and this is determined by XL=6.28 fL ohms, L being the value of the inductance in henrys. If this value is known, and if we also know the value of R for the circuit, it is possible to get a good idea of the overall efficiency of the circuit by comparing the two values. To put it in another form, the ratio of the coil's reactance to the resistance is known as the "Q" of the circuit or coil, and can be expressed thus:

$$Q=\frac{6.28fL}{R}$$

It is often described as expressing the "goodness" of a circuit.

From the above, it will be obvious that R should be kept as low as possible, and this can only be achieved by paying attention to the materials used and the construction of the components, always remembering the demands imposed by high-frequency currents.

*(To be continued.)*

# ON YOUR WAVELENGTH

*By THERMION*

### Too Much Boogie

THE B.B.C. are receiving criticisms concerning the new A.E.F. Programme, from those now in Normandy.

Here is a selection:

"Reception is excellent."

"I'm a swing fan, and as pleased as punch with the programme."

"Thanks, it's splendid."

"What about us highbrows? Can't we have Caruso or Clara Butt? Ten minutes a night of Beethoven or Mozart would satisfy me."

"Too much boogie woogie and six pips—but I listen just the same."

### Libidinous Nitwits

THE foregoing paragraph indicates how difficult it is for the B.B.C. to please everybody. It can be said, however, that they are trying, although it is my view that they should *know* public tastes by this time. After all, if I employ a conjurer to entertain me I don't expect to show him the tricks. If I obtain a job as a fitter I am expected to know how to do fitting. If I am a public entertainer I am expected to entertain. Anyone without any experience can set up in business as an entertainer and find out somewhat expensively what the public want. In the ordinary theatrical business, of course, such a one would end up in the bankruptcy court. The B.B.C. run no such risk. It's heads they win, tails you lose.

If the B.B.C. would take a little more notice of the critics they would arrive at the correct formula without inflicting experimental programmes on the public. A critic of the B.B.C. programmes the other day said that the B.B.C. Forces programme seemed to be produced "for an audience of libidinous nitwits!" whilst the Parliamentary Secretary to the Minister of Information said: "I do not think that a certain amount of crooning by females—what shall I call them?—singers is likely to affect one way or the other the morale of the British Army." I am sorry that the Secretary was at a loss for a sobriquet for female crooners. Had he read this journal he would have discovered heaps of expletives, objurgations, and vituperations, to describe what has always been anathema to me.

### New Zealand's Efforts

ACCORDING to the New Zealand *Standard* warfare against Japan, in the steaming jungles of the Pacific islands and of Burma, has brought with it problems unknown to fighters in more temperate climates. Not the least of these difficulties is the maintenance of delicate radio equipment in conditions of heat and moisture. Army sets which had given satisfactory service under battle conditions in Europe and America failed in the Pacific as the atmosphere of the jungle and the mould-growths which flourish in it ate through insulation and caused electrical breakdowns.

New Zealand radio designers and technicians solved the problem by producing an Army radio set which is "jungle-proof" and "tropic-proof."

In its case it is waterproof and buoyant; you can throw it in a river and float it across.

Every delicate part inside the set which could possibly be affected by heat or moisture is coated with a protective film of wax or petroleum jelly which maintains it in factory-new condition.

Army Signals submitted the set to a test more rigorous than it could ever undergo in the natural course of events. In a special humidity chamber, designed to reproduce tropical conditions on a more intense scale than Nature can produce, the set was subjected for six hours to a temperature of 140 deg. Fahrenheit at a humidity of 100 per cent.—a combination of heat and moisture in which no human being could live. Taken from the chamber, dripping and steaming all over, the set was put into immediate operation under an electrical overload. It worked—not perfectly, it is true, but so near to perfectly as to make no difference in practice, and certainly better than any other set tested in New Zealand.

This set, designated the ZC1, Mark II, differs in many ways from the conventional Army wireless set. A combined transmitter-receiver, its primary difference is that it is designed and built around standard commercial radio components, and it follows the conventional layout of the New Zealand commercial radio set, but it is built to a higher standard of quality and ruggedness and proofed against tropical conditions.

It is in use to-day by New Zealand and United States forces in the Pacific. The Eastern Group Supply Council in India has ordered thousands of them, and they will no doubt play their not unimportant part in the reconquest of Burma and Malaya. ZC1 is a combined transmitter and receiver, designed primarily for use in armoured fighting vehicles. But it is semi-portable and can be used and has been used under active service conditions in the Pacific by infantry. It can be used for either telegraphy or telephony.

With batteries, aerials and spare parts all packed in separate containers, the whole outfit can be comfortably handled by two men.

The set has won great praise from British, American and Canadian authorities. So highly was it regarded in the United Kingdom that the Government requested from the New Zealand Government the loan of some of the scientists and technicians responsible for its production.

Twelve of those men are now on their way to Britain to give to the radio industry there the benefit of their experiences in "tropic-proofing," and no doubt to receive from the British industry knowledge and experience that will benefit the Dominion on their return.

## Our Roll of Merit

*Readers on Active Service—Forty-fifth List*

**R. Ennis (Cpl., R.A.F.).**
**O. H. White (Lt., R.N.).**
**J. H. Higitt (L.A.C., R.A.F.).**
**I. Flitcroft (L.A.C., R.A.F.).**
**C. Waterhouse (P/O., R.A.F.).**
**E. Sears (L.A.C., R.A.F.).**
**T. Bromley (Cpl., R.A.F.).**

**s the B.B.C. Pro-Scot?**

MAURICE LANE-NORCOTT in one of our daily newspapers inquires:

"Is the B.B.C. deliberately plotting to turn the English language into a Scottish dialect? It is almost impossible to switch on the Children's Hour and hear an English voice. Announcers, plays, players, songs, talks, everything seems to be Scottish.

"And when television returns they doubtless will dance Highland flings, too. Why not call this programme the Pawkie Wee Bairns' Hour, and be done with it?"

Aye! Aye! An the Braw Heilan Fling ye mind, as soon as Televeesion maks posseeble! As for the ken-speckled and jealous Sassenachs, let them awa hame and beil their heads! Forbye, they havna ony brrrains tae tak ony injurrry in the prrrocess! 'Tis weel kent ye have tae trravel weel acrrross the Borrderr aforre ye can hope tae find ony siccan a thing as Brrrains. Och. Aye! A'hm tellin Ye!

**Heard on a Two-valver**

B. P. BUDGEN, No. 7,263, asks about log-book entries, but lack of space prevents us giving a detailed reply in this issue. We will, however, endeavour to cover the subject in the very near future.

"I have to-day received the log-sheets and verification forms, with which I am very pleased.

"Could you please tell me the usual way to fill in the columns marked 'Volume,' 'Fading,' 'Statics' and 'Interference'? I believe there is a code used for this.

[*This has been replied to.*—ED.]

"All my listening is done on a home-built straight two-valve receiver using commercial 7-pin coils. My log to date includes FZI, WLWO, WGO, WCBX, WGEA, WRUL, WGEO and Radio Centre Moscow.

"With reference to Member No. 7,214 of Portstewart's letter in a recent issue, the station mentioned received on the 17-metre band was, I should imagine, station WNBI, of Bound Brook, U.S.A., which transmits on 16.87 metres.

"May I add that I think PRACTICAL WIRELESS is the best radio journal, and I never fail to enjoy its contents."

**Mains/Battery Receiver Improvement**

THE usual type of mains/battery receiver uses battery valves of a low consumption type in order to keep the drain on the batteries to a low level. The limitation imposed upon power consumption due to the use of batteries involves the disadvantage that full use cannot be made of the extra power available during mains operation.

It is now suggested that the battery-operated valve be replaced when switching from battery to mains operation by a mains type output valve which will give a better performance when the set is operating on mains supply. The mains type output valve may have its heater connected in series with the rectifier and the switch normally provided for changing from mains to battery operation may be provided with additional contacts and connections such that the mains type output valve is disconnected from the circuit on changing over and the battery-operated valve is connected into the circuit.

By relatively little additional expense, it will be seen that the qualities of this type of receiver are enhanced because the user has the advantage of a receiver which takes little current on battery operation, but which is capable of giving improved performance on mains operation.

**West Africa on the Air**

ON July 26th, in the Home Service programme, an interesting talk was given by Mr. John Wilson entitled "West Africa on the Air."

In West Africa the radio has replaced the ancient language of the drums. Quite recently Mr. Wilson took listeners behind the scenes at Broadcast House, Accra, and described how the West African regards this innovation. Mr. Wilson, who is District Educational Officer, is well qualified to speak on this subject as he first went out to the Gold Coast in 1929.

**Radio Equipment in New Zealand**

"FOR the past two years the radio manufacturing industry in New Zealand has been concentrated on the production of wireless signals equipment for our own and Allied fighting services. This has been a success in mechanised units, and particularly in jungle warfare," said the Minister of Supply and Munitions, the Hon. D. G. Sullivan, recently. "So favourable has been the reputation of the New Zealand designed and produced equipment that the United Kingdom Government has requested the New Zealand Government to make available a team of technicians and scientists.

"The War Cabinet has viewed this request sympathetically, and we are making available to Britain a number of our experts in this important work. The selection of a team which is fully representative of the interests engaged in the production of this wireless equipment has been no simple task. In making the selection the needs of the United Kingdon had to be given full weight, while our own heavy production schedules had to be maintained. Certain key men, whom we would have willingly sent because of their skill and knowledge, we have been compelled to retain in New Zealand to supervise work on the home front."

**Distortion**

FOR perfect reproduction the sound issuing from the loudspeaker should be an aural replica of the sounds in the studio. When this fails to happen as judged by a critical ear, or by the movements of tell-tale meter needles inserted at correct positions in the power feeds, distortion is occurring.

Contrary to popular belief, the high-frequency portion of the circuit is often the cause of more distortion than the low-frequency side. The introduction of so many high-powered broadcasting stations has made the question of selectivity rather an acute one. When a station is sending out speech or music it radiates, in addition to the carrier wave, other frequencies known as sidebands. These are spaced equally on either side of the carrier frequency, and may extend as far as 7,000 to 8,000 cycles either side.

A receiver having razor edge selectivity cuts off a large section of these sidebands or reduces them to such an extent that they compare unfavourably with the amount of amplification accorded to the lower frequencies. Anyone musically inclined will realise that the higher frequencies bring about the brilliance or timbre, and if they are not present then quality must to a certain extent be sacrificed.

---

**EXIT HANDLEY—ENTER GUBBINS**

[The B.B.C. has taken Tommy Handley and "Itma" off the air and substituted in its place, "Sitting on the Fence," by Nathaniel Gubbins.]

Now Tommy Handley's bidden hence,
Another man "Sits on the Fence";

And though the fault may lie in me,
Here, no improvement can I see.

A tale twice told can only bore,
As often we've been told before.

The only grouse we had with Tom,
His show too often was put on.

Till, with apologetic cough,
Since heard before, we switched it off!

Now, once we've read Nathaniel G.,
No doubt some listeners will agree,

A second dose, per radio,
Is farther than they ought to go!

Gubbins, old chap, quite freely we confess,
Your stuff's amusing, when set out in the Press.

Forgive us, Nat—these words they must be spoke—
It's less amusing in a twice-repeated joke!

As for the B.B.C., it plays its same old game—
The more it changes, still remains the same!

Most unoriginal! Note its latest caper:
Warmed-up jokes from last week's Sunday paper!

"TORCH."

# Aerial Principles and Practice—2

**Continued from Last Month, This Second Article of a Short Series Explains the Use of Aerials Having a Length Greater Than One Half-wave, and Deals With the Question of Feeding the Aerial**

IT was shown last month that, in general, the half-wave Hertz or quarter-wave Marconi aerial is most satisfactory. Sometimes, however, particularly on very short waves, aerials of greater lengths than these are employed to advantage. On longer waves, of course, there are serious practical disadvantages in erecting aerials which are more than one-half wavelength long; for example, a full-wave aerial for use on 300 metres would have a length of nearly 1,000 ft.—and there are not many back gardens that are big enough for this! In addition, consideration must be taken of the ratio between aerial length and height. Where possible, a dipole aerial should be not less than one-quarter wave high to obtain a good upward radiation at an angle of about 30 degrees to the ground.

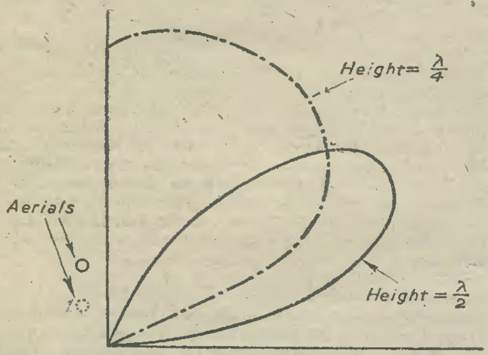



*Fig. 1.—Vertical polar diagrams showing the main lobes of radiation from two horizontal aerials erected at one-quarter and one-half a wavelength high.*

### Height and Length

For normal medium and long-range working it may be taken that the optimum height of a horizontal free-space dipole should be one-half wavelength. To understand exactly what is entailed it is necessary to examine vertical polar diagrams, of which two are illustrated in Fig. 1. At this point it may be stated that the height of the aerial has most effect in deciding the form of the vertical polar diagram, whilst the length of the aerial chiefly governs the horizontal polar diagram, or the radiation around the aerial.

Fig. 2 shows horizontal polar diagrams of a half-wave and full-wave aerial, from which it will be seen that the full-wave aerial has four "lobes," while the half-wave aerial has only two. This means, in effect, that the former is somewhat more omnidirectional. It should be explained that the lobes indicate the relative radiations at various angles from the aerial, and that there will not, in fact, be complete dead spaces between the lobes, as the diagrams seem to suggest. Nevertheless, use can be made of the lobes by ensuring that they point in the directions in which it is desired to transmit or receive most satisfactorily.

Despite the correctness of the horizontal polar diagrams shown in Fig. 2, it may be explained here that special aerials equal in length to two or more half-waves are often used to increase rather than to decrease sensitivity in any one direction. More will be written about this later when dealing with directional aerials.

### Effect of the Lead-in

In the case of aerials not connected to the receiver or transmitter by means of special feeders, the lead-in must be considered as part of the aerial, and must be allowed for in computing the length of the aerial wire. It might also be necessary to make allowance for the coupling coil used between the aerial and earth, as shown in Fig. 3. In this case, it is assumed that a quarter-wave vertical aerial is employed, and that it is coupled to the receiver or transmitter through a small coil coupled to the input or output coil. The coil, even though it will probably have only a few turns, has inductance and capacitance of its own, and these are added to the inductance and capacitance of the aerial-earth system itself.

The "quarter-wave" aerial must therefore be less than a quarter-wavelength long. One method of counteracting the effect of the coil is by connecting a variable condenser in series with the lead-in, as also shown in Fig. 3. It will be remembered that whereas the reactance of an inductance is positive in sign, the reactance of a condenser is negative. Consequently, by placing the two in series the reactance of the inductance may be balanced out. Because of this, the coil will not affect the resonant length of the aerial, which can therefore be one-quarter-wave long—or, more correctly, slightly less than this to make allowance for the end effect, which has already been discussed.

### Aerial Feeders

In considering receiving aerials it is usual to regard the lead-in as part of the aerial, which it really is. But in the case of a transmitting aerial—and also of many receiving aerials required to be of high efficiency or to be insensitive to local or man-made static—the lead-in is replaced by a feeder. This feeder is a lead-in, in that it is used to connect the aerial to the transmitter or receiver, but it does not constitute a part of the aerial. The reason is that care is taken that it shall not be capable of radiating, or of picking-up, any signal. Particularly in the case of a transmitter, the feeder is often used as a matching device, in the same manner that an iron-cored transformer is used to match the output stage of a receiver to the speaker.

### Resonant and Untuned Lines

Feeders are of two main types: tuned or resonant, and untuned or non-resonant. A tuned feeder is one

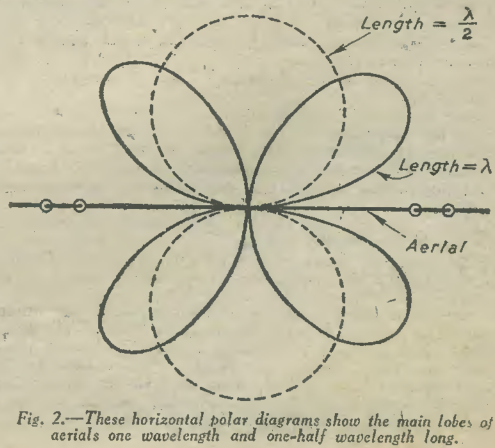



*Fig. 2.—These horizontal polar diagrams show the main lobes of aerials one wavelength and one-half wavelength long.*

which is a certain number of quarter-waves in length, while one of the untuned type may be of any length; excepting, of course, that there is bound to be a certain loss when the feeder exceeds a few-hundred feet, unless somewhat elaborate precautions are taken. In the case of non-resonant feeders, there are both open-wire and co-axial types; resonant feeders are normally of open-wire construction.

As the name suggests, an open-wire feeder consists of two wires, arranged parallel to each other, leading from the aerial to the fixed equipment. Due to the wires being parallel and of accurate length, radiation does not take place from them because it is arranged that any standing waves which might lie along the feeders are of opposite phase at any point along the feeder, and so cancel out. Although it would appear to be a perfectly simple matter to take a couple of lengths of bare wire and run them between insulators placed on short poles, there are several points which call for special attention in designing these open-wire feeders. One point is that the two wires must be of precisely the same length; thus the inner one must be slightly looped when the feeder is taken round a curve or corner. Another is that the feeders must be insulated with just as much care as is given to insulating the aerial. A third is that, in the case of non-resonant lines, the

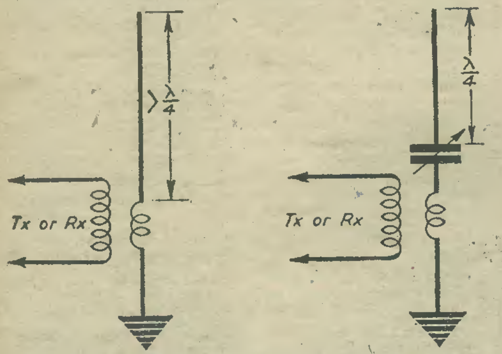



*Fig. 3.—When using the circuit shown on the left the aerial must be less than quarter wave because of the inductance in series with it. The effect of the series inductance is balanced out in the circuit shown on the right by means of a series condenser.*

actual impedance of the feeder is governed not only by the distance apart of the two wires, but also by the diameter of the wire employed.

**Surge Impedance**

It is possible to obtain from various text books and books of tables details of wire diameter and spacing for any particular "characteristic impedance" or "surge impedance," but the formula from which the data is derived is:

$$Z_0 = 276 \log_{10}\frac{2S}{D}$$

where $Z_0$ is the characteristic impedance, S is the distance between the centres of the feeder wires and D is the diameter of the wires. It will be understood that D and S must be in the same units (generally inches). As an example of the results to be obtained from this formula, it may be pointed out that an impedance of 600 ohms (the value most often used because of its convenience) can be obtained by using two 18 s.w.g. wires spaced by approximately 4in., by using two 16 s.w.g. wires spaced by 5in., or by using to 12 s.w.g. wires spaced by 8in. For all low-power working the thinner of the wires mentioned will prove most convenient, but for a transmitter rated at 5-10 kW. it would be necessary to use 10 or even 8 s.w.g. feeder lines, when the correct spacing would be 10in. and approximately 12½in. respectively.

The question of surge impedance or characteristic impedance often causes confusion if the principles are not clearly grasped. It is argued that you cannot speak of impedance unless you first state the length of the feeder under consideration. But if two parallel wires are erected away from the ground they exhibit the properties of distributed inductance and capacity, and hence of impedance. And provided that the wires are the same distance apart and at the same distance from earth throughout their length, the impedance must be the same at any point along them. It is this value of impedance which is referred to as the surge or characteristic impedance.

**Concentric Feeders**

Before examining the question to find how use is made of this property in order to obtain correct matching between aerial and transmitter, it will be well to consider other types of non-resonant feeder. Co-axial or concentric feeder is one variety which is widely used because of its convenience, and also because it can, if suitably made, be buried. This kind of feeder consists, essentially, of one conductor placed inside another of cylindrical form. The two are insulated from each other, and the outer tubular conductor is earthed. In this case the impedance is governed by the ratio between the outside diameter of the inner conductor and the inside diameter of the outer conductor; these two dimensions are shown as d and D in Fig. 4. The relevant formula is:

$$Z_0 = 138.5 \log_{10}\frac{D}{d}$$

but one buys this form of feeder by specifying the required impedance. As a matter of interest, the characteristic impedance is about 90 ohms when the diameter ratio is as 5 to 1.

The concentric or co-axial type of feeder is not balanced, since the two conductors are of different form. This is not normally a disadvantage, due to the outer one being earthed. The concentric feeder has the advantage that radiation from it is practically impossible due to the screening effect of the outer conductor.

**Twisted-wire Feeders**

Another form of non-resonant feeder, which is balanced, is that known as the twisted-wire or parallel-wire type. In this case, two insulated wires are simply twisted together, or run parallel to each other inside an outer insulating case. The surge impedance varies with the diameter of the wires used and the quality of the insulation, and no simple formula can be produced. Feeders of this pattern, however, are sold according to their impedance, and this is often marked on them. In general, the figure varies between about 30 and 80 ohms.

With certain types of aerial it is possible to employ a single-wire feeder and to obtain the requisite matching by arranging that this is connected to the aerial itself at a certain point. Practical details of the manner in which the various types of feeder are employed must be left to the next article in this series.

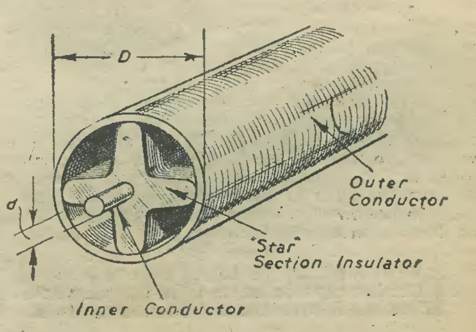



*Fig. 4.—Section through a concentric or co-axial feeder.*

# A One-valve Midget Receiver

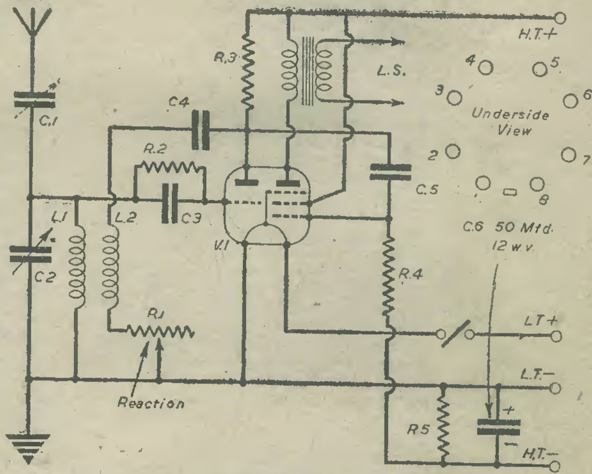
## Constructional Details of a Compact Portable Set

THIS efficient one-valve midget receiver measures externally only 6⅞in. by 4in. by 3½in. Two views of the complete receiver are shown on the cover, and the circuit is shown to the right.

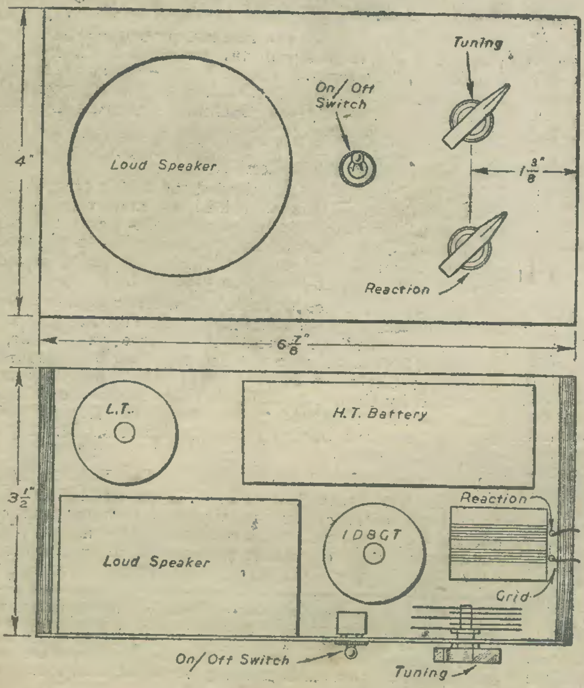
The front and back of the case are of sheet metal, and the remainder of ¼in. three-ply covered with Rexine. The aerial consists of 50 turns of 42 s.w.g. wound under the Rexine. A carrying handle is attached to the top of the case. The output transformer is mounted on the back of the reaction control, and the other components are all mounted on the case with the exception of C6, which is mounted between the H.T. and L.T. batteries. The coil is supported on a small metal bracket held by the same bolts which secure the output transformer, and the valve holder is supported on a metal bracket bolted to the front panel.

A U-shaped clip bolted to the back secures the L.T. battery, whilst the H.T. battery is held to the back by clips and two rubber bands. The L.T. consists of a 1½ volt torch cell and the H.T. a 67½ volt Ever Ready No. 26 battery.

The Home, Forces and European News are easily received on a small throw-out aerial about 10ft. long. The output is 100 mW.




*Theoretical circuit of the one-valve midget receiver. (Inset) Valve base connections.*




*Front view of panel, and layout of components.*

### COMPONENTS

C1 0.50 mmfd. pre-set.
C2 .0005 mfd. variable (mica di-electric type).
C3 .0003 mfd.
C5 .001 mfd.
C6 50 mfd., 12 w.v. (electrolytic).
R1 0-5,000 ohms.
R2 1 megohm.
R3 250,000 ohms.
R4 500,000 ohms.
R5 1,500 ohms.
V1 1D8GT.
L.S. 3½in. permanent magnet.
L1 35 turns 42 s.w.g. close wound on 1¼in. former.
L2 70 turns 42 s.w.g. close wound on 1¼in. former.
International octal valve socket.

# F.-M. Broadcasting in U.S.A.

## Plans for a Nation-wide Service

ACCORDING to an official American publication, more than 100 school systems and colleges and universities have within the past six months applied to the Federal Communications Commission either for licences or necessary application forms, thus taking the first steps toward obtaining their own F.-M. radio broadcasting stations.*

At least 15 States are actively engaged in planning State-wide service through federations of school and college-owned F.-M. stations. Fifty-five State universities and colleges in 40 States have named staff members to follow F.-M. developments and make recommendations.

Growing recognition that radio—and in particular the F.-M. educationally owned and operated station—presents one of the brightest hopes on the post-war horizon stimulates this trend. F.C.C. Chairman Fly's warning that education should "get busy" and occupy its "home of its own on the air" has been heeded. So also has the resolution of the chief State school officers that "careful study be given in the several States toward the development of suitable plans for balanced State-wide utilisation of frequency-modulation radio broadcasting channels set aside for education."

Education's air "home" consists of five channels between 42,000 and 43,000 cycles. Originally allocated in 1938 at the request of the U.S. Commissioner of Education John W. Studebaker, supported by more than 300 educational leaders, "education's megacycle" was reclassified for F.-M. broadcasting in 1940.

### Aids Listed

Many educators who have their eyes on the future are asking for information and guidance on F.-M. To help them, the U.S. Office of Education's Radio Service has developed numerous aids. Here are a few on hand or in prospect.

"F.-M. for Education," a bulletin now nearly ready for the Government Printing Office. It explains the nature of the F.-M. education band, budgets the cost of transmitters, studios and personnel, describes a wide variety of educational programmes of proven worth, and outlines the steps to take to acquire an F.-M. licence.

Another project has been approved for preparation of a guide to architects and school-building planners. This will suggest minimum essentials of equipment for use of radio and motion-picture aids to education in modern schoolhouse construction or reconstruction.

### Free Literature

Free reprints: *General:* "Education's Megacycle, Parts I and II"; "F.-M. Radio for Education Urged—James L. Fly Points to School Opportunity"; "F.-M. Broadcasting and Education"; "Uses Schools are Already Making of Audio Devices," and "Report to the F.R.E.C.—Progress in Stimulating Interest in F.-M. for Education." *Technical:* "F.-M. Broadcast Station Costs in Terms of Service-area Radius"; "Estimated Cost of Constructing an Educational F.-M. Broadcast Station"; "250-watt F.-M. Transmitter Coverage—by Antenna Types," and "1,000-watt F-M. Transmitter Coverage—by Antenna Types."

Coverage and cost tables: Graphs and tables, supplied free, enable local school authorities to make rough determinations of such factors as coverage, antenna height, antenna design, signal strength, and costs.

State plans: Use of the five channels now allocated to education requires careful planning to assure equal opportunity for educational radio service. State planning, therefore, is highly desirable. U.S. Office of Education specialists have already prepared State educational radio network plans for Michigan, Ohio, New Jersey, Louisiana, Connecticut, and Massachusetts. Work is under way on radio maps for Tennessee, Maryland, and certain other States which have asked for this service. In Michigan 40 school board and higher education representatives met on February 2nd in State Superintendent Elliott's office to develop a Michigan F.-M. plan.

### Technicians for Field Service

Field service: Office of Education staff technicians are available for limited field service. Because of personnel and travel fund limitations, the Radio Service prefers to work with regional conferences. Such a conference was held in New York on January 26th for representatives of eight seaboard States. These States have agreed to work out F.-M. plans and then in a subsequent conference adjust their plans to regional necessities.

F.C.C. liaison: The Office of Education maintains close relations with the Federal Communications Commission and offers its services in working out problems that may arise.

Industry contact: The Office of Education radio service also maintains close contact with radio manufacturers on problems of transmitting and receiving equipment for educational use.

Federal Radio Education Committee services: This Committee, composed of 14 educators and broadcasters, encourages the vigorous development of F.-M. for education. Over a period of eight years it has published many documents valuable for educational radio planning. (Catalogue free on request.) The monthly "F.R.E.C. Service Bulletin" is available free on request. At present an F.R.E.C. sub-committee is preparing suggested college standards for training for radio—both of station workers and teachers. The F.R.E.C. now issues monthly "Selected Radio Programmes for School Listening." More than 1,200 scripts and 250 transcriptions are available on loan through the F.R.E.C. sponsored Educational Script and Transcription Exchange operated by the Office of Education.

### New Wavelength Allocations

Wartime research has expanded the usable area of the radio spectrum. This will lead to new wavelength allocations for many purposes after the war. Indeed, the Federal Communications Commission has encouraged the formation of the Radio Technical Planning Board to give advice on re-allocation problems.

Expected expansion of radio's frontiers plus discovery that education's five-channel megacycle failed to provide enough "rooms" in education's "home on the air," prompted Commissioner Studebaker to send the following request to Chairman Fly. In this action he has been supported by the National Council of Chief State School Officers, the National Association of Educational Broadcasters, and other educational leaders. Mr. Fly's reply is also presented.

Both the National Association of Broadcasters and F.M.B.I., the organisation of F.-M. commercial interests, have been most cordial to vigorous development of educational stations. Their leaders see new F.-M. commercial and education stations both performing useful but sharply different services for communities.

* F.-M. stands for frequency-modulation broadcasting as contrasted with amplitude modulation or A.-M., now commonly employed in the standard broadcast band. Many hundreds of F.-M. commercial as well as educational stations will be erected after the war. Most receiving sets will be built to receive both A.-M. and F.-M.

# Practical Hints

## A Simple Tester

I OFTEN have the necessity for testing continuity in coils and wiring, etc., also testing for stray H.T. currents in the filament sockets of a valve holder, in a newly-built set, before plugging in expensive valves.

To facilitate this work I constructed the simple tester shown in the sketch. I mounted an ordinary bulb holder and wave-change switch on the top of a small cigar box, and sectioned off a small portion to contain a No. 8 battery. The wave-change switch connects either the battery in series with the bulb and test prods, or cuts out the battery. For testing continuity the battery is used, and if there is a circuit the bulb lights. For testing for stray H.T. currents in the filament sockets the prods are pushed in the sockets, with the switch cutting out the battery. If there is any strong H.T. current the bulb blows, thus saving valves.

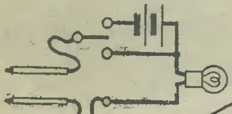
The test prods were made by pushing some rubber tubing over two 3in. nails.—J. R. HUMPHRIES (Ulverston).

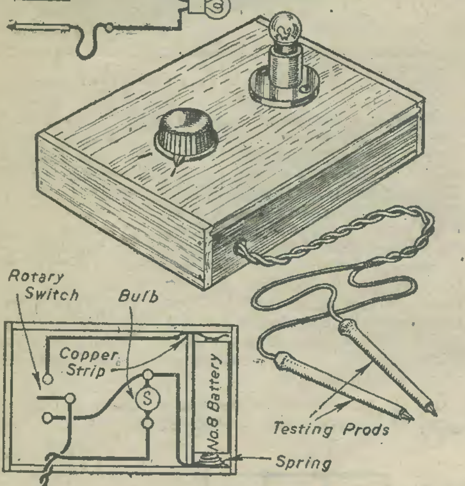
**THAT DODGE OF YOURS!**

Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Practical Hints."

**SPECIAL NOTICE**

All hints must be accompanied by the coupon cut from page iii of cover.

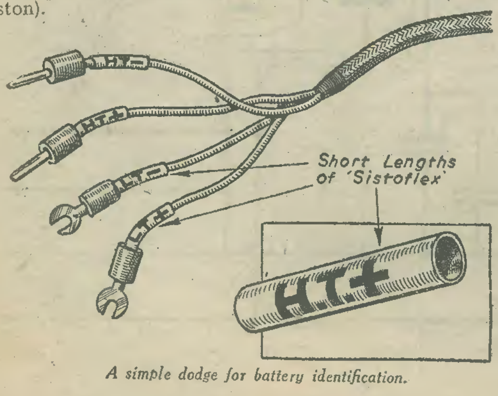





*A useful testing unit.*

## Battery Identification Labels

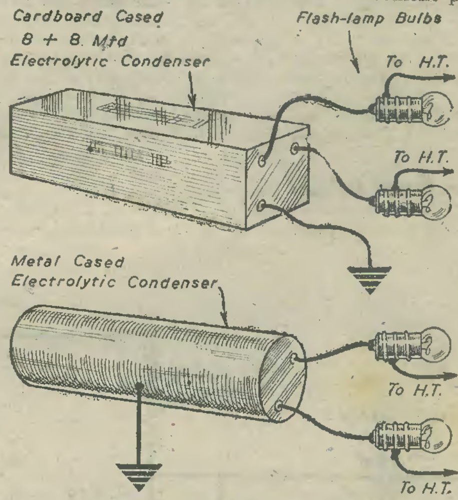
BEING unable to purchase any of the usual battery cord identification labels, I hit on the idea of using short lengths of sistoflex about ½in. long, upon which was indicated the battery, and polarity of the lead in Indian ink. The diameter of the sistoflex is such that it will fit snugly over the lead. This method of identification has the advantage of being smaller, and is flexible the same as the lead.—R. PEARCE (Swindon).




*A simple dodge for battery identification.*

## Preventing a "Burn Out"

A FAULT which is becoming more commonly heard of these days is a "burnt out" mains transformer. This, of course, is usually due to a faulty electrolytic smoothing condenser developing a "short circuit," thus overloading both rectifying valve and mains transformer. While one cannot prevent the fault developing on the condenser, protection of the transformer and valve can be provided as follows: Obtain two or three standard flash-lamp bulbs of either 3.5 volt or 6.5 volt .3 amp. rating and fit one of these in each high tension lead to the condenser. Trace these leads from the condenser and at the most convenient place cut each lead and solder one each to the lamp bulb tip, the other to the side of screwed cap, as shown in the sketch. Tape up all exposed metal to avoid contact with other parts of the wiring and chassis.

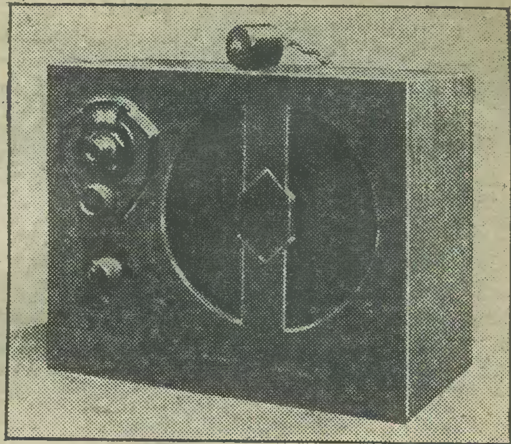



*Method of using lamp bulbs as fuses.*

On circuits where 8 mfd. condensers are installed a flash-lamp bulb of .150 amp. (150 milliamps) may be tried, but on larger condensers the .3 amp. (300 milliamps) is advised. I have fitted this idea to a few of my friends' commercial receivers as a result of proved tests, such as creating a short purposely. I find that these bulbs stand up to any surge which may be developed on switching in, and although in one or two cases a faint red glow of the bulb filament is noticed this does not affect the working of the receiver or the hum level.—E. COOMBES (Widnes).

# A Portable Three

### An Efficient Receiver Built Round Readily Available Components



*General view of The Portable Three.*

THIS set is small and is designed round parts that are not in short supply. It has an internal frame aerial and should give good speaker results in most parts of the country; it has been found satisfactory under quite adverse conditions.

The circuit is shown in Fig. 1. It is a detector-2 L.F. arrangement with pentode output. The medium waveband only is tuned.

The cabinet may be made of ⅜in. thick wood, varnished or covered with American cloth. Fig. 2 shows the size of the front of the cabinet; it is 6ins. deep. The back is removable, being secured by catches.

To commence construction, locate the parts as shown in the plan at Fig. 2. Place the valves in their holders to see that they can be accommodated. When all the components are satisfactorily located screw them down to the baseboard. In Fig. 2 the front of the cabinet is pictured flat with the baseboard to give a clear view of the assembly. The edge of the baseboard fits against the back of the panel; the L.F. and output valve then are each side of the speaker. If 5-pin holders are used for the Detector and L.F. valve, ignore the centre socket. Chassis valveholders could be used, mounting them above the baseboard by means of long screws and sleeves. Note that the grid bias lead from the .25 megohm leak is anchored to the baseboard with a small screw.

**The Frame Aerial**

The frame aerial is wound on strips of wood attached to the front of the cabinet. Two strips 8¾ins. long and two 10⅞ins. long are required; they are 2ins. wide. Take a 20ft. length of 24 s.w.g. enamelled wire and anchor the end by passing through small holes in the wood. Wind on the wire, keeping the turns side by side. The commencement of this winding (point 3) goes to the reaction condenser. Leave a space of about ¼in. and wind on 70ft. of the same wire, spacing the turns slightly; the end of this winding (point 1) goes to the grid condenser. The junction of the windings (point 2) goes to the filament line of the set. Fig. 2 makes the arrangement of the frame aerial clear. The leads from the frame aerial may conveniently be attached to the tuning and reaction condensers as shown, three flexible leads connecting the condensers to the other part of the set (see Fig. 2).

If an air-dielectric condenser small enough is to hand an improvement would result if it were used for

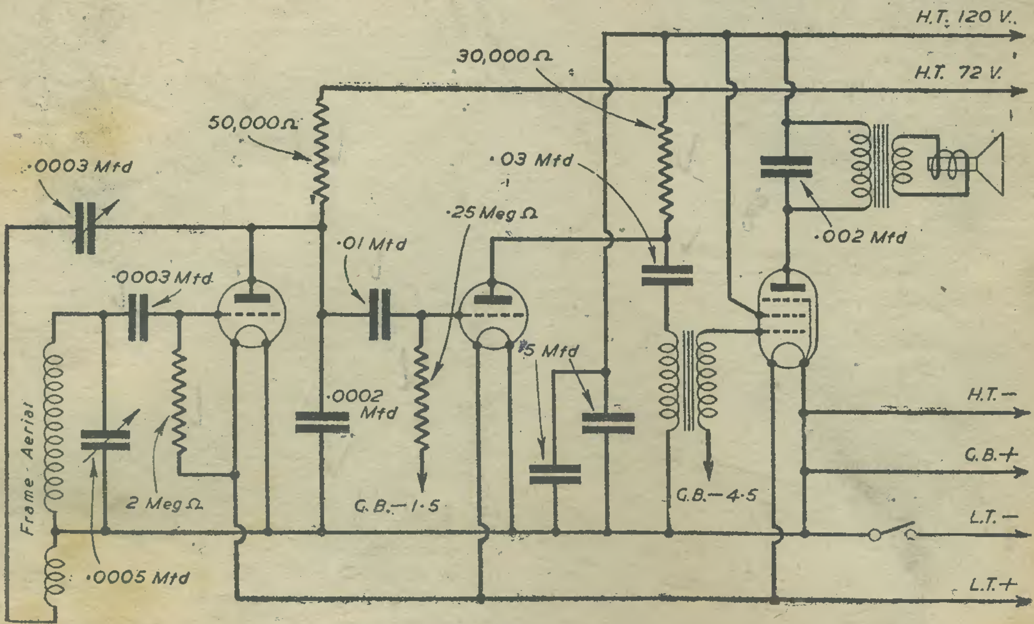



*Fig. 1.—Circuit diagram of The Portable Three.*

tuning. Otherwise a solid-dielectric one must be used. There is little space to spare in the case.

Two .5 mfd. condensers connected in parallel are used for decoupling. A small 1 mfd. component would be satisfactory.

Screw the speaker and output transformer to the back of the panel, taking care to leave room for the valves to be inserted.

As the set was largely used by an invalid in bed the on/off switch was of the enclosed "pear" type and was connected to the end of about 4ft. of twin flex. Alternately, there is room for a switch between the reaction condenser and speaker.

Batteries and accumulator are enclosed in the case behind the set. Suitable valve types are: Detector—Osram HL2/K; L.F.—Osram HL2/K or L21; Output—Osram PT2/K or Cossor 220HPT. It will be found that the set will give good results with a small power valve in the output stage instead of the pentode, and this modification may be preferred by some. In all cases, adjust the grid bias to the recommended values. H.T.72 (the lead from the detector) can be tried in various sockets to obtain best results. A model of this set was made with a moving-iron speaker; if to hand, this makes a lighter set.

Finally, note that in Fig. 2 the front of the set is shown slightly out of scale to save space.

## COMPONENTS

### LIST OF PARTS

| | |
|---|---|
| Fixed condensers: .0002, .0003, .002, .01 (mica), .03 (mica), 2.5 mfd.<br>Rola 5in. moving-coil speaker and pentode output transformer.<br>Three 5-pin valveholders.<br>Resistors: 2 megohm ½ watt; .25 megohm ½ watt; 30,000 ohm 1 watt; 50,000 ohm 1 watt.<br>Parafeed transformer, 1:4 ratio.<br>Small knob for ¼in. spindle. | Coulphone Radio. |
| On/off switch.<br>.0003 reaction condenser.<br>.0005 tuning condenser (solid dielectric).<br>Wire for frame aerial.<br>Large knob with scale or reduction drive; connecting wire, etc. | Premier Radio. |

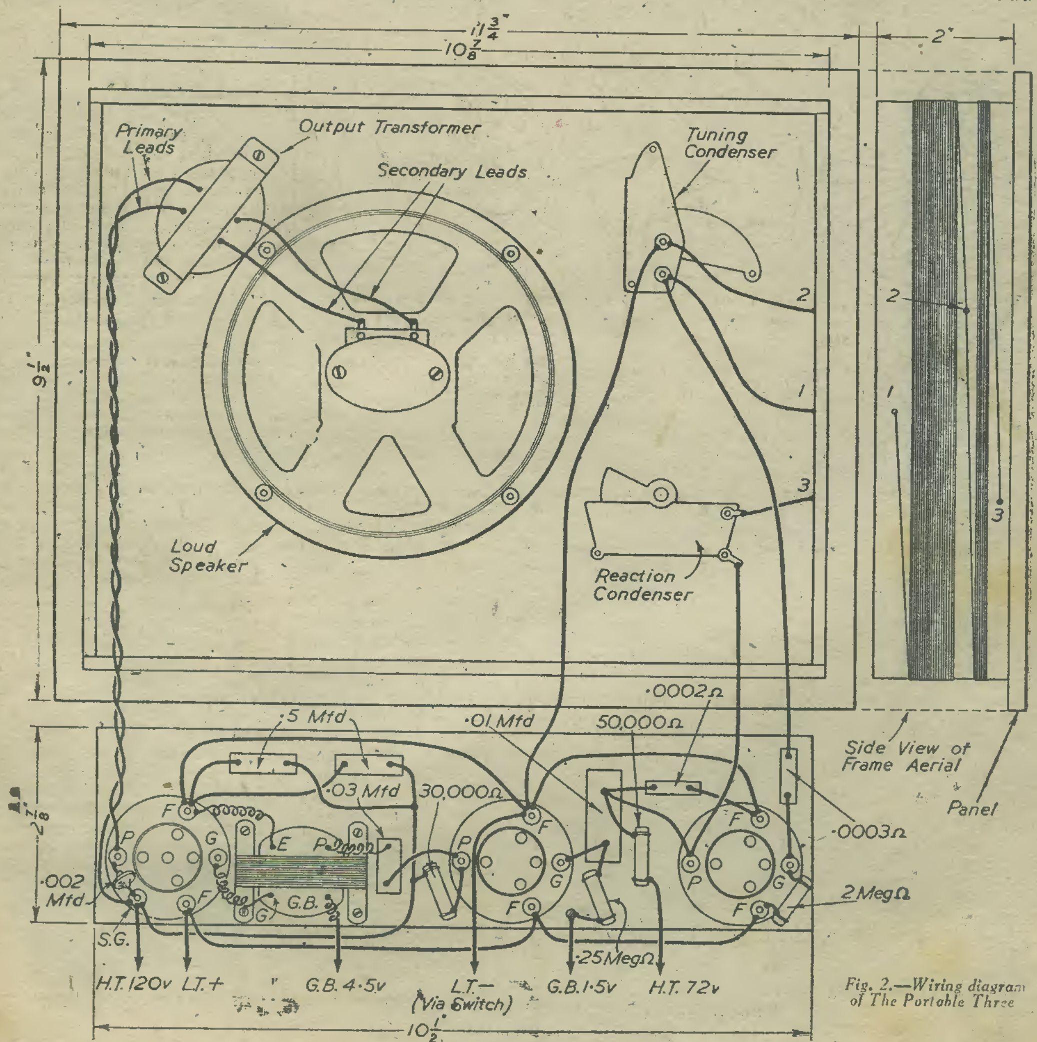



*Fig. 2.—Wiring diagram of The Portable Three*

# Generating Ultra-short Wave Oscillations

## Above 2,000 Megacycles the Electron is Too Slow! By S. A. KNIGHT

WHILE ordinary valve circuits, designed carefully for the job, can be made to function satisfactorily down to wavelengths of a metre or so, they become erratic at wavelengths below this, and are of no practical use for frequencies extending above 2,000 megacycles (about 15 centimetres wavelength). Limitations are imposed upon normal valve oscillators and amplifying stages at such frequencies as this, and render them incapable of producing such oscillations or of amplifying them.

Readers who have experimented with ultra-short wave design, will realise the great effect the inductance of valve output leads and interelectrode capacities can have on the performance of an oscillator. As the wavelength gets shorter and shorter, so do these effects become greater and greater; finally, a point is reached where lead inductance and valve capacities form an oscillatory circuit of their own, and entirely destroy the work of any externally tuned circuit.

While these effects are extremely desirable in themselves, by far the most serious consideration is, however, the effect of the finite time taken for an electron to travel from the cathode of a valve across to the anode under the influence of the anode potential, i.e., the transit-time, as it is called. It is possible to show with frequencies in excess of about 2,000 megacycles per second that the transit-time is approximately equal to the periodic time of the oscillations. This effect leads to a grid input impedance of an extremely low value (input impedance is proportional to $1/f^2$), and so the damping effect of the valve or a previous stage is such that its amplification reduces to some figure less than unity, thus rendering amplification at such frequencies impossible.

Due also to the transit-time, itself dependen upon the anode voltage, there is a difference of phase between the grid input and the anode output, which will vary with the anode potential. This, together with the difficulty of energy transfer from the anode to grid circuits and the low input impedance rules out finally the use of the ordinary valve technique for V.H.F work.

The main types of oscillators used for the production of centimeter waves have been the magnetron, and the Backhausen-Kurz oscillator where the grid is maintained at a high positive potential in relation to the anode and cathode. We are not so much concerned with this latter oscillator, as with the magnetron which employs rather unique features in its operation, and is fast becoming the basic valve for this work.

In order to study the general theory of the magnetron it will be necessary for us to appreciate the effect that a magnetic field has upon the functioning of an ordinary valve.

**Basic Magnetron**

Consider a simple diode having a thin cathode surrounded uniformly by a cylindrical anode. Under normal working conditions, when the cathode is appropriately heated and the anode carries a positive potential, electrons leave the cathode and proceed radially, like the spokes of a wheel, across to the anode. The number of electrons passing across is decided by the potential present upon the anode; by varying this potential the current flowing in the plate external circuit may be decided. (Fig 1.)

Now let a magnetic field, of variable intensity, be introduced, such that its influence extends along the axis of the diode. It will now be found that, under the influence of the magnetic as well as the electrostatic fields, the path followed by the electron is no longer the direct one from cathode to anode, but is curved as is shown in Fig. 2(a). It is possible to show that the track of the electron is a circular one, and, for a given anode voltage, the radius of the circle is inversely proportional to the magnetic field intensity H. In practice, the true circular path is modified slightly by the effect of the space charge surrounding the cathode and the effect of the magnetic field upon this space charge; however, it is slight, and will not affect the arguments to follow.

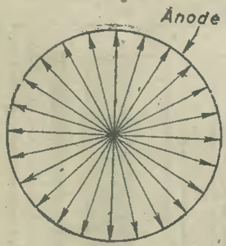



*Fig. 1.—The radial tracks of electrons moving from cathode to anode in a simple diode.*

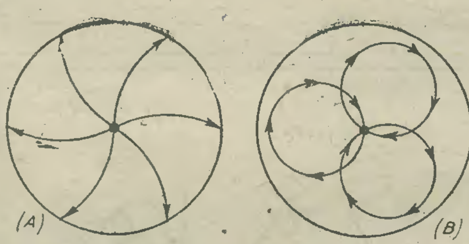



*Fig. 2.—How a magnetic field modifies the electron track and prevents the electrons reaching the anode after a certain limit.*

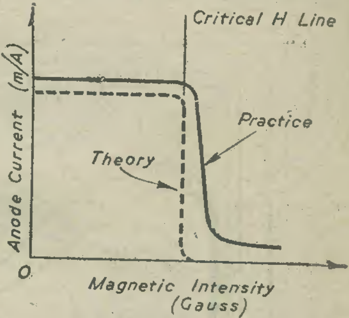



*Fig. 3.—The sharp fall in anode current as the critical H is reached.*

As the field intensity is increased, so does the radius of the electron track decrease; finally, a field value is reached where the diameter of the electron path is less than the radius of the cylindrical anode. The electron is then moving round in a circle without reaching the anode, i.e., the valve is cut-off by the intensity of the magnetic field. (Fig. 2(b).)

Between the limits of the field giving the results of Fig. 2 (a) and (b) there is a critical value for which the electron is just "brushing" the anode. Small variations in the magnetic field at this point will bring about quite large changes in anode current; a slight increase will cut the valve current to zero. Let the value of the critical field be H, let the anode volts be V, and let the radius of the anode be r centimetres. Then—

H varies as $1/r$.

$H = k/r$.

where k is a constant.

It can be shown that for critical cut-off

$$H = \frac{6.72\sqrt{V}}{r} \text{ gauss.}$$

**Anode Current—Field Variations**

If a graph is plotted to show the effect of an increasing magnetic field upon the anode current, a result something similar to that shown in Fig. 3 will be obtained. The general practical curve, shown as a full line will be seen to fall away very rapidly as the critical field value H is reached, though it is not so sharp as the curve obtained by theoretical reasoning, which is shown as a dotted line on the same graph.

This discrepancy is due mainly to mechanical factors in the construction of the valve; if the magnetic field is not absolutely parallel with the anode axis a rounding and flattening of the curve will result, as it will if the cathode is not accurately centralised throughout the anode. Electrical irregularities, such as voltage variations along the heater, and different emission velocities of the electrons, modify the sharp theoretical curve to the rounded practical one.

It will be appreciated, however, that an extremely critical control of anode current may be obtained by fine variations in the magnetic field.

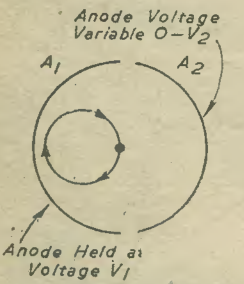



*Fig. 4.—When $V_2 = V_1$ the split anode magnetron is cut off and the electron path is circular.*

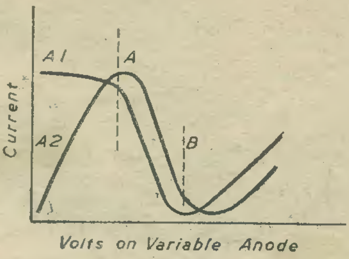



*Fig. 5.—The graph of anode current against anode volts for the split anode magnetron, showing the region of negative resistance.*

**The Magnetron Oscillator**

Before proceeding further the reader must realise the following fact as the basic requirement for the production of sustained oscillations in an electrical circuit. If a resonant circuit is completely free from losses, a current once started in it will continue to flow backwards and forwards indefinitely, i.e., sustained oscillations will occur. In practice, since any circuit has losses, the above ideal condition is simulated by cancelling its actual resistance by inserting an equal or greater (preferably greater) amount of *negative resistance.* Negative resistance is exhibited by any device showing an increase of current when the applied voltage is decreased or vice versa, i.e., a screened-grid valve, once secondary emission has come into play, will show a decrease in anode current for a rise in anode voltage. Any valve showing the properties of negative resistance in this way is capable of functioning as an oscillator when joined to a resonant circuit of sufficient dynamic resistance.

A diode, such as was recently described, under the influence of an axial magnetic field, and having its anode divided into segments, will function as an oscillator and will generate extremely minute waves. There are three accepted methods in which the oscillations may be produced; they will be treated separately here, though the reader is reminded that the theory of them is not even now completely understood and that the dividing line between the various methods is not so clearly defined as the article suggests.

(1) The dynatron method. Here the magnetic field is maintained at its cut-off value or beyond. The frequency of the oscillation produced depends upon the field strengths employed, the size of the tube and the external resonant circuit. The transit-time limits the upper frequency of oscillation.

(2) The resonance method. Here the magnetic field is maintained beyond cut-off values. The frequency of the oscillation produced does not depend particularly upon the external resonant circuit; it does depend, however, upon the valve dimensions and the field strengths, and for a given set of conditions,

$$\text{frequency} = \frac{VN\,10^8}{\pi r^2 H}$$

where V, r and H have the same meanings as before and N is the number of segments into which the anode is divided. The only frequency limit is the upper one in the region of 3,000 megacycles (10 cms.).

(3) The electron method. Here the magnetic field is maintained in the region of its cut-off value. The frequency of the produced oscillation is independent of the external circuits and has an upper limit only of about 3,000 megacycles.

We shall now briefly discuss the characteristics of each of these three methods.

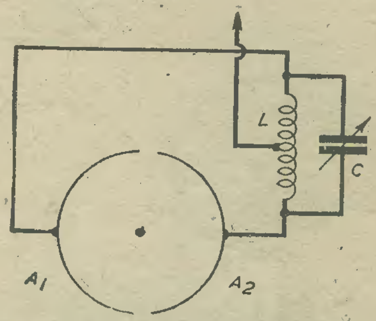



*Fig. 6.—The external resonant circuit connected to the magnetron. This is the dynatron mode.*

**The Dynatron Method**

This method may best be studied by a consideration of a diode in which the anode is split into two equal parts along its length. In magnetron work the anode is invariably split into at least two segments so that a tuned circuit may be connected. Suppose (Fig. 4) that one segment of the anode is held at a potential $V_1$, while the potential on the other is variable between zero and some value $V_2$ which is greater than $V_1$. Also, let the axial magnetic field threading the system be of such a magnitude that it would cut-off the anode current if both sections were at a potential $V_1$. When the potential on the variable anode is zero the electric field overcomes the magnetic effect and a large number of electrons will move across the interelectrode space to the fixed anode. The zero potential anode will receive only a few, if any, electrons, and the current flowing from it will be negligible.

If the potential on the variable anode is now slowly increased the magnetic field begins to make itself evident, and a current begins to flow in the variable anode circuit at the expense of the current in the fixed anode circuit. The nearer $V_2$ gets to $V_1$ so does the anode current of both segments fall; when $V_2$ is equal to $V_1$ the valve will be in the condition of cut-off. Electrons will then be following closed circular tracks as Fig. 4 illustrates, and missing the anodes completely. Should $V_2$ be increased to a value greater than $V_1$, the electric field again overcomes the magnetic effect and a current begins to flow in both segments of the anode. The variable anode will now draw the greatest current, of course, since it is at the greatest potential.

A graph of anode current (for each segment) against anode voltages will appear somewhat as depicted in Fig. 5.

This graph is important because it shows us that between the points A and B approximately, there is a region of negative resistance, i.e., an increase in anode voltage causes a decrease in anode current.

Within limits, in practice, the current which flows to the lower potential segment is greater than the current which flows to the higher potential segment, the extent of this negative resistance effect being increased by a step up in magnetic intensity. A tuned circuit connected, as is shown in Fig. 6, will form with the dynatron method of magnetron technique, an oscillatory system capable of generating and sustaining oscillations. A high value of field intensity will cause the current to flow only on the oscillation peaks and a Class C push-pull type of oscillator is produced.

The dynatron method will not generate waves whose periodic time is comparable with the transit-time of the electrons.

**The Resonance Method**

The dynatron method just discussed depended for its frequendy of operation upon nothing particularly associated with the field intensities; provided that the

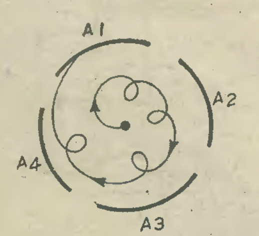



*Fig. 7.—The cycloid track of an electron under the influence of an alternating p.d. and anode gaps. This is the resonence method of oscillation production.*

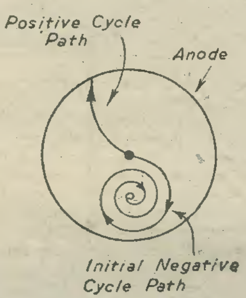



*Fig. 8.—How an electron moves, depending upon whether it is emitted during a positive half cycle on the anode or a negative half cycle. This is the electron method of oscillation production.*

magnetic field was so chosen to exceed cut-off, the frequency generated was solely decided by the tuned circuit, and alterations in the frequency did not necessarily mean alterations in the field intensity.

In the case of the resonance method of magnetron work the external circuit does not have a large effect upon the frequency of operation, though the field strength does. As the formula

$$\text{frequency} = \frac{VN\ 10^8}{\pi\ r^2 H}$$

shows, the frequency of operation is given optimumably for the particular conditions of a given magnetron and only a slight variation in the tuning of the external resonance circuit is necessary to cause oscillations to cease.

The theory of the resonance magnetron is rather complex, but it may be considered at its simplest in this way. If a cylindrical anode is split into a number of sections, say four as shown in Fig. 7, and an alternating voltage is applied to them in such a way that an electron on its normal circular course from cathode to cathode is deflected in turn by each anode gap from this circular course, then a condition is set up whereby micro-wave oscillations may be produced and maintained.

The anodes are normally set with the magnetic field so that the valve is beyond cut-off and so the normal electron path will be substantially circular. When subjected to the alternating voltage on the anode segments it appears that in passing any of the gaps an electron is decelerated and deflected in the direction of the anode at the lower potential (on the A.C. cycle). Conditions are arranged so that the electron does not immediately strike this anode, otherwise dynatron oscillations will occur. Instead, the deflection suffered is not sufficient for the electron to arrive at an anode and it will begin to diverge again towards the cathode. It is prevented from doing this by the various anode alternations and the effect of passing across the gaps; its final track will be as shown in Fig. 7, where, after a large number of deflections its loss of energy compels it to fall to one of the anodes. By the actual observation of ionised electron tracks in a magnetron containing a trace of gas this theory is substantially correct.

The alternating anode voltage must be of such a frequency that the electron path is of this nature. The resonant condition of a magnetron working in this way exhibits the properties of a normal series circuit, except that all resistive and reactive elements are negative in design.

The frequency generated has an upper limit of about 3,300 megacycles (9 cms.).

Since frequency = velocity ÷ wavelength, we may write the previous formula in terms of wavelength, thus

$$\text{wavelength}\ \lambda = \frac{pr^2\ H}{VN\ 10^8}$$

where p = velocity of propogation.

Thus we see that $\lambda$ is proportional to the square of the anode radius and inversely proportional to the number of anode segments. Therefore, for very short wavelengths, a small anode radius and a large number of anode segments are the order of the day.

A limit is reached when the smallness of the anode and the large number of segments makes power dissipation difficult.

**The Electron Method**

With this method the wavelength produced can be as low as 10 cms. and it is independent of external circuit conditions. As previously stated, the intensity of the magnetic field is such that the valve is maintained in the region of cut-off; also the angle at which the field is set in relation to the axis of the anode is critical and is not zero. Anode gap width has no effect upon the functioning of the system, and the maintenance of oscillations seems to depend upon the energy transferred from the space electrons to the anodes rather than the material flow of electrons themselves.

We will consider the electron method in the light of a valve with an unsplit anode (Fig. 8), since gap width has no effect upon the efficiency of the system. The anode is held at a steady potential and the magnetic field is adjusted to just beyond cut-off so that the electron path is circular.

An alternating p.d. of the electronic frequency is now superimposed upon the steady anode potential so that it alternates above and below the critical value of the cut-off, i.e., in the positive direction overcomes the balancing effect of the axial magnetic field. If an electron leaves the cathode during the positive half-cycle when the magnetic field is overcome it will move directly to the anode and give up its energy as heat. If an electron leaves the cathode during a negative half-cycle when the magnetic field is sufficiently on top to hold the valve in the condition of cut-off, it will spend the time of the half-cycle period in describing part of the circular path. As it is on its way back to the cathode after completing part of the circuit the anode alternation will begin to run again positive with the result that the electron will again begin to swing outwards. This process will continue for several alternations of the anode and throughout the period the electron will be *handing energy to the anode circuit,* since at any instant of its travel the anode alternations will be such as to oppose its radial motion. As shown in Fig. 8, the path of the electron is neither a circle nor a gradual cathode-to-anode curve; it is in the form of a closing spiral. As the electron approaches the centre of the spiral it moves more and more in a region where the potential is constant (potential gradient being considered from cathode to anode) and the speed of its rotation increases. Thus the phase of the spiralling electrons, which are the useful ones, changes more and more continuously with the anode alternations until a point is reached where *energy is abstracted by the electrons from the anode circuit.*

*(To be continued)*

# Radio Examination Papers—34

Another Selection of Questions, With Suitable Answers by THE EXPERIMENTERS

**QUESTIONS**

1. *Draw a circuit diagram of a crystal-controlled I.F. amplifier stage, and give brief details of it.*
2. *Explain the meaning of positive and negative reactance, giving an example of a circuit in which these two properties occur.*
3. *Describe a simple field strength meter.*
4. *What is an artificial aerial, or dummy aerial? When is it used?*
5. *What is a D.C. amplifier, and for what purpose is it employed?*

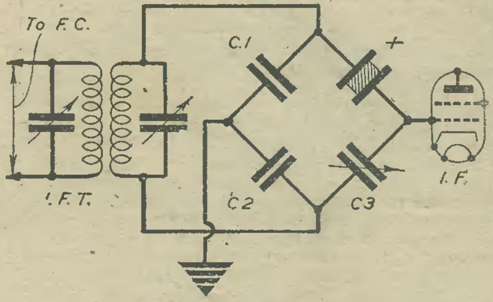



*Fig. 1.—A simple type of crystal gate used between the frequency changer and first I.F. stage of a superhet.*

**1. Crystal-controlled I.F.**

THERE are various ways of connecting a quartz crystal in an I.F. amplifier circuit to control the frequency and act as a "gate," but one of the simplest arrangements is that shown in Fig. 1. In general, a crystal "gate" of this kind is used only for C.W. reception when an extremely high degree of selectivity is required. It is possible, however, to modify the arrangement to a certain extent in order that variable selectivity is obtained by means of a multi-way switch.

The circuit is not drawn in the form that it is generally seen, but has been arranged to emphasise the fact that the crystal is connected in a capacity-bridge system. Condensers C.1 and C.2 are fixed and are of equal capacity (a value of .0001 mfd. is usual in an I.F. amplifier for operation on about 465 kc/s), whilst C.3 is a variable condenser and described as a "phasing control." Its value is dependent upon the crystal and holder employed; the capacity would usually be in the region of 25 m.mfd. maximum.

The crystal gate is usually wired between the first detector or frequency changer and the first I.F. stage, where it exerts the maximum controlling effect. It will be seen that the output from the secondary winding of the I.F. transformer is applied between two opposite corners of the bridge, whilst the I.F. amplifier is fed from the two other corners. In use, the phasing condenser is adjusted so that the bridge becomes balanced; space does not permit a full explanation of the procedure which is followed.

Crystal-controlled I.F. amplifiers are not to be found on broadcast receivers, being mainly confined in application to communication receivers intended for C.W. reception, often in poor conditions of reception. A switch is frequently fitted to cut out the crystal circuit for telephony reception. The switch short-circuits the crystal itself and at the same time breaks the connection between the phasing condenser and the bottom corner of the bridge.

It would be possible to eliminate condensers C.1 and C.2 by taking the earth connection to a centre tap on the I.F. transformer secondary. This method is seldom satisfactory, however, in view of the extreme difficulty in finding the electrical centre with the degree of accuracy which is necessary. In some cases, C.1 and C.2 are pre-set variables so that the electrostatic centre tap can be found with greater accuracy.

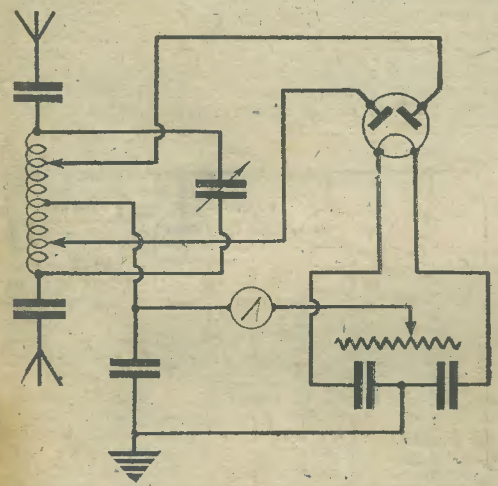


*Fig. 2.—A type of field-strength meter, the use of which depends upon the measurement of the rectified output from a double diode.*

**2. Positive and Negative Reactance**

IT may be argued that the question is badly expressed, and that there is no question of sign when dealing with reactance. The reactance of an inductance, for example, is a certain value in ohms, and the reactance of a condenser is also a definite value in ohms. In both cases the reactance is real or positive.

But it will be remembered that when an alternating voltage is applied across an inductance, the current through the inductance lags 90 degrees behind the applied voltage. Similarly, in the case of a condenser, the current leads the voltage by 90 degrees. In further explanation it may be pointed out that the instantaneous current passing through an inductance reaches a maximum one-quarter cycle after the alternating voltage has reached its maximum. With a condenser, the current reaches its maximum value one-quarter of a cycle before the alternating voltage attains a maximum value.

It will be seen, therefore, that if an inductance is connected in series with a condenser across a source of alternating current, the two reactances tend to cancel each other. Values of inductance and capacitance can, in fact, be found so that there will be complete cancellation. In that circumstance, the overall impedance of the circuit (neglecting resistance) will be zero.

Thus, in order to ascertain the impedance of a series oscillatory circuit the reactance of the condenser is subtracted from that of the inductance. For that reason, capacitive reactance is often referred to as negative.

Use is made of this principle in the acceptor-circuit type of wave-trap as used to eliminate interference from

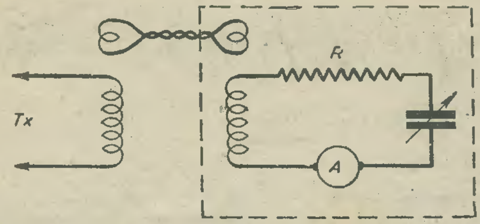



*Fig. 3.—A form of dummy aerial consisting of a coil, resistor, tuning condenser and thermo-ammeter enclosed in a metal box. The screening box is indicated by broken lines.*

a transmitter on a certain frequency. A series circuit tuned to the frequency of the unwanted transmission is connected in parallel with the input tuning circuit of the receiver. The principle is also used when it is desired that the added reactance of the aerial shall not affect tuning of the aerial circuit; the aerial is connected to the tuning coil through a fixed or variable condenser.

### 3. Field Strength Measuremen[t]

THE field strength around a transmitting aerial can be measured in finite terms of microvolts per metre, but it is more usual to take only comparative measurements. Thus, the requirement is to compare the strength of the signal radiated by the aerial at different points around the aerial—generally points which are equidistant from the aerial.

It will be seen from this that the usual so-called field strength meter is nothing more than a simple type of receiver fitted with a milliammeter or micro-voltmeter which will indicate the relative input to the receiver via its aerial.

One type of field-strength meter would consist of an anode bend detector, with its tuning circuit and a small rod aerial. In the anode circuit of the valve would be a sensitive milliammeter; this would normally give a very low reading, and any rise in anode current would be that produced by rectification of signals picked up by the aerial. In the same way, use could be made of an ordinary receiver with A.V.C. and a visual tuning indicator. The change in reading on the indicator when the receiver were brought into tune with the transmitter would be an indication of the input to the aerial, and therefore of the field strength at the particular point at which the aerial was situated.

Another very stable type of field-strength meter is shown diagrammatically in Fig. 2. It will be seen that a double-diode is connected to a centre-tapped tuning coil to which are attached two short aerials to form a dipole. The diode anodes are tapped down the coil in order to reduce damping. A micro-ammeter or micro-voltmeter is connected between the centre-tap of the coil and an "artificial" centre-tap across the diode filament, to measure the rectified output from the valve. In practice, switched shunts would be connected across the meter so that the sensitivity of the instrument could be adjusted to suit the power of the transmitter being checked and also the distance of the meter from the transmitting aerial.

The aerials would be short rods, and the instrument would be mounted in a screened metal box to reduce hand-capacity effects when tuning. Values of condensers and inductance would be governed by the frequency range over which the instrument was to be used. The filament potentiometer would have a value of between 50 and 100 ohms.

### 4. Dummy Aerials

AN artificial or dummy aerial is, as the name implies, a device for simulating the properties of a normal elevated aerial. It is used when it is required to set up a transmitter without allowing it to radiate. Many readers will remember that, before the War, amateur transmitters were in two grades: those who had a "full" licence, and those who had a permit to use a transmitter on an artificial or non-radiating aerial only. Call-signs allocated to those permitted to use only an artificial aerial consisted of a figure followed by *three* letters; for example, 2BJO. "Full" licence-holders were given a single-figure-two-letter call-sign, such as 5VO.

An aerial has inductance, capacity and resistance. Consequently, a dummy aerial must have similar properties. One type of dummy aerial has the simple circuit shown within the broken lines in Fig. 3. The coil is tuned by a variable condenser, which is in series with a fixed resistor. In addition, an ammeter of the thermo-junction or hot-wire type is included in the circuit in order to take readings of the output from the transmitter while adjustments are being made.

The particular type of dummy aerial shown should be enclosed in a metal screening box, and coupled to the tank coil of the transmitter by two loops connected together by a twisted lead.

One of the simplest types of dummy aerial consists merely of an electric lamp, or of two or more lamps in parallel. An instrument of this kind is of greatest value when the transmitter is to be connected to a resonant aerial of known resistance. The lamps can be arranged to simulate the resistance of the aerial to be used.

### 5. The D.C. Amplifier

D.C. amplifiers are normally used when it is not required to amplify radio- or audio-frequencies, but when small rectified voltages have to be amplified in order to simplify their comparative measurement.

One method of using a D.C. amplifier is indicated by the circuit at Fig. 4. Here we have a back reference to the answer to question 4, because the resistance R.1 and condenser C.1 constitute a dummy aerial. With reference to question 2, it may be pointed out that C.1 is used to cancel out any inductive reactance of the resistance R.1, so that the impedance of the load is pure resistance and is constant over a range of frequencies.

The amplifier itself closely resembles the ordinary type of resistance-capacity-coupled amplifier, except that there is neither grid condenser nor cathode by-pass condenser. There is also a milliammeter in the cathode circuit to measure the H.T. current passing through the tetrode amplifier. It will be clear that the cathode current will vary with the rectified voltage (positive in polarity) applied to the control grid. This is the rectified output from the diode, which is, in turn, governed by the power applied to the dummy aerial.

Potentiometer R.2 would be pre-set after finding a setting such that the cathode current through the tetrode was well within the nominal rating, with R.4 set to about its midway position. The anode resistance R.4 would then be set so that the milliammeter gave a convenient reading in absence of a signal across the input points. Increase in cathode current with the application of a signal would be indicative of the power applied to the dummy load. It would be a fairly simple matter to draw curves to show power inputs in watts against meter readings.

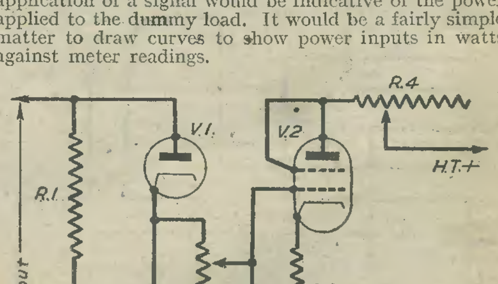



*Fig. 4.—In this circuit V.2 acts as a D.C. amplifier, and amplifies the rectified voltage applied to its grid from the diode rectifier V.1.*

# Direction Finding

## As Applied to Frame and Loop Aerial Systems

SOME issues ago, in an article on directive aerial systems, the directive properties exhibited by dipole arrays were discussed, and the manner in which these systems could be employed for the determination of the angle of elevation of a downcoming signal. We shall now consider the frame, or loop aerial systems, and the directive effects exhibited by these.

### General Theory

Anyone who has used a receiver employing an internal or external frame aerial will be acquainted with the directive properties shown by the receiver, that is, once tuned accurately to any broadcast, the signal strength will be varied as the frame aerial is rotated, a maximum strength being reached when the plane of the loop is in line with the direction of the transmitting station. When this plane is at right angles to the transmitter, a null point is reached, and signal strength falls, theoretically, to zero.

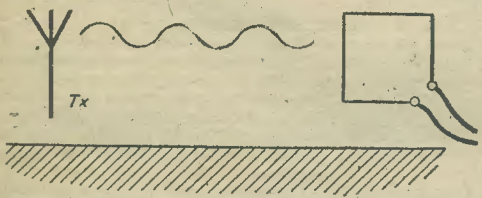



*Fig. 1.—A simple loop energised by a distant transmitter. This is the maximum signal position.*

In this necessarily brief survey it will first be preferable to consider the magnetic and electric fields produced at a point by the passage of electromagnetic waves. If at a point $P$ situated at some distance from an active transmitter $T$, an observer were to set up two recording instruments, one capable of indicating the presence of a magnetic field and the other capable of indicating the presence of an electric field, then he would record there:

(a) An alternating vertical electric field.

(b) An alternating horizontal magnetic field, this being at right angles to the direction of the transmitter and parallel to the ground.

These fields would be in time phase, that is, they would rise and fall in unison, a maximum electric field being produced at the same instant as a maximum magnetic field, and vice versa.

It is the existence of these two fields that give a lot of people entirely erroneously the conception that wireless waves are travelling magnetic fields *plus* travelling electric fields. To the observer of the previous paragraph, the waves, as far as he is concerned, are stationary in space.

It can be shown that it is immaterial whether electromagnetic waves are pictured either as travelling magnetic fields *or* a series of travelling electric fields. An e.m.f. induced vertical rod aerial, for instance, may be attributed either to vertical electric fields sweeping past *or* the fact that the rod is cut by the flux of magnetic fields moving across it. We shall come back to this point later on.

### E.M.F. in a Simple Loop

In Fig. 1 is shown a receiving loop, energised by signals from a distant transmitter $Tx$, the plane of the loop being in the direction of travel of the signal waves which are moving parallel to the intervening ground. As we have already seen, the induced signal strength with the loop in this position will be a maximum, falling away on either side, until after a rotation of 90 deg. it will become a minimum. When the loop is now rotated further, the induced e.m.f. will again begin to build up, but this time it will be opposite in direction to that present during the first quarter revolution; in other words, a complete phase reversal occurs when the frame passes through its zero e.m.f. position. Fig. 2 shows the polar diagram (discussed in the earlier article) obtained for a 360 deg. movement of the loop, the phase reversal condition being indicated by marking the right and left hand lobes positive and negative respectively. This notation is commonly employed.

The magnitude of an induced e.m.f. can be calculated in the following way: when the area of the loop is given by $A$ sq. metres, the magnitude of the magnetic field intensity present there is $H$, and due to the radiation from the transmitter there may be considered to exist at the loop an alternating magnetic field and an alternating electric field. The latter will not produce an e.m.f. round the loop, but an e.m.f. will be produced because of the changing flux of the magnetic field which is threading the loop turns.

If now the loop has $T$ number of turns, then:

Loop e.m.f. = rate of change of flux turns $\times 10^{-8}$ volts.

$= d/dt\ (10^4\ ATH \sin \omega t) \times 10^{-8}$ volts.

But $\omega = 2\pi f$, where $f$ is the transmitted frequency.

$= (2\pi f\ ATH \cos \omega t) \times 10^{-4}$ volts.

If the R.M.S. value of the magnetic field intensity is $H_1$, and the R.M.S. value of the loop e.m.f. is $E_1$ then:

$E_1 = 2\pi\ ATH_1\ f \times 10^2$ microvolts.

The magnitude of $E_1$ is not dependent upon the shape of the loop, but it is upon the area. When the plane of the loop is at some angle $\phi$ with the direction of the incoming signal, the expression becomes:

$E_1 = 2\pi\ ATH_1\ f\ .\ \cos \phi \times 10^2$ microvolts.

When the plane of the loop, therefore, is parallel to the incoming signal direction, $\cos \phi$ has its maximum value of 1 and the induced e.m.f. is also a maximum. With the loop at right angles to the distant transmitter, $\cos \phi$ is zero, and consequently the loop e.m.f. is also zero.

### Practical Effects

As with most things in radio engineering, the perfect states obtained by theory do not hold out in practice, and this is so in the case of frame aerials. Complications occur when a simple loop, such as was described in the previous section, is employed for direction finding, the chief of these being known as the Direct and Vertical effects, and the inability to obtain an absolute bearing or sense of the transmitter.

The direct effect is caused by the leads from the loop aerial to the receiver, and the coils and leads of the receiver itself, picking up a small amount of the radiated signal and passing it on to the detector, irrespective of the setting of the frame. When such reception occurs a zero point cannot be obtained at any loop position; the cure for this trouble is obvious—efficient screening


*Fig. 2.—The horizontal polar diagram for the simple receiving loop of Fig. 1.*

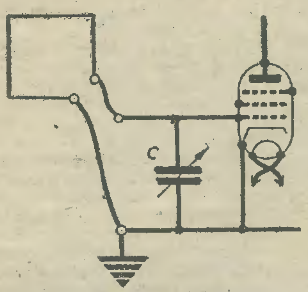



*Fig. 3.—Showing the path differences to earth from each end of the loop aerial causing the vertical effect.*

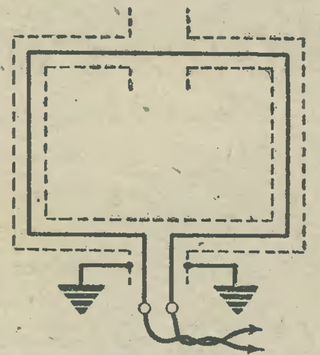


*Fig. 4.—A screened frame aerial, designed to overcome the vertical effect.*

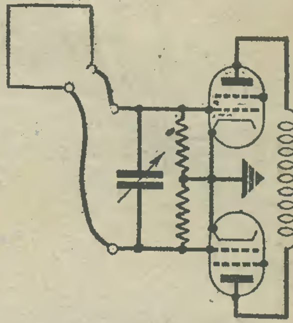


*Fig. 5.—A push-pull method of overcoming vertical effect.*

of the coils and leads most likely to pick up the incoming signal.

The vertical is the name given to the effect in which the main consideration is that the loop will act as an ordinary vertical aerial; as we saw earlier on, the e.m.f. in the loop is caused by vertical electric or horizontal magnetic fields sweeping past, the behaviour of the loop being regarded from the viewpoint of an observer situated within its turns. He would find present there, as before:

(a) a stationary alternating electric field which would be vertical.

(b) a stationary alternating magnetic field which would be horizontal and at right angles to the direction of the incoming signals.

These stationary fields would be caused by the arriving waves, and except (theoretically) when the plane of the loop is at right angles to them, the flux of the stationary horizontal magnetic field would thread and energise the loop. This would induce the normal loop e.m.f. to flow round the loop as we have already described.

But as well as this the stationary vertical electric field would affect the frame as if it were an ordinary vertical aerial rod; equal e.m.f.s would be induced in the two sides of the loop and the behaviour of the arrangement affected. This is the vertical effect.

Consider the ends of a simple loop aerial connected across the grid and cathode of the first receiver valve in the conventional manner. The e.m.f. induced in the loop varies with the angle it makes with the arriving signals, and is zero when the loop is at right angles to the wave direction. The p.d. across the tuning condenser should then, of course, be zero, and this condition would obtain if it were not for the vertical effect. Because of the equal e.m.f.s induced in the two sides of the frame, currents flow down these branches to earth. But the paths provided from each end of the loop to earth are not the same, one being directly connected while the other is through the grid-cathode interelectrode capacity of the valve. (Fig. 3.)

Consequently, although the induced e.m.f.s are equal, the currents flowing up and down the vertical sides of the loop are unequal, and there is always a small p.d. present across the tuning condenser C, irrespective of the setting of the loop; therefore a nil signal position cannot be found.

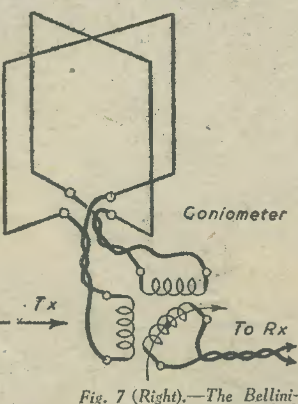



*Fig. 7 (Right).—The Bellini-Tosi direction finder, in which two loop aerials and a goniometer are employed.*

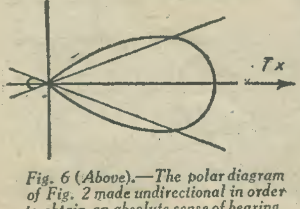



*Fig. 6 (Above).—The polar diagram of Fig. 2 made undirectional in order to obtain an absolute sense of bearing.*

### Solution of Practical Difficulties

There are several methods employed for the elimination of the vertical effect, some of which will now be discussed. A very effective method is depicted in Fig. 4, and consists of the application of electrostatic screening to the problem. The loop is surrounded by a copper tube, the bottom of which is earthed, while a gap is left at the top. This gap is generally filled in with an insulating compound and is necessary to prevent the flow of large currents round the screening tube, the flux of which would oppose the original flux and consequently diminish it, thereby seriously reducing the loop e.m.f.

The stationary alternating electric fields do not produce an e.m.f. in the loop due to the presence of the screen, but there is no effect on the e.m.f. round the loop caused by the magnetic flux threading through it. Slight vertical e.m.f.s are, without doubt, induced in the screen itself, but this is far from resonance, and on the whole the arrangement behaves as a very inefficient vertical aerial.

Another method for overcoming vertical effect is the use of a shielded transformer, the primary being connected to the loop and the secondary to the first valve grid circuit. The transformer has its primary screened from the secondary by a copper band in which is left a small gap for the prevention of large eddy currents, since otherwise the screen would behave as a shorted turn. Due to this electrostatic screen, the primary-secondary capacity is reduced to an almost zero value, the principle being very similar to that of the screened grid valve. The p.d. fluctuations of the primary due to the vertical e.m.f.s have no effect on the secondary due to the presence of the screen, but the latter exercises no control over the magnitude of the e.m.f. induced in the secondary by the ordinary loop current in the primary, which is therefore applied to the receiver.

Push-pull valves can be employed for the elimination of the vertical effect; the conducting path from each end of the loop aerial to earth then being equal. (Fig. 5.) The grid p.d.s of each valve set up by the vertical e.m.f. will at any instant be equal to one another, and will cause equal changes of anode current. These will produce no effect in the tuned anode circuit, since this type of amplifier will only function when the grids are operating antiphase.

### Determination of Sense

In the earlier article we saw how the determination of sense was achieved by making the aerial array unidirectional by means of reflectors or directors. This method can be applied to frame aerial systems, thus

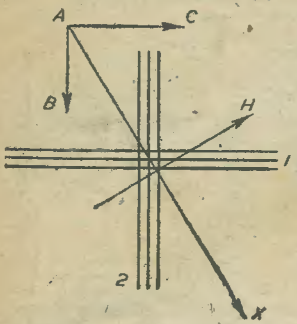


Fig. 8 (Left).—Vector representation of the operation of the Bellini-Tosi D.F. system.

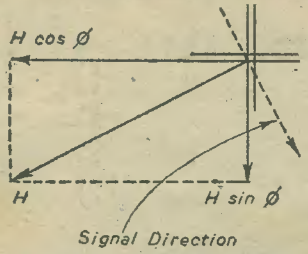


Fig. 9 (Right).—When the gonio rotor is at right angles to the signal direction, the rotor e.m.f. is zero.

making the polar diagram of Fig. 2 unidirectional as shown in Fig. 6.

If a vertical rod is placed close to the simple loop of Fig. 1, the latter being in a position of maximum pick up, and both the loop and the rod are connected to the first tuned circuit of the receiver, then if the vertical aerial is so adjusted that the receiver e.m.f. induced by its current is equal to the receiver e.m.f. induced by the loop e.m.f., the loop will behave as an ordinary inductance and its current will lag by 90 deg. on the loop e.m.f. This e.m.f. lags by 90 deg. on the magnetic flux of the signal waves, consequently the loop current lags 180 deg. behind the arriving magnetic flux. The vertical aerial has an e.m.f. induced in it which is in phase with the magnetic flux, and (if the rod has a very high resistance) the current is in phase with the e.m.f., that is, the vertical aerial current is in phase with the magnetic flux of the signal waves.

The e.m.f.s induced in the receiver by the vertical aerial and the loop currents will therefore be equal, but antiphase, consequently no signal will be heard. If now the loop is rotated through 180 deg. the receiver e.m.f.s induced by the vertical rod and the loop currents will be in phase and additive. Directivity has therefore been achieved and the polar diagram is as shown in Fig. 6.

While in actual practice the phase relations of a simple loop and a vertical rod are not quite as simple as those explained above, the arrangement can nevertheless be adjusted so that the induced e.m.f.s are substantially equal and the determination of sense achieved.

### Practical Systems

Suppose two loops are placed at right angles to each other as shown in Fig. 7, then the magnitude of the e.m.f. induced in either will be characteristic of the direction of the incoming signal. If the output of the two coils is taken to the stator windings of a goniometer (also described previously), then a zero signal will be obtained at some setting of the gonio rotor or search coil which will also be characteristic of the direction of the incoming signal.

Assume that in Fig. 8 a signal is arriving in the direction $AX$, and the magnetic field present at the frames is at right angles to this, indicated by $H$. This may be resolved into two vectors $H \sin \phi$ and $H \cos \phi$, where the flux of $H \sin \phi$ is in the direction $AB$, while the flux of $H \cos \phi$ is in the direction $AC$. The e.m.f. in loop 1 is therefore proportional to $H \sin \phi$ and the e.m.f. in loop 2 is proportional to $H \cos\phi$.

The loop currents flowing in the gonio stators are represented in Fig. 9, such that the e.m.f. induced in the search coil is zero when its plane is parallel to the vector $H$. Thus, the direction of arrival of the signal waves is a line at right angles to the plane of the gonio rotor when the latter is in the position of zero signals. This system is known as the Bellini-Tosi direction finder.

In aircraft work a system known as the Robinson D.F. is sometimes employed. This system employs two loops at right angles to each other as in the Bellini-Tosi arrangement, but in this case one contains about three times as many turns as the other. The main loop which has least turns is in series with the large turn auxiliary loop, but it is so switched that the e.m.f.s induced in the latter can be either added to or subtracted from the e.m.f.s induced in the former.

If the plane of the main loop is in line with the incoming signal the e.m.f. induced in it is, of course, a maximum, but the e.m.f. in the auxiliary loop will be a minimum, since this frame is at right angles to the arriving wave direction. The signal given out by the receiver remains constant, therefore, in both positions of the auxiliary loop reversing switch.

When the signal is arriving at some angle to the plane of the main loop, an e.m.f. is present across the auxiliary loop and the effect of operating the change-over switch will then be a rise or fall in the intensity of the emitted signal. In one position the loop e.m.f.s are additive, while in the other they subtract. The directional properties of this system lie in the design of the auxiliary coil, which in order to observe small changes of signal strength must obviously possess a greater number of turns than the main loop; in practical forms it is usually about three times greater.

### Indirect Reception

The loop systems we have discussed work very well when they are operated by the ground or direct ray from a transmitter, but complications and erratic behaviour arise when an indirect wave is being received, that is, a wave caused by reflection from the Heaviside or other ionised layer in the upper atmosphere. Downcoming radiation from these layers is generally negligible during the hours of daylight, but after dark it can become quite strong. If the indirect waves were vertically polarised their presence would not affect to any great extent the accuracy of the loop bearings; this is obvious from a study of Fig. 10a. The electric field at the loop is indicated by the vectors $Ef$, while the magnetic field $Hf$ is indicated by the dotted circles, at right angles to and coming up out of the paper. This magnetic flux threads the loop and is a maximum when the loop is in line with the direction of the arriving waves, the position shown.

When the downcoming signal is horizontally polarised the electric and magnetic fields present at the loop are as indicated in Fig. 10b, when the magnetic flux is not parallel to the ground and does not thread the loop in the position shown. The loop will be threaded in any other position but the one shown up to 180 deg. of revolution. So, with a horizontally polarised wave a signal will be received in any position except when the plane of the loop is in line with the arriving signal, which is the exact opposite of the cases we have been discussing all the way through. The loop has, therefore, a bearing error of 90 deg.

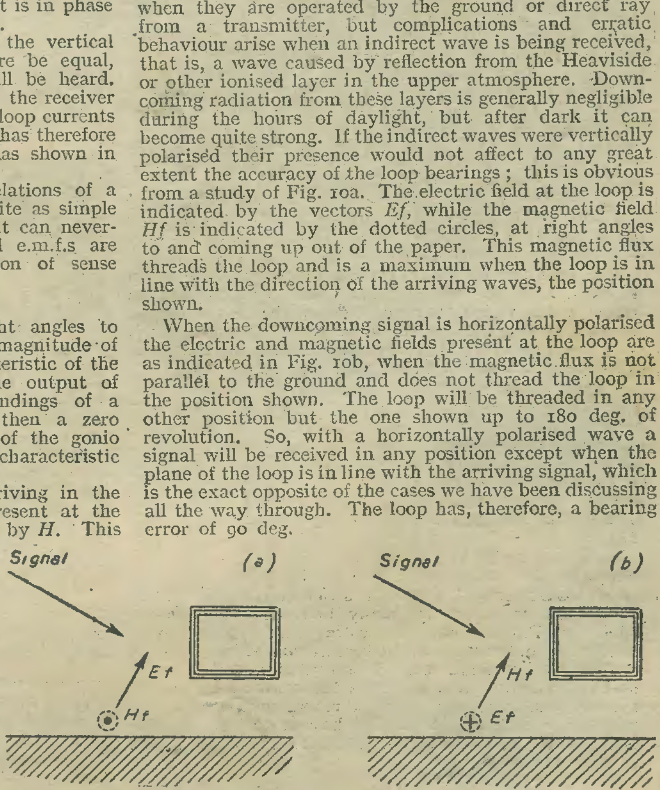


Fig. 10.—(a), Indirect vertically polarised waves do not affect the directional properties of a loop; (b), horizontally polarised waves give a bearing error of 90 deg. in loop systems.

# Impressions on the Wax

## Review of the Latest Gramophone Records

### H.M.V.

THE outstanding recording in the H.M.V. list this month is Gustav Holst's "The Hymn of Jesus," which occupies five sides of three 12in. records, the sixth side being blank. It is a noteworthy addition to the already imposing list of recordings made under the auspices of the British Council, and I recommend it most strongly to all who appreciate exceptionally fine choral performances. The composition is a masterly piece of work in five parts, namely Prelude, The Hymn—Glory to Thee, Divine Grace is Dancing, Divine Ye in Dancing, and, finally, When I am Gone. The words have been translated from the Apocryphal Acts of St. John, and their rendering by the Huddersfield Choral Society—chorus master, H. Bardgett—is superb. Dr. Malcolm Sargent conducting the Liverpool Philharmonic Orchestra reveals a fine and thorough understanding of the whole composition, and great credit is due to all concerned for the magnificent performance of a work requiring the best from all taking part. The records are *H.M.V. C*3399–3401.

Lovers of Negro spirituals will find much to please them on *H.M.V. DA*1846, which contains two fine recordings by Marian Anderson, the possessor of a contralto voice of great beauty. She sings for us—with piano accompaniment by Franz Rupp—that traditional spiritual "Oh, what a Beautiful City" and the Negro spiritual "Let Us Break Bread Together" with deep feeling and perfect diction.

As mentioned before, I always enjoy a good military march provided it is equally well played. On *H.M.V. DA*1845 I have found two which satisfy both requirements to the full, and for those who have a similar liking to myself I recommend this record. The recordings are by Eugene Ormandy and the Philadelphia Orchestra, and the marches are those two ever-popular ones "Stars and Stripes for Ever" and "Washington Post," both, of course, being by the March King Sousa.

"Hutch" (Leslie A. Hutchinson) has recorded "Don't Ever Leave Me," which is featured in the film "Bees of Paradise," and "I'm Going to Build a Future World" on *H.M.V. B*1083.

Joe Loss and his Orchestra have a snappy number on *H.M.V. BD*5849 entitled "The Quack Quack Song," a quick waltz, which they put over, with the aid of Bill Macfarlane as vocalist, in a very pleasing manner if you are feeling in light mood. Linked with this is "An Hour Passes," quite a good foxtrot.

Glenn Miller and his Orchestra have recorded two film feature tunes, "My Prayer" and "A Nightingale Sang in Berkeley Square," two good tunes well presented.

Swing music enthusiasts have a very good record in *H.M.V. B*9375. This has been made by Earl Hines and his Orchestra, with E. H. at the piano, the numbers being "Ridin' and Jivin'," linked with "Indiana." These form Nos. 585 and 586 of the Swing Music Series, 1944.

### Columbia

A TRULY delightful record is *Columbia DX*1157. It contains an exceptionally fine recording by the Liverpool Philharmonic Orchestra, under the baton of Dr. Malcolm Sargent, of "Overture in Italian Style in C Major," by Schubert. The overture makes most pleasing listening, and although the work comes within the classics, it is one which I recommend to all who appreciate good music without having to be a "high-brow," and a first-class performance by an orchestra of high repute.

The only other 12in. Columbia I have this month is that containing a recording by that talented soprano, Isobel Baillie, accompanied by the Liverpool Philharmonic Orchestra, again conducted by Dr. Malcolm Sargent. Miss Baillie has selected the recital "O Didst Thou Know?" and the aria "As When the Dove," from Handel's "Acis and Galatea," which is the title of the record, the number being *Columbia DX*1158. Her performance is flawless.

I head the 10in. series with *Columbia DB*2144. This is a fine recording of Rachmaninoff's "Prelude in C Sharp Minor" (Op. 3, No. 2), played by those two popular and gifted stars Rawicz and Landauer as, of course, a piano duet, and they link it with the same composer's "Prelude in G Minor" (Op. 23, No. 5).

Frank Sinatra, whose first Columbia record I reviewed last month, has made two more recordings, this time with Harry James and his Orchestra, on *Columbia DB*2145. The numbers are "All Or Nothing At All" and "Ciribiribin," which he puts over quite nicely, but, well, that's all. Turner Layton has selected two numbers which enable him to reveal his qualities far better than some of his other recent recordings. He sings, on *Columbia FB* 3031, "Deep River" and "Thou Art Risen, My Beloved," and, of course, accompanies himself on the piano, thus giving a very nice performance It is the best recording of him I have heard recently. Felix Mendelssohn and his Hawaiian Serenaders have made a good record, "Romantic Waltzes (No. 3)," on *Columbia FB*3029.

Victor Silvester and his Ballroom Orchestra have recorded, on *Columbia FB*3033, "Dipsy Doodle"—quickstep, and "One Love," a waltz. Two good numbers well presented.

Carroll Gibbons and the Savoy Hotel Orpheans have selected "There's Nothing Like Music"—foxtrot, and "I'll Walk Alone"—slow foxtrot. These they play, in first-class style, on *Columbia FB*3030.

### Parlophone

"PICCADILLY Pastime" and "Music for Anglo-Saxes" are the two lively pieces played by No. 1 Balloon Centre Dance Orchestra on *Parlophone F*2028.

Joe Daniels and his Hot Shots in "Drumnasticks" record "At the Military Ball" and "Nattering Around." For those who like it "hot" these two numbers, on *Parlophone F*2029, will meet with approval.

"Tin Pan Alley Medley, No. 62" will be found on *Parlophone F*2030, where Ivor Moreton and Dave Kaye introduce "Lille Marlene," "I'll Get By," "Amor amor," "Mairzy Doats and Dozy Doats," "I Couldn't Sleep a Wink Last Night," and "A Lovely Way to Spend an Evening."

### Regal

REGINALD DIXON has made another good record in *Regal MR*3734. It is called "Dixontime (No. 17)," in two parts, and introduces "Mairzy Doats and Dozy Doats," "Don't Ask Me Why," "I Heard You Cried Last Night," "I'm Sending My Blessing," "Kiss Me" and "Paper Doll."

"Good-night Wherever You Are"—foxtrot, and "There's Nothing Like Music," also a foxtrot, are the two numbers played in a very nice style by Harry Leader and his Orchestra on *Regal MR*3735.

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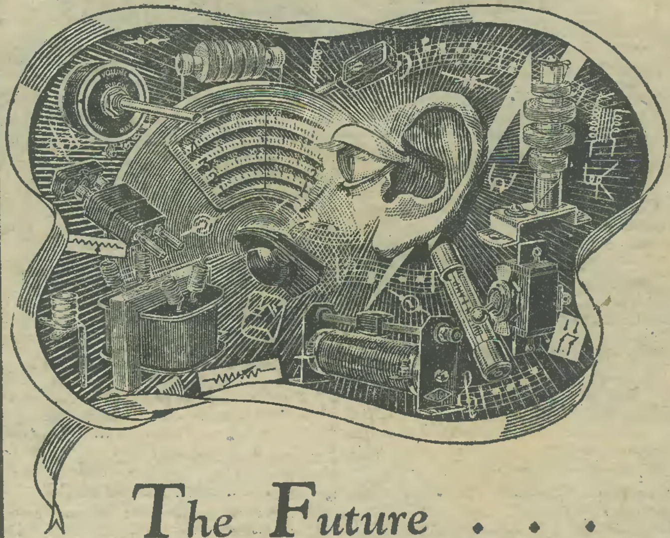

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# Open to Discussion

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).

## Poor B.B.C. Transmissions

SIR,—So many readers' letters relating to the poor reception of the B.B.C. transmissions have appeared in PRACTICAL WIRELESS that a brief summary of the suggestions given by the Corporation's engineers may possibly be of interest. They are as follows :—

Although many modern sets will give powerful results with a poor aerial, a good aerial should nevertheless be used. It is worth while trying a short aerial without a horizontal part; this should be outside if possible, although in some localities a wire suspended vertically above the receiver inside the house will be better. This is especially so where the signal is strong but distorted.

Ignore the aerial connecting the earth to the aerial terminal. Alternatively, reverse the aerial and earth connections to the receiver. This should be tried where signal strength is good but distortion is present, even in the daytime.

Wind a frame of about 10 turns round a box about 8ft. in circumference and connect the ends of the winding to the aerial and earth terminals of the set. The frame winding must be on a vertical plane and turned until best results are obtained. This method has been found successful in some places, but, because of the comparatively low signal pick-up of the frame, it is best used with a sensitive receiver.

Receivers with a self-contained frame aerial should be tried on all the B.B.C. stations broadcasting the desired programme, and with the frame in all positions.

With relation to adjacent-channel interference and man-made static, the Engineering Branch of the G.P.O. gives free advice to licence-holders when possible.

I am indebted to the B.B.C. Year Book for a large portion of the above information, and hope it may be of practical use to listeners.—F. G. RAYNER (Longdon).

## Stroboscopic Calculations

SIR,—I am indebted to Mr. W. H. Dowland (July issue) for his comments on my letter on stroboscopic calculations (May), in which I state that the stroboscope was due to Dr. Stampfer, of Vienna, in 1830.

It is true, of course that the attribution of certain technical devices to any one person is not easy, but my authority in this instance was the late Will Day, historian of the cinema. In 1936, seeking further information on the origins of the stroboscopic method (which to-day has been developed in many forms for particular jobs or applications), I discussed the subject with Mr. Day, whose collection of cinema relics included a model of the early stroboscope, whilst his researches indicated that it was due to Dr. Stampfer around 1830, and was contemporary to Dr. Plateau, of Ghent.

Of course, if one wishes to go back far enough, it is not difficult to conceive an early Greek, running past the pillars of a temple and, looking over his shoulder, seeing the hand-thresher in a field on the other side of the pillars in arrested or slowed motion when the relative speeds of motion were right! Then, as early as 1825, Dr. Roget, compiler of the famous *Thesaurus*, drew attention to the fact that if a revolving wheel is viewed through a fence, the individual spokes become visible again but appear distorted. A little later Michael Faraday showed interest in this type of phenomenon, and around 1830, apparently, several scientists independently reported the fact that if instead of observing a series of identical spokes or cogs one viewed a series of simple pictures, an illusion of movement could be obtained. Between 1830 and 1840 a number of such devices, with names like Zœtrope and Phenakistoscope, were patented, and many of these forerunners of the cinema (due to the inertia of the eye, i.e., "persistence of vision") may still, I believe, be seen in operation at the Science Museum, South Kensington. If any other reader has further facts to offer on this topic I, for one, will be very pleased to have them.—DONALD W. ALDOUS (Torquay).

## A Reader's Log

SIR,—Here are some extracts from my log for the past fortnight which may be of interest to readers :—All India Radio, Delhi, broadcasts a musical programme for Indians overseas from 5.15 p.m. until 5.50 p.m., when the transmission ends with a news bulletin in English. This programme is carried on 25.27, 25.45, 31.15, 41.61 and 61.98 metres. I have also heard All India Radio on 19.62 m. calling the Far East at 1.30 p.m. with a news bulletin followed by a musical programme. "The Far Eastern Station" from Delhi broadcasts news in English at 8 p.m., followed by news in Japanese, in the 25, 31 and 48 m. bands. Radio Dakar, 26.13 m., gives a news commentary in English at 10.30 p.m. on Wednesdays only. Leopoldville, on 19.78 m., transmits a programme in English from 12 to 12.30 p.m.

Other stations received include JCL3, Tokio, on 19.20m.; HCJB, Quito; FZI, Brazzaville; PRL8, Rio de Janeiro; and the following American stations: WKRX, WKRD, WGEA, WGEX, WLWO, WLWK, WLRL, WRCA, WOOC, WCBN, WOON, WBOS, WRUL, WRUS, WRUW, WRUA, and WLBX. The set is an 0-v-1 of my own design and construction using two detector valves.—P. A. DEVLIN (Belfast).

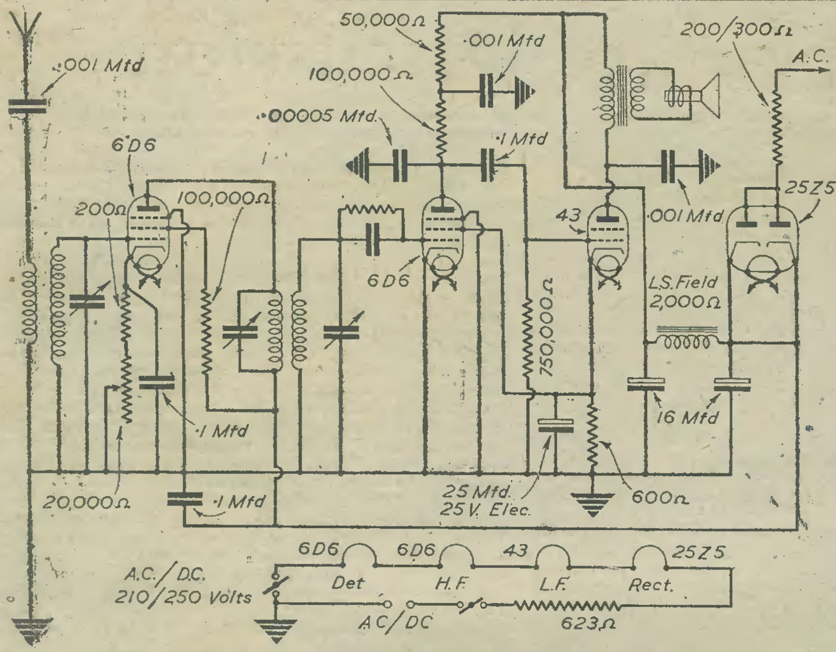
## Midget A.C./D.C. Receivers

SIR,—In building and experimenting with midget A.C./D.C. receivers the following points were noted, and I am submitting them for your consideration as they may be of interest to other readers. A circuit of my receiver to illustrate these points is attached.

The popular anode-bend type of demodulator is commonly employed in midget A.C./D.C. receivers; however, it may not be known that the grid-leak type can be equally as successful, and may possibly be much more sensitive than the former if the following tips are noted. Using a 6C6, or more usually a 6D6 (vari. mu H.F. pen.), in the circuit shown, it will be seen that the screen volts are obtained from the biasing voltage on the cathode of the 43 type output pentode. This is excellent for the purpose, since the biasing condenser (by-passing the L.F. component) is usually a large-value electrolytic type, and the voltage about 18/22 volts, just what is required for the purpose. As a result there is no H.F. instability in the 6D6 screen circuit and the screen volts are not subject to variation. Moreover, it saves the cost of a resistance, condenser, and potentiometer network.

It may be argued that sensitivity at the cost of selectivity has been obtained; this, however, in this case is incorrect. Selectivity is good and on a fixed indoor aerial, run along the top of the picture-rail round the room, 12ft. of aerial gives ample volume on the two Forces and Home Service stations; later in the evening other Continental stations are received equally loudly.

A wrinkle for ensuring selectivity is to tune the primary of the H.F. transformer coupled to the detector with a variable mica type condenser of .0001 uf. max capacity. This should be done with the receiver tuned to the station it is most desired to receive. Also, if a trimmer is fitted to the H.F. stage tuning condenser it will be found that these two trimmers will be adjusted in conjunction with each other for the final lining, up on the station. Also, in reference to the H.F. stage it has been found that it is not necessary to include a




*Circuit diagram of Mr. Marshall's midget AC/DC receiver*

circuit between cathode and screen as the bias obtained from the fixed resistance and potentiometer is quite sufficient for a cut-off biasing voltage of up to 35 volts.

It will be noted that in the H.F. stage the full gain of which the 6D6 is capable of is realised to the full by taking the H.T. supply to the anode direct from the cathode of the 25Z5 rectifier, and not in the conventional manner; this does work out.

As to the value of anode resistance shown for the 6D6 demodulator, this gives a maximum value of 3 milliamps anode current, and gives the greatest gain commensurate with quality.

In the anode circuit of the 43 type output pentode a condenser of the value shown serves to give a reasonable fixed tone control effect, not too much top, and additionally prevents H.F. instability. This, at least, has been my experience.

To ensure long life for the 25Z5 rectifier a 1 watt type carbon resistor (Erie) of 200/300 ohms is included in the anode circuit in series. This acts as a form of surge limiter, in addition to slightly dropping the applied voltage, and in practice, although it does get a bit hot, it does help to prolong the useful life of the valve. One which I have in this receiver has been running now for about 18 months, as have the other valves, and is in perfect condition.

Should any other reader be interested enough to build a receiver from this circuit, he is, in his own interests, advised to adhere to the component values shown, as these are the result of much experimenting.—L. C. MARSHALL (Whitehaven).

## Stations Logged

SIR,—In the past two years I have constructed eight short-wavers with little or no success, but now I have a really fine 0-v-1 in use. I have also built the emergency three-valver with the H.F. stage left out, but I could not get any satisfactory results with it. I am going to build the low cost quality three which is in last month's issue. I have made A. J. Aldworth's "gramo motor" from January, 1944, issue. Here are some of the stations I have logged in the past month: WGEA, 19.57 m.; WCBX, 25 m.b.; WCBN, 25 m.b.; WCRC, 25.36 m.; WGEO, 31.48 m.; WBOS, 19.72 m.; WRUS, 25 m.b.; WOOW, 25.3 m.; A.F.H.Q., 20 m.b.; VUD-3, Delhi, India, 25.62 m.; Armed Forces Radio Service, 25 m.b.; Radio Metropole, 25.65 m.; the Voice of Free India, 26.16 m.; FZI, Radio Brazzaville, 25.06 m.; the American TX in Europe; PRL-8, Rio de Janeiro, Brazil, 25.60 m.; Algiers, 24.17 m.; French National Radio, 19.68 m. I have also received three stations not yet identified; they are Swiss, on the 25 m.b., ZNR, 24 m.b., and a station calling "Sabu, Sabu 93, Sabu 35," and then reading a number of letters. I would appreciate any information concerning these stations from other readers. My aerial is a 15ft. indoor one and no earth.—F. J. LONGMAN (Mansfield).

## Stations Identified

SIR,—In a letter in the July issue of PRACTICAL WIRELESS G. C. Bagley gives a list of commercial morse stations he has logged, and requests information regarding these stations. I have great pleasure in supplying the following information, extracted from official lists issued to merchant ships.

WQL, WQS, WIY and WIJ are located at New Brunswick (New Jersey), and are listed as "fixed stations," used for radio communication between fixed points. WQV is located at Rocky Point (New York State), and is also a "fixed station."

WAR is listed as a "coast station," used for service with ship stations, and is located at Washington and operated by the U.S. Army. The aerial power is 2 kW. Depending on the time of day and night, WAR operates on frequencies of 159, 600, 4255, 8510, 12765 and 17020 kc/s.

WSC is another "coast station," located at Tuckerton (New Jersey) and operated by R.C.A. The frequencies used, both high and low, are far too numerous to mention here. On the low frequencies the power is 5 kW. and high frequencies 40 kW.

It may be of interest to note that on 6340 and 8430 kc/s WSC radiates Press reports at 0418 G.M.T. and traffic lists at 0100, 0300 and 2300 G.M.T. Traffic lists are also sent out at 1300, 1500, 1700 and 2100 G.M.T. on 16860 kc/s.

I am sorry I can trace no details of WD68 and WLYA as logged by G. C. Bagley. If any other readers require information regarding commercial morse stations, etc., I shall be very pleased to give what help I can.

On and off I have been a regular reader of PRACTICAL WIRELESS for about six years, and as this is the first time I have written to you, may I take the opportunity of congratulating you on the high standard of the magazine, and the way in which you cater for both the beginner and advanced amateur? Continue the good work!

I am a radio officer aboard ship, and I spend quite a lot of my spare time experimenting and building receivers, etc. I have made up a large number of PRACTICAL

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**CHARLES BRITAIN RADIO** (K. H. Ede) offers real Bargains in New Radio Spares! Lists now available for 1d. stamp. **CELESTION SPEAKERS,** 10in. P.M. with trans., £2; 8in. P.M. less trans., 21/-; 6½in. P.M. with trans., 27/6; 6in. Goodman less trans., 22/6; mains energised 2,000 ohm field with trans., 30/6. **SERVICE KIT** (A): two 16mfd. can type 350 wkg. Electrolytics, 60ma. Choke, one .3 mains dropper with var. tap and fixing feet, **£1 10s. 6d.** Service Kit (B): two 16mfd. 350v., two 25mfd. 25v. can type condensers, six .1 tubulars, 6 assorted valveholders, 6 resistors, **£1 1s. 6d. PLATE GLASS DIALS.** Cossor 3-band, 13½ x 5½, 2/6 ea. H.M.V. 7½ x 4½ or 7 x 3½ 3-band, 1/6 ea. 2-band clock-face celluloid 5 x 4, 1/3 ea. Cossor 3-band 7½ x 4, 1/6 ea. Small dials for midgets, 3 x 4in., 9d. ea. **TUNING CONDENSERS.** .0005, 3-gang American, 8/6 ea.; 4-gang, 8/6 ea. (large screened type); wavechange switches, Yaxley type, 2-pole 4-way, 2-pole 3-way, 4-pole 2-way, all 3/6 ea. **VALVE-HOLDERS.** British 5, 7, and octal; American 4, 5, 6, 7 and octal, 7/6 doz. Grid connecting clips, 1/- doz. Tinned copper wire, 16 s.w.g., 18, 20 and 22, 2/6 per ½lb. reel. Twin-screened sleeving, 2ft. lengths 1/- ea. Wander Plugs, red and green, 2/6 doz. Spade Terminals, red and black, 2/9 doz. **MAINS DROPPERS** with var. taps and feet, 350 ohms .3 amp., 5/6 ea.; 1,000 ohms .2, 4/6 ea. Little Maestro type (no feet), 5/6 ea. The three for 12/6. Telsen Loud-speaker Units, 5/- ea. Telsen S.M. Disc drives, 2/-. Assorted Mansbridge condensers, 600v. test, 6/- doz. **THIS MONTH'S SPECIAL OFFER.** Screened H.F. Chokes resistance, 200 ohms, ex Ekco, 1/- ea. For Volume Controls, Tubular and Mica Condensers, etc., see advts. July and August issues. Terms: Cash or C.O.D. over £1.—**Charles Britain Radio** (temp. address), "Eureka," Surrey Gardens, Effingham, Surrey.

**SYNCHRONOUS MOTORS.—"Sangamo,"** 200-250 volts A.C. 50 c. self starting fitted Reduction Gears. Ideal movements for Time Switches, Electric Clocks, etc. Rotor speed 200 r.p.m., final speed 1 rev. -12 minutes approx. Consumption 2½ watts. Size 2½ x 2½ x 1¼, 22/6.
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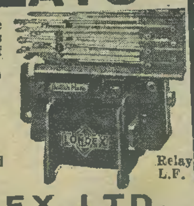

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**B.A.** thread screws and nuts, 1 gross assorted useful sizes, **2/6**; ditto brass washers, **1/6** gross; fibre washers, **1/6** gross; assorted solder tags, **2/-** gross; assorted small eyelets and rivets, **1/3** gross. Rubber-covered stranded copper wire, **1d.** yard; heavier quality, **1½d.** yard; very heavy quality, **2½d.** yard; ideal for aerials, earths, etc. Tinned copper connecting wire, 20ft. coil, **6d.**; ditto rubber covered, 10ft. coil, **6d.** Braided twin electric cable, **6d.** yard. Finest quality resin-cored solder, ½lb., **2/-**. Wood's metal stick, 2½in. by ½in., **1/-**. Cotton covered copper instrument wire, ¼lb. reels, 18, 20, 22, 24 gauges, **1/6**; 26 gauge, **1/9**; 42 gauge double silk-covered, 2oz. reel, **2/-**; 36 gauge ditto, **1/9**. Sensitive permanent crystal detectors, Tellurium-zincite combination, complete on base, guaranteed efficient, **2/6**; reliable crystal with silver cats-whisker, **6d.** Reconditioned headphones, complete, 4,000 ohms, **12/6**. All postage extra—Post Radio Supplies, 33, Bourne Gardens, London, E.4.

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**MIDGET** aerial and H.F. medium wave, T.R.F. coils, ideal for the T.R.F. midget, **9/-** pair; standard, M. and L. wave, T.R.F., with reaction, circuit, boxed, **12/6** pair.
**MIDGET** speaker tran. (Pen.), **7/6**; standard ditto, **9/-**; heavy duty 10 watt ditto, **10/6**.
**MIDGET** speaker, P.M., 5in., with tran., **32/6**. High sensitivity.
**MIDGET** knobs, black or brown, standard knobs, ditto, **9d.**, **8/-** doz.; large knobs, 3in., brown, **1/6**.
**MIDGET** chassis, drilled for four valves, sprayed grey, de luxe, 10½ by 6 by 2in., **9/6**; standard, 10 by 4½ by 2in., **5/6**.
**MIDGET** chokes, 50/60 ma., **7/6**; heavy duty, superior job, 80 ma., 500 ohms, **12/6**; 120 ma., **15/-**; 0.5 henry, 20 ma., C.T., **25/-**.
**GANG** condensers, variable, 0.0005 mfd., 2-gang, first class job, at **12/6**.
**CONDENSERS**, tubular electrolytics, 2 mfd., 350 V.W., **4/6**; 50 mfd., 50 V.W., **3/6**; 12 mfd., 50 V.W., **2/6**; tubular paper, 2 mfd., 200 V.W., **3/6**; 0.1 mfd., **10d.**, **9/-** doz.; 0.01 mfd., **8d.**, **7/-** doz.; paper block, 4 mfd., 450 V.W., **4/6**.
**WIRE** wound potentiometers, 2,000 ohms., for bridges, etc., **6/6**.
**DROPPERS**, universal type, for all receivers, 1,000 ohms, 0.2 amp., fitted 2 variable taps, **4/6**; 750 ohms, 0.3 amp., ditto taps, **5/6**; heavy quality dropper, superior porcelain former, fixing feet, ditto taps, a quality job, 950 ohms, 0.2 amp., and 800 ohms, 0.3 amp., **7/6**.
**LINE CORD**, 60 ohms per foot, 0.3 amp., 3-way, **6/6** per yard.
**DIALS**, three wavebands, short, medium and long, station names in colours, ivorine, 7 by 4in., **1/6**.
**NUTS/SCREWS**, 4 B.A., brass, round heads, 2 gross in all, **6/6**.
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*(Continued top of next column.)*

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**CRYSTALS** (Dr. Cecil), **6d.**; with Catswhisker, **9d.**; **COMPLETE CRYSTAL DETECTORS**, **2/6**; **TELSEN REACTION CONDENSERS**, .0001, **1/9**; **TELSEN LARGE DISC DRIVES.** Complete Boxed (Type W184), **2/6**.
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*(Continued top of next column.)*

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**PUSH BUTTON UNITS.** 12-way, complete with knobs and escutcheon plate **5/6** each. Crystal detectors on ebonite base, **2/6** each. Short wave chokes, 10-180 metres, **1/3** each. Volume controls, with switch, ½ meg., **5/-**. Small meter switches, **2/-** each. 2 B.A. soldering tags, **2/6** gross. All tin solder, ¼ lb. reel, **1/-**. 6-pin dual range coils, complete on base, **4/6** each. 2 mm. sleeving, **3/-** doz. yards.
**MAINS DROPPERS.** Complete with fixing legs. .2 amp., 950 ohms, **6/-** each. Ditto, .3 amp., 800 ohms, **6/-** each. Each with 2 variable sliders.
**WIRE.** Double cotton covered, per ½ lb. reel, 18 g., **1/9**; 20 g., **1/10**; 24 g., **2/-**; 26 g., **2/3**; 28 g., **2/8**; 30 g., **3/-**; 32 g., **3/-**; 34 g., **3/3**. Also single cotton and enamelled wire, 22 g., **1/9**; 26 g., **2/-** per ½ lb. reel. Silk covered, per 2 oz. reel, 28, 30, 32, 34, 36 38 and 40 g., **1/6** reel. Heat resisting connecting wire, 12ft. coils, **6d.** each.
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Volume Controls, ¼, ½ and 1 meg., less switch, at 2/9 each; with switch, 5/9 each. .2 and .3 amp. mains droppers, 4/9, 5/9 and 7/6 each.
.3 amp. 3-way line cord, 70 ohms, per foot, best quality, at 5/9 yard.
Slow Motion Dial and Drive, Escutcheon type, 2/6 each. Resistors, assorted, Kit of 48 ¼, ½ and 1 watt at £1 lot.
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A SMALL or medium-sized Cycle and Radio Business (retail). Any district considered if well populated and with good post-war prospects. Full particulars in first instance to Box 115, "Practical Wireless," Tower House, Southampton Street, W.C.2.

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Battery All-Wave Three (D, 2 LF (RC)) .. .. .. .. — PW55*
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1938 "Triband" All-Wave Three (HF, Pen, D, Pen) .. .. — PW84
F. J. Camm's "Sprite" Three (HF Pen, D, Tet) .. .. — PW87*
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Battery Hall-Mark 4 (HF Pen, D, Push-Pull) .. .. .. — PW46
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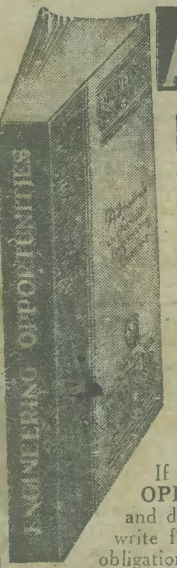

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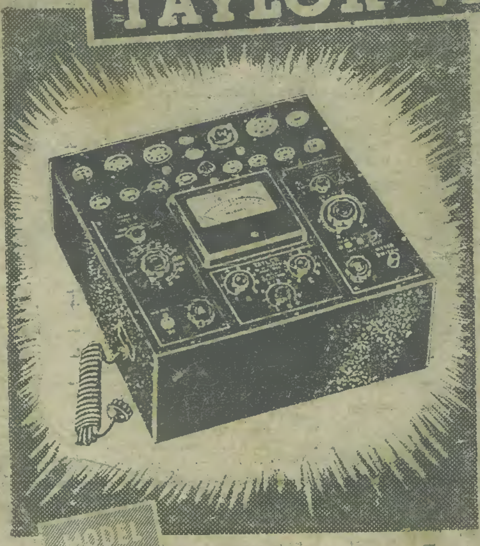


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