The Wireless World
AND RADIO REVIEW

VOLUME XIX

JULY 7th—DECEMBER 29th, 1926.

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UNREASONABLE DELAY.

It is now well over three months since the Report of the Broadcasting Committee was published, setting out, as it did, the recommendations of the Committee for the future conduct of the broadcasting service. In view of the fact that at the end of the year the new authority is due to take charge and the present licence of the B.B.C. expires, it would seem that an altogether unreasonable delay has occurred in the matter of acting upon the recommendations of the Committee. It surely cannot be supposed that the new authority can jump into position and carry on smoothly the work of this great organisation without any preliminary experience. We had been led to understand that, although the official taking over of the B.B.C. would not come about until the end of the year, yet the new authority would have been constituted by now and would be actively engaged in studying the task which it had before it. We foresee that unless matters are speeded up now the position will arise when towards the end of the year there will be no time or opportunity left for any discussion directed towards modifying one or two of the recommendations of the Committee which have not met with general approval.

The Report of the Broadcasting Committee emphasised the national character of the broadcasting service, and it would be unjustifiable if the new authority should be constituted without ample opportunity being given for consideration and discussion in the House.

CONTENTS.

THE TWO-STATION TRANSMISSIONS.

The recent experiment carried out by the B.B.C. in London, when the 2LO station and the station at Marconi House both transmitted independent programmes on wavelengths differing by approximately 100 metres, has been productive of some interesting results, but, in particular, a lesson has been provided which we sincerely hope the B.B.C. will take to heart.

Almost throughout London users of valve sets found little difficulty in separating the two stations, but over a wide area crystal users had the experience of listening to two programmes simultaneously. We have so repeatedly criticised the B.B.C. for their policy of organising the broadcasting service for the crystal user that it is hardly necessary to repeat our protests, but it would seem that we have now two alternatives: the one being to continue the policy of serving first the crystal user, and by so doing curtailing and, perhaps, suppressing progress in the matter of alternative programmes and better service, whilst the other is to put the broadcast organisation and the supply of alternative programmes first and let the designers of apparatus follow the lead, provided that no unreasonable changes are made, such, for example, as alterations of wavelength which would render existing sets obsolete.

In our opinion the B.B.C. should encourage listeners to use valve sets rather than shape their policy to meet the requirements of those who are using the crudest forms of unselective sets.

BATTERY ELIMINATORS.

Rectified A.C. as a Substitute for the H.T. and L.T. Batteries.

By F. H. HAYNES.

ECONOMY and convenience combined with equal efficiency must be the first properties of any device designed to replace the filament heating and H.T. batteries. For operating a single-valve set it is doubtful whether, on the score of economy, any eliminating apparatus is less costly to run than batteries, while for working on very small load the attention required by the filament heating accumulator and the dry cell H.T. battery is almost negligible. Taking initial cost into account, it can be conclusively stated that battery eliminating or home charging equipments are not worth while for running the one-valve receiver.

Comparative Cost.

For operating three, four, or more valves, however, the case is very different. The cost of the energy consumed from the mains for high-tension battery substitution is practically negligible, and the entire apparatus required can be installed for less than the price of six battery renewals, but it must not be overlooked that the life of the valves used in the rectifier is not indefinite, though, if not overrun, replacements will, of course, be rare. In making any comparison of the cost of an H.T. rectifier against the H.T. battery, it can be said that the rectifier is the better proposition assuming a life of 1,000 hours for the rectifying valves. When worked well within maximum output capacity, this estimated life will undoubtedly be considerably exceeded.

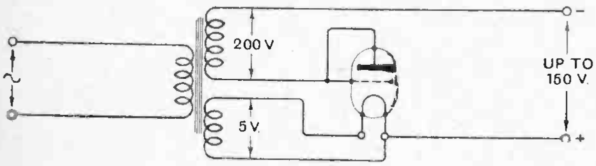


Fig. 1.—Simple form of half-wave rectifier

The Half-wave Rectifier.

The most popular form of A.C. battery substitute in use to-day is that in which a two-electrode valve, often a standard receiving valve with the grid and plate pins bridged across, is used as a half-wave rectifier. By means of a transformer with primary connected to the supply mains, a suitable potential is obtained from a step-down secondary for heating the filament of this rectifying valve, while a tertiary winding giving a potential of about 150 to 250 volts is fed to the plate *via* the output circuit (Fig. 1). A smoothing equipment comprising iron core choke coils of high inductance and bridging condensers of high capacity are, of course, required, and, to be really effective, constitutes the most costly part of the apparatus. The periodicity of A.C. supply is usually 50, and never exceeds 100, cycles, and consequently pulses of unidirectional current are passed on to the smoothing circuit at this frequency. A high-tension potential varying from zero to maximum 50 times a second is somewhat difficult to smooth so as to give a perfectly steady potential at the output terminals. The choke coils, with their property of opposing any change in the value of the current flowing in the circuit, must possess exceedingly high inductance to be effective at this comparatively low frequency, whilst the condensers must be of very liberal capacity in order to serve as current reservoirs which will not run too low in potential in the intervals between one charging pulse and the next.

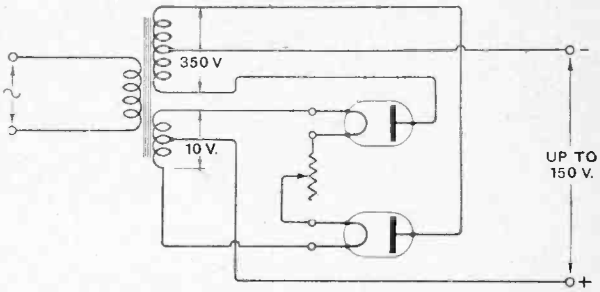


Fig. 2.—Full-wave rectifier. When the valve filaments are parallel connected, adjustments of the rheostat will displace the filament winding tap from the electrical centre.

It is surprising that apparatus of this simple kind, making use only of half-wave rectification, is capable of delivering a constant H.T. potential at the low frequencies met with in domestic A.C. supply.

Full-wave Rectifier.

Full-wave rectification as provided by two rectifying valves is the next step in advancement and is usually to be preferred to the half-wave arrangement, firstly because the frequency of the current pulses passed to the smoothing apparatus is doubled, and, assuming that the valves are similar to that in the single-wave rectifier, the current output also is doubled. A slightly increased load is, however, taken from the supply, but in any case this is insignificant while the secondary and tertiary windings need to be doubled in size.

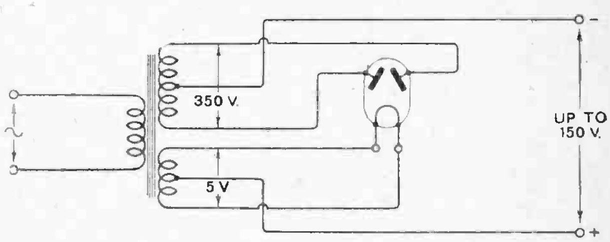


Fig. 3.—Full-wave rectification with two-plate valve.

The circuit (Fig. 2) shows the valve filaments connected in series so that adjustments of the rheostat will not displace the filament winding tap from the electrical centre. It is quite common practice, however, to wind the transformer, assuming that the valve filaments are to be parallel connected.

Battery Eliminators.—

Instead of using two valves, a single valve with two plates will provide full-wave rectification (Fig. 3). There is no saving of filament watts by such a valve, for an emission similar to that of the two valves is still required, and it therefore virtually comprises two valves in a common vacuum, while a filament burn out is equal to the simultaneous destruction of two half-wave valves. In such a valve it would seem desirable, therefore, to bring out separately the leads to both filaments, in which

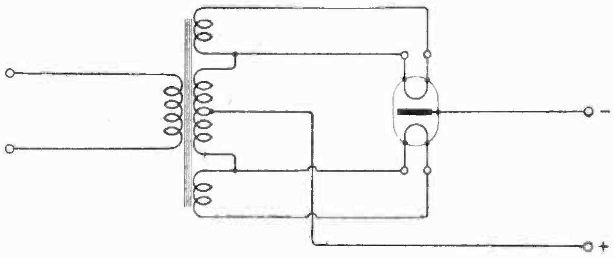


Fig. 4.—Double filamented valve as a full-wave rectifier.

case the alternative circuit arrangement of Fig. 4 could be adopted.

Glow-discharge Tubes.

Filamentless soft valve rectifiers are in use in the United States, and a rectifying circuit making use of such a valve is shown in Fig. 5. As in the case of the neon lamp, a certain initial potential is required before the path through the valve becomes conductive, and thus the rectified current has a somewhat different wave form from the filament type rectifier. Condensers are usually connected between the negative tap on the transformer and the point electrodes of the valve, the discharge of which prolongs the duration of the rectified current pulse after an initial peak voltage has been reached on each half-cycle, rendering the point-to-plate path conductive. This rectifier is entirely satisfactory providing that adequate smoothing apparatus is connected in the output.

Electrolytic.

Rectifiers of the electrolytic type have been experimented with, mostly by amateurs, for obtaining an H.T. battery substitute. A typical electrolytic full-wave rectifier is shown in Fig. 6. Rectifiers like this are not in

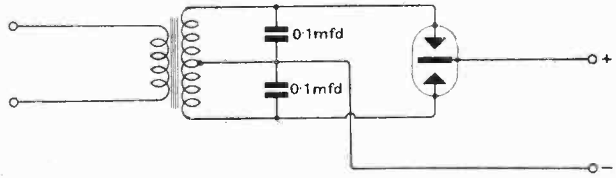


Fig. 5.—Soft filamentless valve rectifier.

general use, mainly owing to the difficulty of smoothing the rectified output. The electrolytic rectifier operates by a process of unidirectional conductivity depending upon polarisation and oscillograph records of the wave form of the output reveal brief current reversals. The plates, until recently, were invariably of lead and aluminium, and it must be borne in mind that these plates will not remain "formed," making it necessary to first apply the current through a protective resistance. Such a rectifier is messy, the solution requires renewing from time to time, and constant attention is needed, owing to evaporation; the aluminium electrodes, moreover, become consumed.

Rotary Rectifiers.

Small motor generators have been constructed consisting of an A.C. motor directly coupled to a high-voltage generator. Here the principal difficulty is that of constructing a small self-exciting high-voltage dynamo of reasonable efficiency. Commutator ripple is, moreover, encountered, although this trouble has undoubtedly been solved in certain anode converters on the market. The presence of the alternating current field of the motor is liable to create an appreciable hum in the direct-current output, unless the two machines are adequately spaced, efficiently screened, and the coupling between the shafts constructed of a non-magnetic material.

Heating the Filaments with A.C.

Turning now to filament heating, it may be definitely said, in spite of frequent statements to the contrary, that the use of alternating current is entirely unsatisfactory. The running of an oscillating detector valve with an A.C. heated filament will give rise to a hum which can be heard above the strongest of signals, and, even if a detector valve running on independent D.C. supply or a crystal is used, a hum will still be discernible. Much

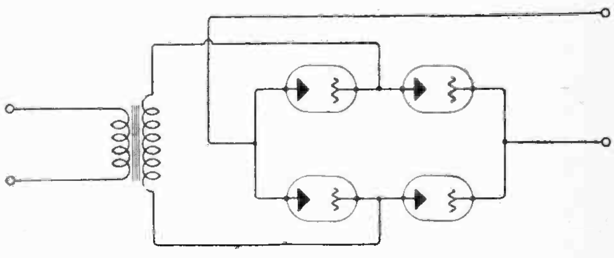


Fig. 6.—Full-wave electrolyte rectifier.

depends, however, on the filament characteristics of the valves employed, and thick filaments running at high temperatures give better results on A.C. than do the thinner dull emitter filaments, where well-defined initial temperature is required before liberal emission is obtained.

Trickle Charging.

Undoubtedly, the best solution would seem to lie in the direction of a low-capacity charging set imparting a steady charge to a small accumulator floating across its output terminals. The low internal resistance of the battery is effective in smoothing out the current rises from the rectifier, although for perfectly rippleless reception it is, perhaps, advisable to disconnect the charging current when the battery is feeding the receiver. This system of trickle charging is an easy solution of the A.C. filament heating problem, and several different methods of charging can be adopted, while the battery will remain in good condition as a result of never being permitted to remain in a discharged state. Overcharging, which is detrimental to a battery, must, of course, be guarded against, and not

Battery Eliminators.—

infrequent attention is necessary as regards the addition of distilled water. The battery, which may gas liberally, must under no circumstances be housed as part of the rectifier or receiving set, as the escaping acidulated moisture will break down the surface insulating properties of ebonite panels and other insulated parts. A small electrolytic form of rectifier will keep the battery charged; a two-position switch connecting the battery either to the receiving set or to the charging circuit when additional contacts set the charger in operation.

Tantalum Rectifier.

The tantalum electrolytic rectifier is better suited to this purpose, principally because, using sulphuric acid electrolyte, it can be accommodated in a compartment with the battery without fear of contamination, but care must be exercised to prevent traces of the ferrous matter in the electrolyte gaining access to the accumulator acid. Water only need be added to the rectifier to make up for evaporation, and the tantalum plates are not consumed by continuous chemical reaction.

A valve rectifier as already described for H.T. supply (Fig. 3) will successfully keep a small battery in condition, though several valves will be needed to give a satisfactory charging rate. Valves used in this way, however, will give only limited service, as the life of a valve depends on the load.

Small Arc Rectifiers.

Undoubtedly the best proposition is that of an "arc" rectifier. Half-wave rectifiers working on this principle and delivering charging currents of 3 to 10 amperes are well known, but small arc rectifying valves are now available fitted with electrodes arranged to give, if desired, full-wave rectification and capable of charging a 6-volt battery at about 1 ampere.

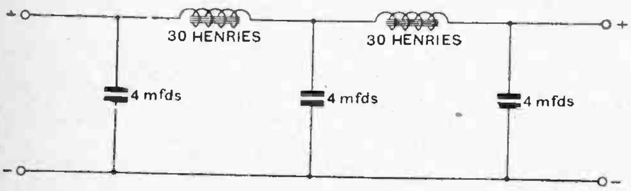


Fig. 7.—The choke coil in the smoothing circuit must be of high inductance, and the condensers of adequate capacity

In an endeavour to eliminate the use of batteries as far as possible, it might be pointed out that grid biasing potentials may be produced across a resistance connected in a valve grid circuit and arranging to form part of the path of the H.T. current supply. By this means the grid battery can be dispensed with and the circuit arrangement can be so adjusted that any ripple which is existent in the plate potential is also existent in the grid biasing potential tending to nullify the irregularities. Thus a rise in the plate potential is counteracted by an increase in the negative biasing potential applied to the grid.

It must be admitted that the quality of speech and music reproduction is definitely spoilt by the slightest hum even although only audible when a transmission ceases.

Filter Circuits.

Referring to filter circuits, the chief essential is that both chokes and condensers are adequate in size. The best arrangement is that shown in Fig. 7, consisting of two chokes in the positive lead bridged across to the negative by three banks of condensers.

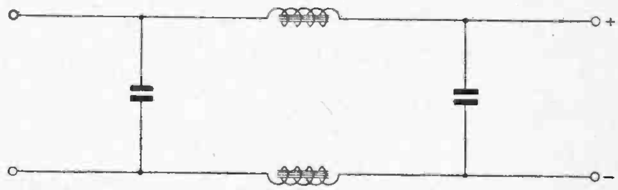


Fig. 8.—In this form of smoothing circuit the choke in one of the leads may become short circuited by being earth connected both on the mains side and through the receiver.

Rarely in commercial smoothing circuits does one find a pair of chokes used in this way, and if a single choke only is to be used it should have a value approaching 100 henries. The principle reason for not adopting the smoothing circuit shown in Fig. 8 is that, in the event of an autotransformer being employed so that the negative lead is earth connected on to the mains, the section of the choke in the negative lead becomes short-circuited when the negative output terminal is earth connected through the receiver.

It is not often realised that the residual hum and interference existing at the output of the filter are due as much to radio-frequency effects as to the actual fluctuating potentials on the line. Many readers must have observed the click produced on the receiving set when an electric light switch is turned off, and have heard the hum produced when a small motor is switched into circuit. This interference is transferred to the set mainly by radio-frequency waves, and when the mains are directly connected to the set this effect is more marked. Radio-frequency chokes, therefore, of low self-capacity and an inductance value of about a millihenry may with advantage be connected in the H.T. leads. Bridging condensers between the various H.T. points of distribution and the filaments in the receiver are essential. Owing to radio-frequency interference, earthing on to the mains in the usual way through a protecting condenser is inadvisable, and the use of the mains as an aerial which, in any case, can only serve as a poor collector, is inviting a form of interference which is difficult to eliminate.

SPECIAL FEATURES IN NEXT WEEK'S ISSUE.

HOW TO BUILD A TANTALUM TRICKLE CHARGER.
NEW PIEZO-ELECTRIC WAVEMETER.
PORTABLE SUPERHETERODYNE.

SMALL POWER TRANSFORMERS.

A Design for a Valve Rectifier.

By W. JAMES.

OUR problem is to design a transformer for supplying A.C. power to the filaments of a valve receiver and to a rectifier-filter combination for the plate circuits. We will assume the valves used in the receiver are of the 6-volt type, and require a maximum current of 2 amperes at 5.5 volts; this current allowance is ample, even when power valves are used. We will also assume that a direct current at approximately 160 volts is required for the plate circuits, a value which is satisfactory when valves of the 6-volt ¼-ampere type are used in the low-frequency and output stages. This voltage will have to be reduced in those instances where the valves used will not stand prolonged running at so high a voltage, although it should be remembered that one of the main requirements for good quality loud-speaker reception is an ample supply of current at a high voltage.

Estimating the Dimensions.

This brings us to the question of the rectifier. Valve rectifiers are undoubtedly the most reliable, but many of those interested in the conversion of A.C. to D.C. will not wish to use a special rectifying valve, but would rather use ordinary receiving valves as rectifiers. The next thing to be settled is the type of valve which will prove most economical in the long-run. Of course, for ordinary receivers taking a total plate current of about 15 milliamperes, a power valve of the "D.E.5" type with its plate and grid connected together can be used in each side of the rectifier, but when the receiver takes a plate current of 30 milliamperes or more, as a 5-valve set would when employing an "L.S.5.A" valve in its output stage, it would probably prove to be more economical to use "L.S.5" type valves.

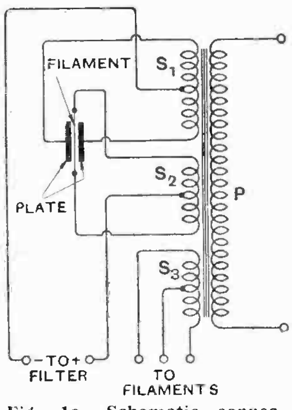


Fig. 1a.—Schematic connections of a full-wave rectifier. In practice the rectifying valve may be as indicated or two ordinary valves can be used.

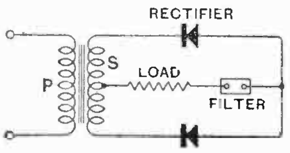


Fig. 1b.—Explanatory diagram of a full-wave rectifier connected to a load through a filter.

Our rectifier will be connected as in Fig. 1, and the transformer will require four windings, one primary for connecting to the mains (P), two for the rectifier (S_1, S_2), and one for the filaments of the receiving valves (S_3), and we will assume the main supply is at 240 volts 50 cycles. We have now to provide windings giving 5.5 volts for the filaments of the receiving valves, 5.5 volts for the rectifying valves, and 160 + 160 volts for the plate circuit of the rectifier.

There are now two things which ought to be considered before proceeding with the actual design of the transformer. The first is that the efficiency of the rectifier is not very high, so that it will not be worth while to take a great deal of trouble to make the transformer thoroughly efficient. A second thing is, that while a manufacturer will design his transformer on a cost basis, the amateur constructor will more likely be guided by considerations of convenience and ease of construction. For instance, if the amateur has to cut his own core pieces

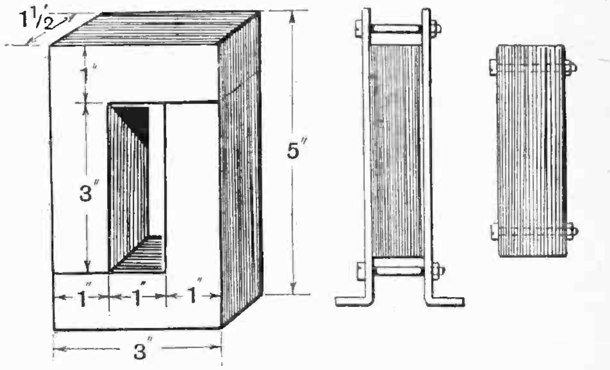


Fig. 2.—Details of the core of the transformer.

from sheet transformer iron, he will probably be desirous of employing a small iron core with correspondingly larger windings, while, should he be so fortunate as to be able to purchase material suitable for the core, he will, no doubt, make the core as large as possible, so as to reduce the number of turns of wire in the coils. A further point of some importance is that the amateur will find that he cannot put as many turns in a given space as a manufacturer with his coil-winding machines.

It is, therefore, to be expected that a home made transformer will be a little more bulky than a manufacturer's product of the same rating, although this is a matter of negligible importance.

We have assumed that our filament circuits will require 5.5 volts 2 amperes each, or, say, 22 watts and the plate circuits 15 milliamperes at 160 volts. It will, therefore, be reasonable to assume that the full load primary current at 240 volts will not exceed 0.2 ampere. Now the current to be carried is the main factor to be considered when deciding on the size of the wire, and we will choose No. 18 D.C.C. for the filament windings, No. 38 D.C.C. for the plate circuit windings, and No. 28 D.C.C. for the primary. These wires wind 297, 5,000 and 1,600 turns per square inch respectively.

A method of design which has proved satisfactory was given in detail by the writer in *The Wireless World* of August 27th and September 24th, 1924. The method, briefly, is this: From the formula

$$E = 4.44 f\, ZN \times 10^{-8},$$

where E = voltage,
f = frequency,
Z = maximum value of the flux, and
N = number of turns,

Small Power Transformers.—

we can find the number of turns by putting in the formula the known values of E and f and an assumed value of Z. To get an idea of the maximum flux we will assume the core to have a cross-section measuring 1in. × 1.5in., and the maximum flux density to be 60,000 lines per square inch. Then, assuming 0.8 of the cross-section of the core is iron, the remainder being occupied by the insu-

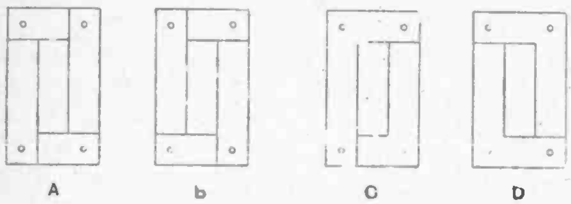


Fig. 3.—Method of assembling core pieces. The first layer is arranged as at A or C, the second layer as at B or D, and so on.

lated surfaces of the laminations, the total flux is 1 × 1.5 × 0.8 × 60,000 or 72,000 lines. Now the applied voltage is 240, and the frequency 50 periods per second. Then

$$N = \frac{240 \times 10^8}{4.44 \times 50 \times 72,000} = 1,500 \text{ turns.}$$

Having found the number of turns in the primary winding, we can at once estimate the turns required for the secondaries, and these work out at 35 each of No. 18 D.C.C. for the two filament heating windings and 1,000 + 1,000 of No. 38 D.C.C. for the plate circuit winding. To compensate for the fall in voltage when carrying current the number of turns in the filament windings may be increased to 38 each.

The amount of space required for the windings must now be found and works out at 1.8 square inches. To this must be added the space occupied by insulating material, giving a total winding space of, say, 3 square inches. A trial transformer core can now be drawn, making the opening or the window of the transformer 3 square inches. From this the weight of the iron can be estimated, which, in the case of the core of Fig. 2, works out at about 5 pounds. Assuming Stalloy is used, the loss in watts per pound for which is about 0.75, it is found that the total core loss is about 3.8 watts.

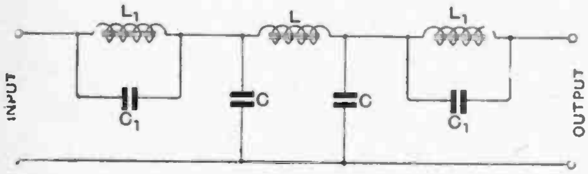


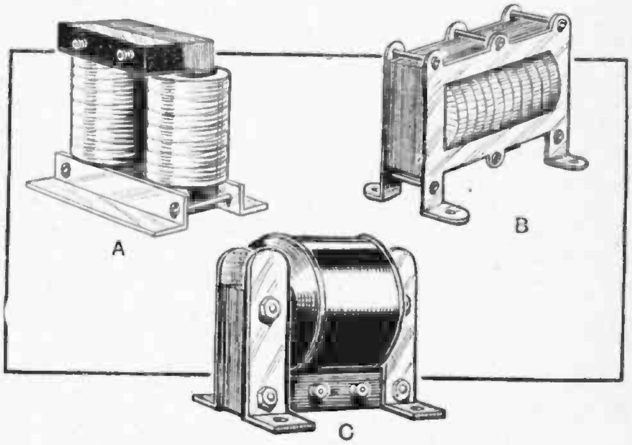
Fig 4.—Connections of an effective filter.

Next, the copper losses should be estimated by calculating the length of the wire in the different windings and then their resistance. Assuming a mean turn to be 6in. long, we have for the primary a length of 250 yards, which has a resistance of 35 ohms; for the secondary plate circuit winding, 280 ohms; and for the two filament windings, 0.15 ohm. If the total copper losses are now estimated they will be found to be about 2.6 watts. Thus the estimated losses are, for the iron 3.8 watts, for the copper 2.6 watts.

Finally, the magnetising current should be found, and in the example we are considering is approximately 0.06 ampere. This figure is obtained by finding the ampere turns required to magnetise the core, and is given by the mean length of the core multiplied by the ampere turns per inch, which may be taken as 10 for Stalloy. Thus the ampere turns required are 120, and this divided by 1.4 multiplied by 1,500 gives the current.

The transformer will, therefore, be a satisfactory one, although its efficiency could be increased by reducing the size of the window, but as this would necessitate very careful construction of the coils it is better to sacrifice a little efficiency for ease of construction.

The core should preferably consist of Stalloy stampings about 0.015in. thick, and L pieces should be used in preference to straight core pieces. These are assembled as indicated in Fig. 3, and the completed core may be held together by bolts passed through holes in the corners, or the laminations may be clamped between brackets.

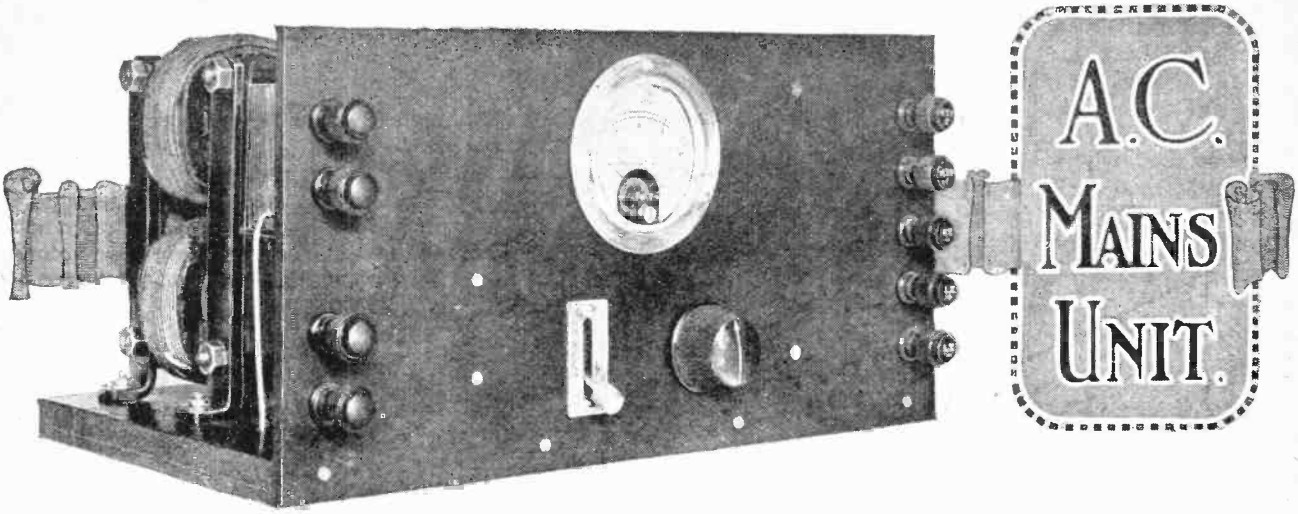


(a) General arrangement of typical transformers. Transformers A and C are of the core type; while B is of the shell type.

It will be necessary to wind the coils on a wooden former, and the core should be made a little larger than the iron core of the transformer. Cheeks should be fitted and the core split so that it can be removed from the coil without difficulty.

There are two satisfactory methods of winding; one is to place all the windings on one limb, and the other is to put half the primary on one limb with the high voltage secondary, and the other half of the primary on the second limb with the two filament windings. Probably the simplest method is to put all the windings on the one limb. The primary winding should be put on first, then two or three layers of Empire cloth, followed by the high voltage winding. This winding should also be covered with a few layers of tape, and then the filament windings can be put on. Finally, the coils are tied, taken from the former, and taped over.

The varying current obtained from the rectifier is not a satisfactory supply for the plate circuits of a receiver; a smoothing system has to be used, and is connected between the rectifier and the receiver. A filter which has been found satisfactory is connected as in Fig. 4, and the values for 50 cycle full-wave rectification are as follow: L, 50 henries; C, 5 mfds.; L_1, 0.63 henry; C_1, 4 mfds.



A.C. MAINS UNIT.

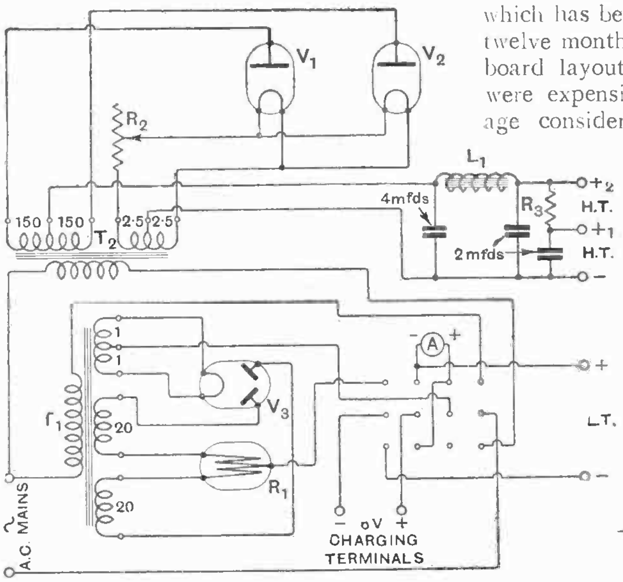
Making an Instrument for Deriving H.T. and L.T. from the Lighting Mains.

By F. H. HAYNES.

THE frequent requests for information as to the best method to adopt for deriving filament heating and plate current from public supply alternating current mains has caused the writer to convert a miscellaneous collection of apparatus used for this purpose into a compact unit with controls and terminals conveniently arranged.

Rectifying equipment working from a 240-volt 50-cycle supply was primarily required for supplying high voltage to a small transmitter, and the application of the apparatus as a substitute for the H.T. battery of a receiver was the logical outcome. The writer well remembers a discussion at a meeting of the Transmitter and Relay Section of the Radio Society of Great Britain on the use of 50-cycle A.C. for plate current supply. There was an almost undivided expression of opinion that the problem was by no means easy to solve. It is quite a simple matter to obtain a smooth rectified output when the frequency of the supply exceeds 250 cycles. So, retaining a rectifying system fed from noisy revolving machinery delivering a 700-cycle supply, the writer set about building an auxiliary plant for operating direct from the 50-cycle mains.

He had certain prejudices at the onset in respect of two points. Firstly, that single-wave or even full-wave rectification using rectifying valves of moderately high impedance was unsatisfactory, and that electrolytic rectifiers were messy and required constant attention, the wave form of the output being such that smoothing would be both difficult and costly. These objections still hold good, electrolytic rectifiers for H.T. supply having passed practically out of use, while the smoothing equipment of a 50-cycle valve rectifier costs more as a rule than the rectifier proper. The exacting requirements of a transmitter as to smoothness of plate current supply set a high standard, for a rippling H.T. gives rise to a broadening of tuning resulting in loss of range, while fluctuations would be very evident when attempting telephony transmission. A successful H.T. mains unit was evolved which has been in constant service for some twelve months, but although a simple baseboard layout was adopted the components were expensive, in view of the high voltage considered necessary for working a resistance-coupled L.F. amplifier and the considerable load taken by the transmitting set.



Full-wave rectification is provided on both the H.T. and L.T. circuits. When the H.T. rectifier is in operation the change-over switch breaks the primary of the battery charging transformer taking the accumulator off charge and connecting it through to the L.T. output terminals. Throwing the switch to cut off the H.T. supply sets the arc rectifier in operation imparting a steady charge to the accumulator.

Full-wave Rectification.

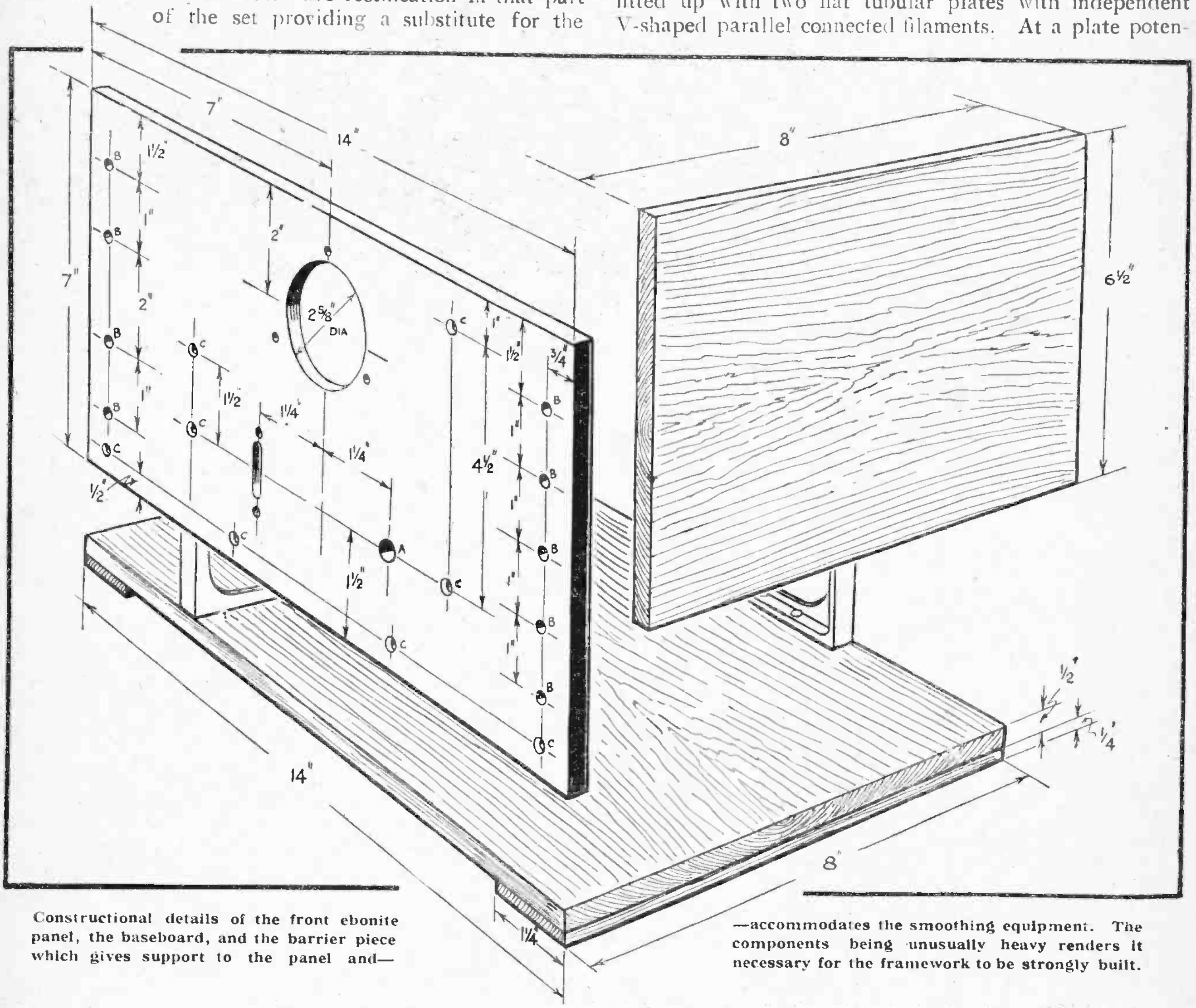
When the maximum potential required does not exceed 150 volts and the load is limited to 10 or 12 milliamperes, a rectifier can be constructed cheaply and easily, the running of which will show a saving on the use of dry cell H.T. batteries.

Although satisfactory results can be obtained with a half-wave valve rectifier, the adoption of full-wave rectification is strongly recom-

A.C. Mains Unit.—

mended, for a less elaborate filter circuit will be needed. Not the slightest A.C. hum is to be permitted, for a ripple, although not audible above a telephony transmission, will combine with the speech frequencies tending to destroy some of the finer qualities.

Not so much with a view to economising in the current consumed from the mains, but primarily to limit the dimensions of the transformer, valves with dull emitting filaments are used for full-wave rectification in that part of the set providing a substitute for the



Constructional details of the front ebonite panel, the baseboard, and the barrier piece which gives support to the panel and—

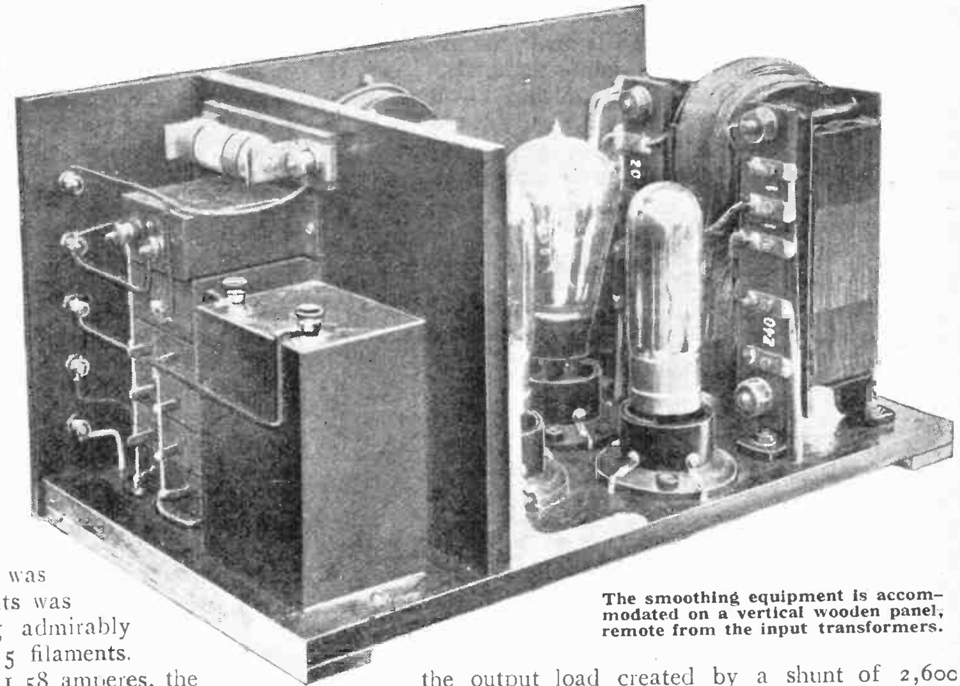
—accommodates the smoothing equipment. The components being unusually heavy renders it necessary for the framework to be strongly built.

H.T. battery. The filaments are heated by means of a step down winding, and the load imposed on the transformer is about one-third of the total output.

Valves of the D.E.5, D.F.A.1 or B.4 types proved to be most suited to the work, the grids and plates being linked across externally in the valve socket. Several valves are now available of special construction possessing very low impedance and with the grids omitted. Those used are the new Osram type U.4, requiring a filament potential of five to six volts and passing a current of 0.25 ampere. With five volts applied to the filament and a plate potential of 25, the very liberal emission of 12 milliamperes is obtained, the plate current increasing rapidly up to 30 milliamperes with a plate potential of 50 volts.

Tested on a plate potential of 96 volts and a filament potential of 5.4 volts, the total emission reached 44 mA. Another type of Osram valve has been developed by the General Electric Co., Ltd., for rectified H.T. supply, to be known as the U.5. It is a full-wave valve fitted up with two flat tubular plates with independent V-shaped parallel connected filaments. At a plate potential of 25 volts and 5 volts across the filament, the emission is 60 mA., and at 60 volts is 180 mA., showing the impedance to be of an exceedingly low order brought about by very small filament to plate spacing. Low impedance is a desirable property of valves used in this way, as the voltage drop across the valve is kept to a minimum, and less elaborate smoothing becomes permissible. The U.5 gave a maximum emission of 240 mA., though the filament current at 5 volts is in excess of that taken by two D.E.5 valves in parallel, and the transformer used in the rectifier shown here is

A.C. Mains Unit.—
incapable of providing the required current.



The smoothing equipment is accommodated on a vertical wooden panel, remote from the input transformers.

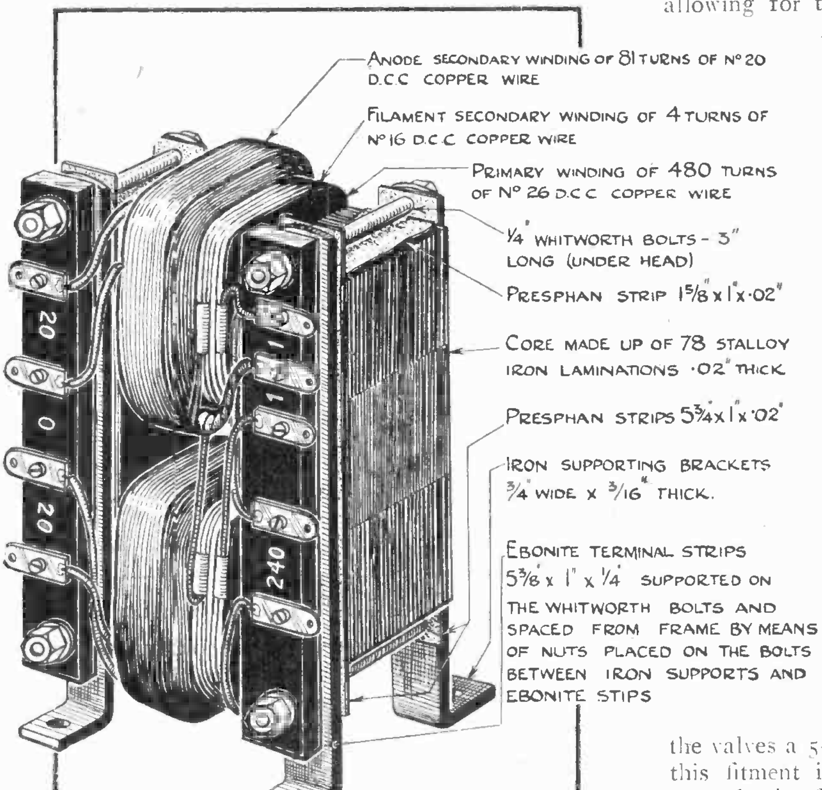
The H.T. Transformer.

The transformer used for heating the filaments of the rectifiers is a standard product on the market. At first sight it was thought to be too small for the job, and was, therefore, subjected to test before being incorporated in the instrument. The primary, which is marked 220, was tested with a potential across the terminals of 200 volts at 50 cycles. On open circuit the filament secondary developed a potential of 5.6 volts, and when a normal working load of 0.6 ampere was applied, a potential of 5.4 volts was maintained, the output being admirably suitable for heating the D.E.5 filaments. When loaded to the extent of 1.58 amperes, the potential was 4.8 volts. As to the high voltage secondary, a potential of 290 volts was given when the output was shunted by a resistance of 4,000 ohms. On the output load created by a shunt of 2,600 ohms, the voltage fell to 240. The secondary is, of course, split by a centre tap, so that 120 volts is the potential fed to the plates of the rectifying valve, and, allowing for the voltage drop through the valves in the filter circuit, a final output on full load of 100 volts is satisfactorily maintained. On test there was no sign of overheating after one hour's run at full load.

Smoothing Equipment.

The remainder of the apparatus in the H.T. supply circuit consists of a 50-henry choke, two banks of smoothing condensers of 4 and 2 mfds., and a resistance bridged with a 2 mfd. condenser to give the required voltage drop for providing a suitable potential to the detector valve.

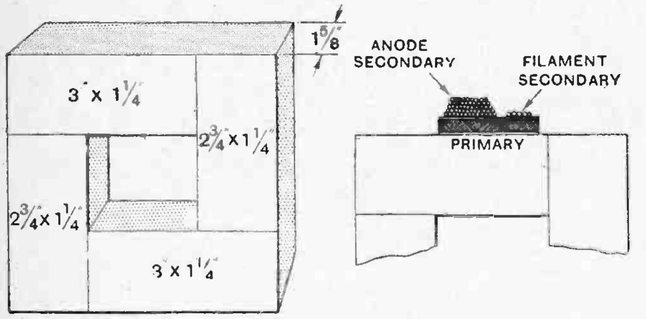
There is considerable latitude as regards actual layout of the components for H.T. supply, and those readers who do not feel disposed to incorporate the L.T. equipment will find that the form of construction adopted in which the smoothing choke and condensers are assembled on the side of a wooden cross panel placing the two valves in the centre of the instrument and the transformer on the extreme left works out very well. The front panel in this case should be 2½in. shorter. For the purpose of controlling the output voltage by regulating the potential drop through the valves a 5-ohm filament rheostat is provided, although this fitment is not essential. The change-over switch controls the filament current supply to the L.T. output terminals, and when only concerned with the H.T. equipment, this should be replaced by an "on and off" switch connected in the primary.



Details for making the L.T. transformer.

A.C. Mains Unit.—

The trickle charging method is made use of for feeding the L.T. plus and minus output terminals. Another pair of terminals is fitted, to which a 6-volt accumulator is connected and kept on a steady rate of charge when the receiving set is not in use, and, by throwing the key switch, the H.T. equipment is brought into action,

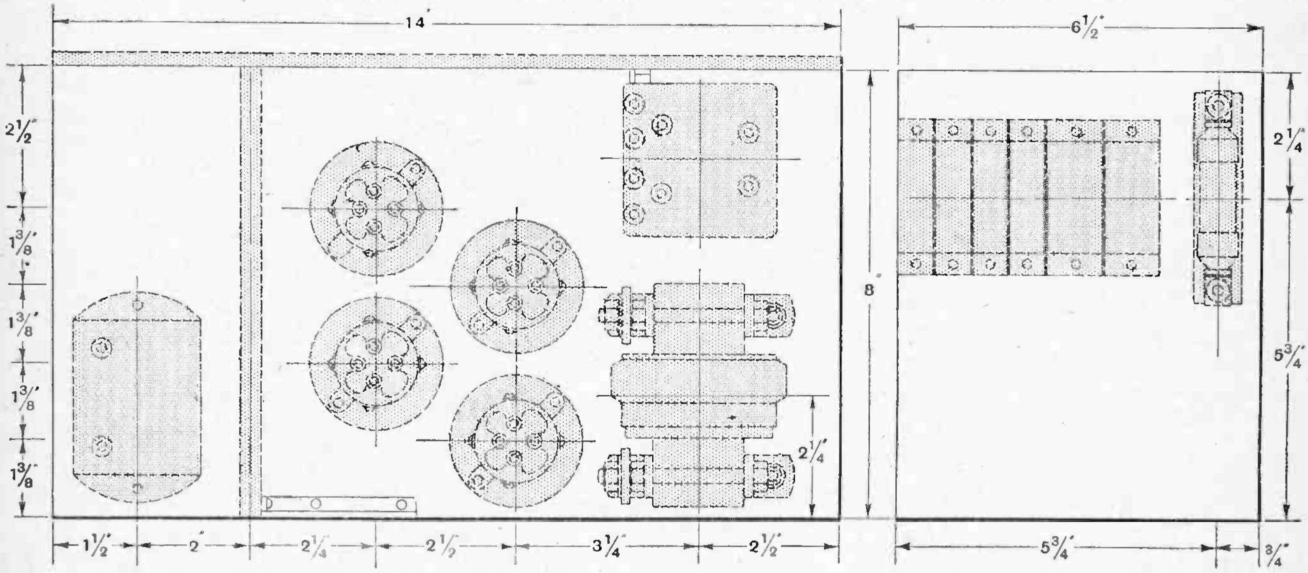


The L.T. transformer is assembled with Stalloy iron strip 1¼ in. in width. So that the strips can be interleaved, the top and bottom limbs are built up first with the pieces 2¾in. in length, the free ends projecting alternately in opposite directions. It is advisable to construct a cardboard bobbin to carry the primary winding. The two secondaries are pile wound.

while the battery is taken off charge and put through to the L.T. terminals.

"Trickle" Charging.

The writer has carefully tested all systems of battery charging from A.C. supply, including buzzer rectifiers,



Dimensional drawing showing the positions of the various components on the baseboard and vertical barrier.

small motor generators, and electrolytic cells, but the so-called "arc" rectifier is probably the most satisfactory, as it requires no attention, is clean and non-corrosive, silent and safe in operation, and a failure of the supply current does not demand immediate disconnection of the battery. The valve used with this system has not an indefinite life, but a small cheap type of valve is now available capable of charging a 6-volt battery at about 1.3 amperes and having a life of at least 1,000 ohms. The principal problem with which the amateur is faced is that of obtaining a transformer for use with this class of valve, and although the manufacturers of the valve supply a transformer incorporated in a complete charging outfit, the reader may feel disposed to construct his own transformer for building into this A.C. mains unit. The small Philips valve will give full-wave rectification, and the filament, which is of low resistance, is operated on a 2-volt supply, while the two anodes are fed at 20 volts from two independent windings linked across by a protecting resistance which is arranged in the circuit as a current limiter to the output leads. This resistance, also a Philips product, is made especially for use with the small rectifying valve, and is itself built in valve form, being fitted with pin connectors for use with the standard valve-holder.

A meter has been fitted having 1.5 ampere full-scale reading as an indicator of the rate of charge and discharge, and two of the switch contacts reverse the connections to the meter in preference to making use of a scale with centre zero.

Preventing Induction between A.C. and D.C. Leads.

The wiring up is carried out almost entirely beneath the base with No. 22 S.W.G. tinned copper wire in lengths of insulating sleeving of various colours. Care must be taken to guard against bringing the leads carrying the smoothed H.T. output into close contact with leads carrying alternating current. The arrangement of the components has been carefully considered bearing this point in view, the transformers being separated from the smoothing apparatus by the valves, the output choke and condensers being accommodated immediately behind the output terminals and arranged so that the leads are kept well away from the input circuits.

The service given by the unit will undoubtedly repay one for the time and expenditure incurred in its construction.

The unit described was essentially developed for operating a seven-valve superheterodyne receiver, and the performance obtained is precisely similar to when using

PARTS REQUIRED.

¼in. Ebonite panel, to finish, 7in. × 14in.

½in. Planed mahogany for the baseboard and upright back panel.

2 Wooden strips, 8in. × 1¼in., × ¼in. to batten the baseboard and provide a recess for wiring.

9 Terminals. One pair at least should be ebonite shrouded for connecting the main leads.

4 Valve holders, Aermonic (A. F. Bulgin & Co., 9-11, Cursitor St., London, E.C.4).

Mains transformers for H.T. (Electro Supplies Co., 19a, Broadway, London, S.W.19, or Leslie Dixon & Co., 9, Colonial Avenue, Minories, London, E.C.1), while a suitable compact form of ring transformer is obtainable from A. W. Knight, Ltd., 167, Rye Lane, Peckham, London, S.E.15.

Step-down transformer for the L.T. rectifier and built to the data given (Rich & Bundy, 13, New Road, Ponders End, Middlesex).

Two position 4-pole switch, Utility (Wilkins & Wright, Utility Works, Kenyon St., Birmingham).

5-ohm filament rheostat.

4 2-mfd. condensers. The ordinary T.C.C. type will be found quite satisfactory.

Intervalve transformer for use as smoothing choke or a special high inductance choke of adequate current carrying capacity is obtainable from Rich & Bundy.

Western or other reliable moving coil meter reading up to 1·5 amps. (optional).

2 U.4 valves.

Philips type rectifying valve, No. 328, also protecting resistance lamp, No. 329.

4 ozs. No. 22 S.W.G. tinned copper wire.

Lengths of insulating sleeving in various colours.

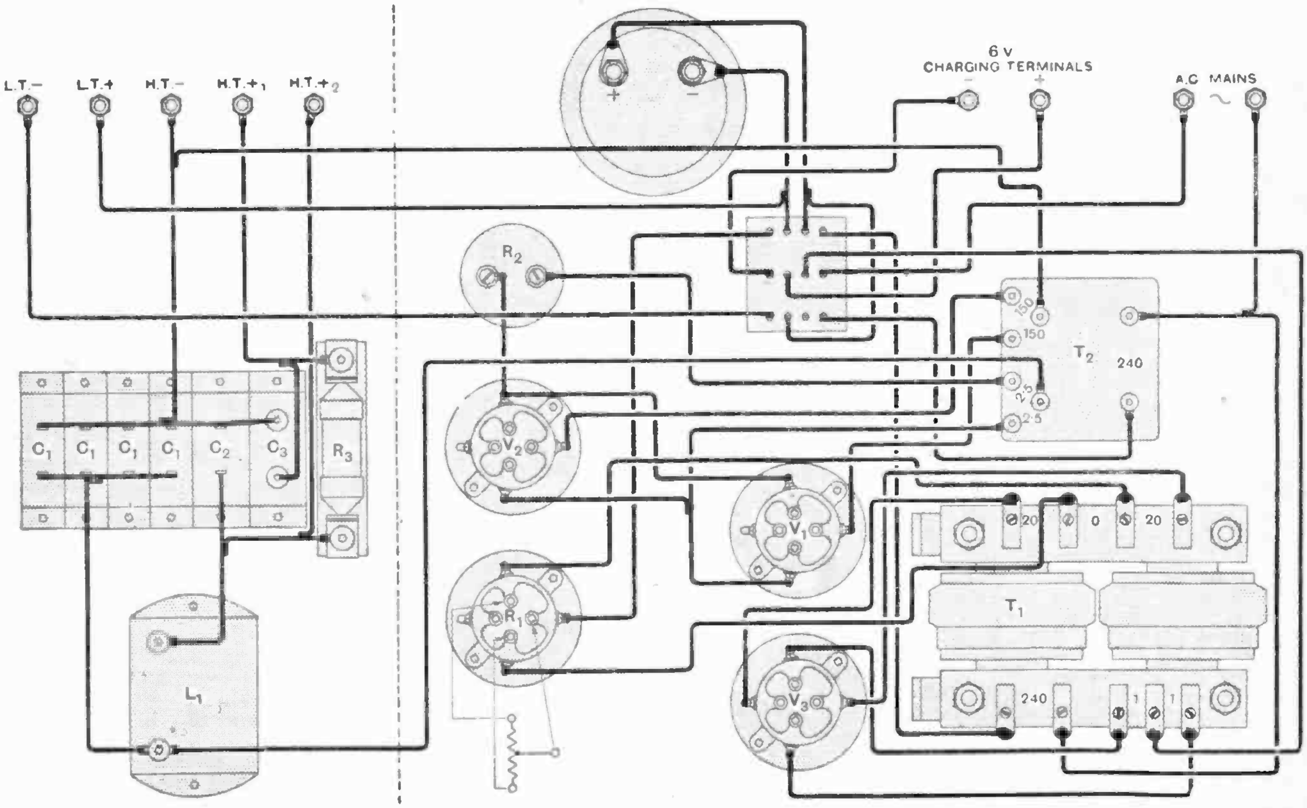
2 Angle brackets (A. J. Dew & Co., 33-34, Rathbone Place, Oxford St., London, W.1).

The rectifying unit can be accommodated in a standard American type cabinet 14in. × 7in. × 8in. deep obtainable from W. & T. Lock, St. Peter's Works, Bath.

Varley resistance with clips, 20,000 ohms (Oliver Pell Control, Ltd., Granville House, Arundel St., London, W.C.2).

Approximate cost without meter or cabinet, £6. The three valves and lamp resistance will cost £2 7s. 6d.

a secondary H.T. battery. The somewhat critical H.T. voltages required by the superheterodyne can be satisfactorily maintained, and a falling off in sensitiveness experienced in the case of an H.T. battery when the potential starts to fall is avoided. Small changes in the output potentials have been observed, due essentially to fluctuating conditions on the supply mains. The output H.T. voltage varies slightly according to the number of valves in use in the receiving set, and, connected up to a five-valve neutrodyne with negative biased H.F. valves, the maximum voltage was about 100 to 105, while the potential fed to the detector was brought down to about 40 volts by a non-inductive series resistance having a value of 20,000 ohms. The potential drop created by the resistance will depend upon the value of the anode current in the detector circuit. If a power valve



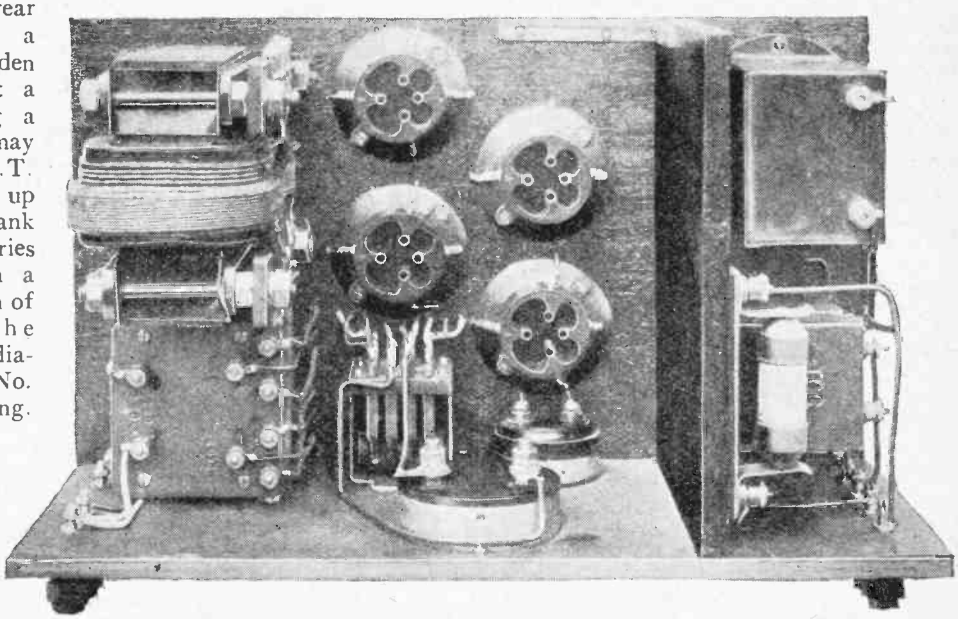
Although the wiring may appear to be complicated it is quite easily accomplished, as capacity between the leads is of no consequence and connecting up with soft wire in insulating sleeving by the shortest route is very much more simple than stiff wiring necessary in wireless receiver construction.

A.C. Mains Unit.—
demanding a moderate anode current is brought into operation in a receiver deriving H.T. from the unit, it must not be overlooked that the potential applied to other valves in the set may become slightly reduced.

Reference to one of the rear view illustrations shows that a space has been left on the wooden dividing board in order that a radio-frequency choke having a value of roughly 1 millihenry may be accommodated in the H.T. positive lead as it passes up through the base to the first bank of smoothing condensers. A series of basket coils assembled on a spindle is perhaps the best form of construction to adopt. The cards should be 2in. in diameter with 1in. centres, and No. 36 D.S.C. wire used for winding. Eight basket coils held apart with thin card spacers and secured to the wood by three long brass screws make a good H.F. choke.

The unit is readily adapted for the use of a full-wave rectifying valve for H.T. supply. For this purpose it is only necessary to link across the grid pin of the valve holder which is to accommodate the full-wave valve to the plate pin of the other holder.

Both holders may with advantage be cross-connected in this way for giving a particularly liberal output.



View of the baseboard, showing the arrangement of the components. All wires pass straight down into the board and are pulled tight, taking the shortest path from point to point.

NEWS FROM THE CLUBS.

Wavelength Measurement by Lecher Wire Method.

At a meeting of the Golders Green and Hendon Radio Society held on June 3rd, Mr. C. L. Thompson gave a very successful demonstration of the Lecher wire method of measuring wavelengths. He employed a three-meter oscillator, using two L.S.5 valves with the metal bases removed. These functioned well on the short waves and delivered plenty of power. Considerable interest was aroused by the tantalum rectifier by means of which Mr. Thompson drew his power from the mains.

Hon. Sec. Lt.-Col. H. A. Scarlett, 357a, Finchley Road, N.W.3.

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Warwick School Society Visits 5XX.

By kind permission of the B.B.C. some twenty members of the Warwick School Wireless Society visited the high-power station at Daventry on Wednesday, June 16th. The party was kindly conducted over the station by two members of the Staff.

The telephony transmitter was seen in operation and the conversion of the speech input from London into a modulated carrier wave clearly explained panel by panel. It was obvious that extreme precautions were taken to minimise the delay caused by any ordinary breakdown, which explains the rarity of a prolonged technical hitch in 5XX's transmission. At the conclusion of the visit, the guides very patiently answered many questions regarding the technique of Broadcasting.

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Progress at Ilford.

Reviewing the results of the past twelve months, Mr. D. S. Richards, Hon. Secretary, reported at the Annual General Meeting of the Ilford and District Radio Society, that there had been an approximate increase of 50 per cent. in the total membership, and this, despite the adverse conditions ruling during the period mentioned. The Society was amongst the leading ones in the Essex group. Lord Lambourne, the Lord Lieut. of the County of Essex, had graciously honoured the Association by becoming its patron, and now the Council had to announce that Mr. John Elborne, M.A., had kindly consented to act as Hon. Legal Adviser and Solicitor. The Council were actively engaged in promoting co-operation and closer relationship with other radio societies in the County of Essex. Mr. H. H. Lassman (2PX), was elected President for the ensuing year.

Hon. Secretary, Mr. D. S. Richards, 50, Empress Avenue, Ilford.

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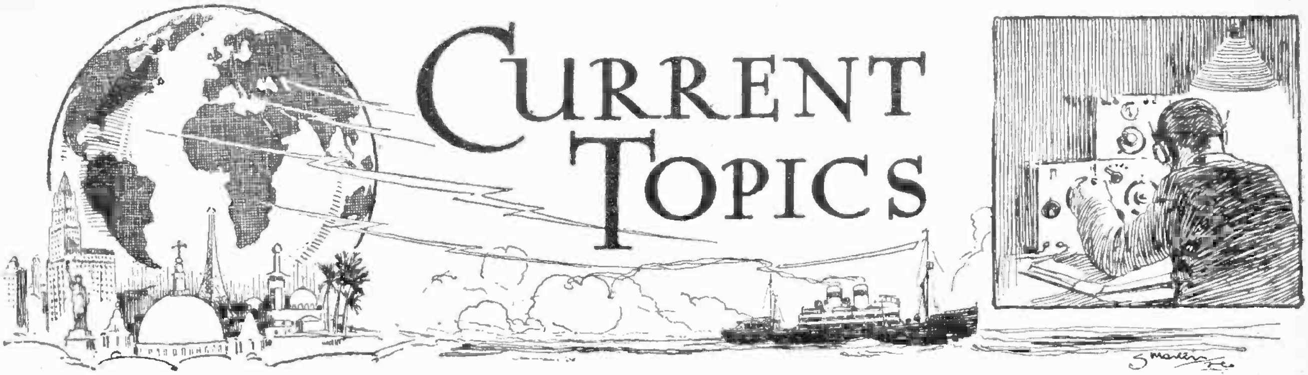
A Perfect Day.

Three men in a boat, with a small yellow pennant bearing the letters "I.R.S." floating above them, attracted much attention as they slowly paddled downstream at Flatford, near Ipswich, on Sunday, June 13th. It was a strange craft. Overhead was a motley collection of wires of ingenious design, whilst over the stern hung a bright tin can on a length of copper wire. From the ship's ventilator issued a sweet if not too powerful edition of the Sunday programme from Savoy Hill. The party were but one section of the Ipswich and District Radio Society, whose "Summer" field-day experiments had led them thither on that particular afternoon.

Ashore in a meadow, the main body were carrying out further experiments on a far larger scale, and after three casts a 30ft. aerial swayed between two large elms. A few minutes later three valves were supplying two loud-speakers with the necessary current. Close on a hundred people within a 50-yard radius enjoyed the music, and some of the rustics found themselves "listening" for the first time.

Tea was taken about five o'clock and after a thoroughly enjoyable outing the Society returned to Ipswich.



CURRENT TOPICS

Events of the Week in Brief Review.

GERMAN STATE AND BROADCASTING.

Under the new broadcasting adminstration in Germany the State will hold 51 per cent. of the shares.

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WIRELESS FOG SIGNAL.

An unattended fog signal, operated by wireless, has been permanently established on Rosneath Beacon, in the Firth of Clyde.

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SUPER-REGENERATION.

"The installation of wireless in Borstal institutions is aiding the regeneration of young lads hitherto almost untameable."—Sir William Joynson-Hicks.

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BRIGHTER LIGHTHOUSES.

In response to an appeal to the public, Mr. Hoover, U.S. Secretary of Commerce, has received nearly four hundred wireless sets for distribution among lighthouse men on the American coast.

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AN UNAPPRECIATIVE AUDIENCE.

Although the Colombo broadcasting station has been in operation for over two years, the number of licensed listeners throughout Ceylon is still under 300.

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GETTING VALUE FOR MONEY.

Mr. and Mrs. A. Povey, of Perth, Australia, are proudly proclaiming that they have never missed a single programme from the local broadcasting station.

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A COSTLY LEAD-IN.

A Montreal wireless enthusiast recently set his home on fire when trying to enlarge a lead-in hole.

He explained to the district fire chief that finding the hole too small he decided to enlarge it by using a red-hot poker. But, his house being a wooden one, the tarred paper used as an outside lining of the wall caught fire and the flames spread.

Quick work by the firemen prevented the fire from spreading to adjoining dwellings, though the wireless enthusiast will have to make good damage to his own house from ground to third floor.

BERLIN SPEAKS TO TOKIO.

A wireless telephony feat has been performed at Nauen, where the engineers have succeeded in conversing with Buenos Aires and Tokio. According to our Berlin correspondent the wavelength employed was 40 metres.

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WIGAN AGAIN.

In the Wigan County Court a few days ago the Registrar remarked that Wigan possessed a perfect forest of wireless aerials. Several broadcast comedians are said to be pondering over the observation.

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SETS ON HIRE.

You can hire a wireless receiver in Holland. A wireless hire service is the object of a company which has just been formed, and it is interesting to note that the hiring fee will include the cost of maintenance of valves and accumulators.

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ASKING FOR IT?

A Colonial wireless paper gives constructional details of "An All-iron Receiver." Says the writer: "At the risk of being called both foolish and ignorant, we have come to the conclusion that an all-iron receiver can be built about as efficient as one using copper."

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BROADCASTING AND THE BOLTON BOBBY.

The Chief Constable in Bolton reports that the wireless set installed in the police station during the general strike has now been removed. Is it possible that the delights of broadcasting proved too powerful a distraction for "Robert"?

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PANAMA SOLD OUT.

Very soon after the opening of the new broadcasting station at Balboa, Panama, the public demand for crystal sets was so great that local stocks were exhausted, dealers having to order shipments from foreign manufacturers.

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THOSE LOUD LOUD-SPEAKERS.

A number of complaints have recently appeared in the daily Press on the subject of noisy loud-speakers. In certain

AL FRESCO WIRELESS. The radio societies have not been slow to take advantage of a belated summer. The photograph shows members and friends of the Golders Green and Hendon Radio Society enjoying loud-speaker reception on the occasion of their annual picnic at Berkhamsted. A six-valve superheterodyne was used with a two-valve amplifier.

cases the trouble appears to be due to thin party walls and the only cure seems to be a noble and self-denying reduction of signal strength. In other instances, however, the vexation is caused by loud-speakers at open windows.

It is surely a thoughtless generosity which prompts people to imagine that every passer-by is thirsting for a wireless concert. When a concert is to be enjoyed *indoors* there seems to be no reason for planting the loud-speaker on the window sill; and if the programme is to be listened to in the garden the loud-speaker can easily be taken to the spot where the listeners are situated. Volume can then be reduced.

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SLUMP IN U.S. RADIO?

The Freed-Eisemann Radio Corporation, manufacturers of radio receivers under the Hazeltine and Latour patents, state that they have "entered the washing machine field with a revolutionary device."

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BERLIN RADIO EXHIBITION.

The third Berlin Radio Exhibition is to be held in the Radio Hall, Kaiserdamm, from September 3rd to 12th.

One of the principal features of the Exhibition will be the section organised by the postal authorities, who are partly responsible for the broadcasting service. Sound-proof cabinets will be available throughout the building so that visitors will have every facility for testing receivers under ideal conditions. The latest methods of radio photo transmission will be demonstrated, and a special section will be set apart for the display of amateur sets.

The organisers state that the Exhibition will not be "a mere show of dead apparatus, but a live picture of the radio industry."

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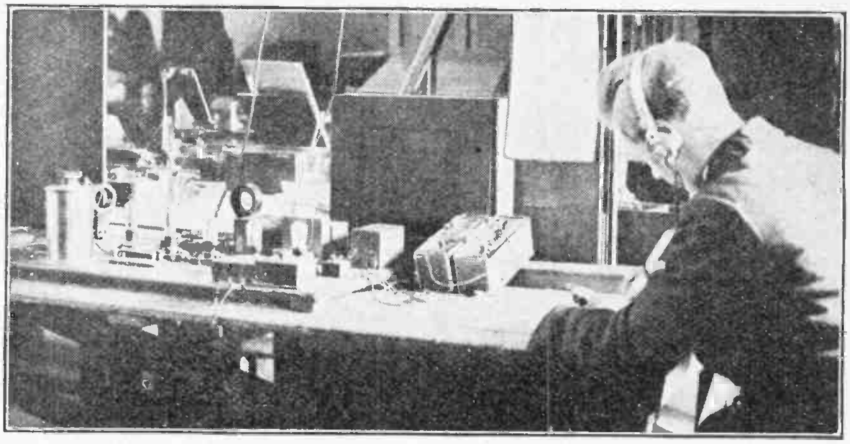
DISTANT CONTROL OF TARGET SHIP.

Wireless control has proved extremely useful to the British naval authorities during recent manœuvres off Malta. An old cruiser, employed as a target ship during gunnery practice, was directed entirely by wireless; the cruiser's course was altered, speed was increased and decreased and the smoke screen was thrown out, all these actions being controlled by wireless from another vessel.



NEW RECEIVING STATION AT 2RN. To supply the Irish listener with a daily summary of foreign news the Free State Ministry of Posts and Telegraphs has installed a special receiver at the Central Telegraph Office. In the photograph the operator is seen picking up foreign news for subsequent transmission from the Dublin broadcasting station.

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SPAIN OVERCOMES INTERFERENCE.

To prevent clashing between the various broadcasting stations the Government authorities in Spain have hit upon a very simple expedient. Each month a schedule of broadcasting times is prepared whereby adjacent stations may not transmit simultaneously. Such a scheme in this country might solve many perplexities, but it would hardly provide a solution of the alternative programme difficulty. In a word, the Spanish plan appears to be an admission of defeat.

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BROADCAST COPYRIGHT IN U.S.A.

The rights of authors and composers in connection with the broadcasting of their works have been definitely recognised in America by the National Association of Broadcasters, which has consented to a schedule of payments to members of the American Society of Authors, Composers and Editors in respect of copyright items broadcast.

The schedule runs thus:—

Stations of 5 to 100 watts, 2 cents per item.

Stations of 101 to 500 watts, 4 cents per item.

Stations of 501 to 1,000 watts, 7 cents per item.

Stations of 1,001 to 3,000 watts, 13 cents per item.

Stations of 3,001 to 5,000 watts, 18 cents per item.

Stations above 5,000 watts, 60 cents per item.

The payments relate to each separate performance of a copyright piece.

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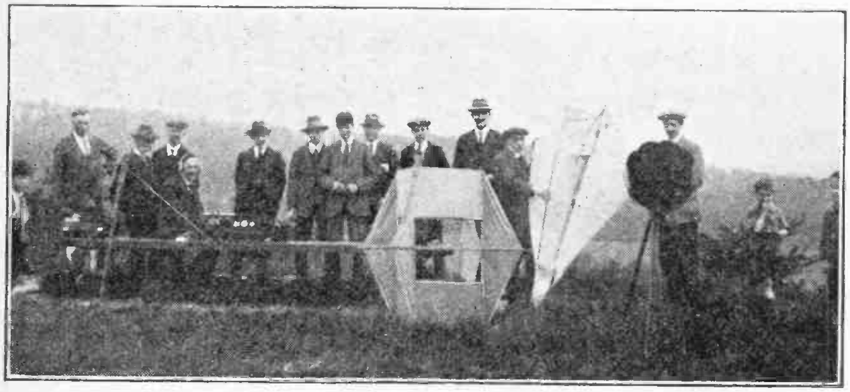
BROADCASTING FROM THE SEA.

A licence to broadcast from a yacht in American waters has been granted to the A. H. Grebe Company. The yacht will use the call sign WRMU.



EXPERIMENTS WITH KITE AERIALS. Members of the Guildford and District Wireless Society photographed on Pewley Downs, where successful experiments were carried out with kite aerials to determine the screening effect of the surrounding hills.

WIRELESS AT WESTMINSTER.

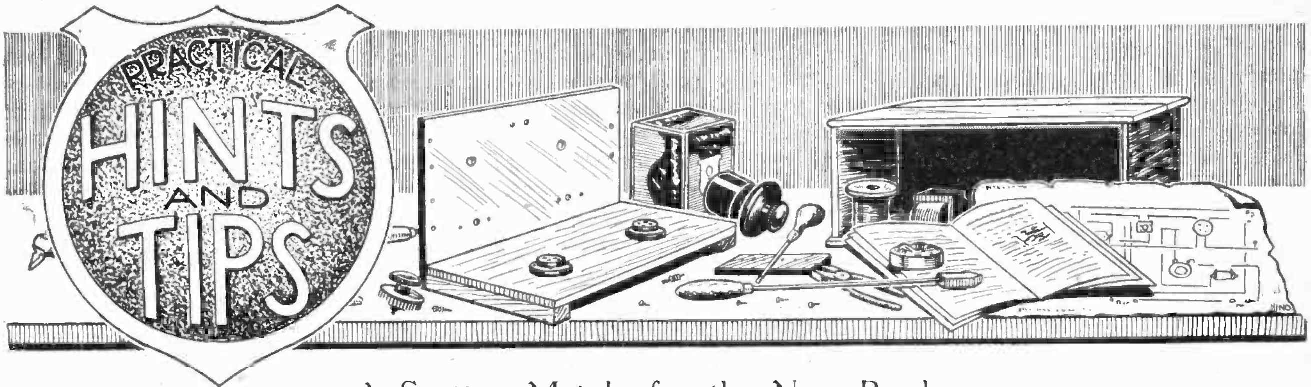
By Our Special Parliamentary Correspondent.

P.M.G. and Radiating Receivers.

In the House of Commons last week Mr. Day asked the Postmaster-General whether, in view of the oscillation annoyance experienced by wireless listeners, he would consider action to prohibit the use of reaction on the aerial.

Viscount Wolmer said that on the recommendation of the Broadcasting Committee of 1923 a condition was inserted in all wireless receiving licences that "reaction must not be used to such an extent as to energise any neighbouring aerial." He did not think it would be in the general interest to prohibit entirely the use of reaction, which was of considerable advantage in increasing the sensitiveness of wireless sets and only caused interference when improperly used.

Mr. Day asked if the Postmaster-General would see that the regulation was enforced and Viscount Wolmer replied that the authorities were enforcing it very strictly.



A Section Mainly for the New Reader.

POLARITY OF EXTENSION LEADS.

Twisted twin flexible wire is largely used for connection between a receiving set and a loud-speaker installed in a different room and is, as a rule, well suited for the purpose, although it is admitted that, in a very long length, there may be an undesirable high capacity between the two leads.

Amateurs often experience difficulty in determining which lead should be connected to the marked positive terminal of the distant loud-speaker, and, unless the two wires are distinguished from each other by differently coloured braiding, or in some other manner, it is necessary to make a test, using phones or a galvanometer. This test should be carried out before the wire is finally fitted between the two points, in order to avoid the necessity of a long testing lead.

In cases where the extension has already been installed without taking the precaution to mark the leads, or where the original markings have been destroyed, it is often possible to ascertain which is the positive wire by connecting, at the receiver end, one lead to the output terminal joining to H.T. +, and disconnecting the other wire. At the loud-speaker end of the extension, contact should be made with one hand to some earthed or partially earthed object, such as a gas pipe or radiator pipe, and the two bared ends of the wire should be touched in turn. That giving a slight shock will, of course, correspond to the end joined to the H.T. + terminal of the distant receiver. The average person is not inconvenienced by shocks from a battery of some 120 volts, but if any uncertainty is felt on this score it would be as well to reduce the H.T. voltage before commencing operations! This test is obviously only applicable when the negative end of the H.T. battery is earthed.

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A SIMPLE DUAL-AMPLIFICATION CIRCUIT.

The majority of the troubles encountered in getting a combination of H.F. amplifying valve and crystal detector into a state of satisfactory operation are directly traceable to an unsuitable form of coupling between the valve and crystal, or to the heavy damping effect of the latter on the tuned circuit across which it is usually connected. The design of suitable H.F. transformers to meet these conditions is by no means an easy matter, particularly when a wide band of wavelengths is to be covered.

Fig. 1.—A simple valve-crystal receiver.

The circuit shown in Fig. 1 enables us to avoid these difficulties, and possibly deserves to be better known, considering its simplicity and the fact that inexpensive components only are required. The aerial and secondary coils, L_1, L_2, and the reaction coil L_3, may be of the usual interchangeable pattern, although a conventional form of coupler, with a reaction winding of from 30-40 turns (for the broadcast waveband) is better, particularly when the aerial circuit is not separately tuned.

The crystal detector may with advantage be of high resistance; Perikon or "permanent" types usually give good results. The tuning condenser C_1 should have a maximum capacity of from 0.0003 to 0.0005 mfd., while C_2 (the use of which is more or less optional) acts as an H.F by-pass, and may be extremely small, say, about 0.00005 mfd. Its best setting will be ascertained by trial, and, once decided on, need not be altered. The effect of reversing the crystal should be carefully tried, as it will be found that one connection will give much better results than will the other.

Due to the fact that the crystal, which functions as a potential rectifier, is taking practically no current, the tuning of the circuit L_2C_1 is sharp, and the arrangement has a very fair degree of selectivity. Almost any type of valve may be used, and a low-frequency amplifier may be added in the usual manner, by connecting the primary of a transformer in place of the phones, without introducing any complications.

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OSCILLATING NEIGHBOURS.

A peculiar and unpleasant form of distortion is introduced by the effects of a near-by receiver either on the point of oscillation or actually oscillating "in step" with strong incoming signals, although no audible whistle or "beat note" may be detected. Experienced amateurs will recognise the symptoms at once, but the effects are apt to puzzle beginners, who often think that a fault has developed in their receivers.

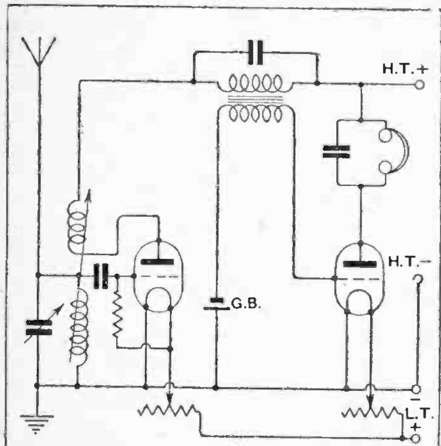
Provided that the aerial of the interfering set is really close at hand, the tuning of the receiver will be found to be unusually flat over several degrees of the condenser scale; this is probably one of the most certain indications that a neighbouring aerial is re-radiating strongly. Signal strength will sometimes be observed to vary considerably as the tuning of the interfering receiver is altered.

This very real trouble is much more prevalent than is generally realised. Unfortunately, there is no remedy—or, more accurately speaking, no remedy other than peaceful persuasion—which can be suggested in these columns, for obvious reasons. The conscientious wireless user will not only avoid actual oscillation, as indicated by the production of a beat note, but will also refrain from working his set just off the apparent oscillation point, at any rate, on the wavelength of the nearest station, whose signals are probably being received by the majority of his neighbours.

DISSECTED DIAGRAMS.

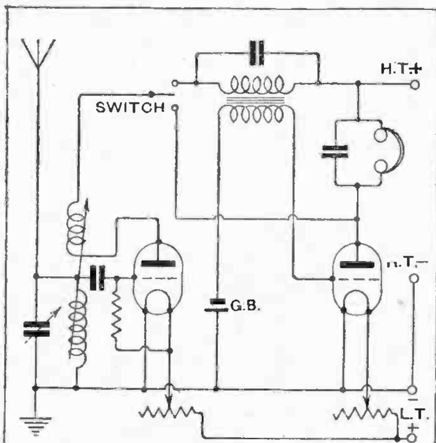
No. 35.—Switching a Standard O–V–1 Receiver.

The problem of eliminating the second valve of a detector-L.F. combination may appear to be an easy one, but in practice there are various minor difficulties, mainly connected with the H.T. supply, which must be overcome, generally at the expense of some slight complication. Various switching devices of practical utility are shown below.



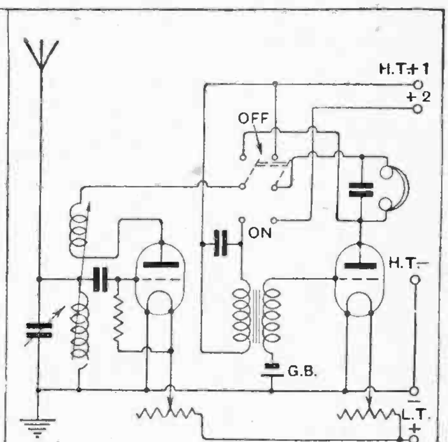
1

The simplest type of O–V–1 receiver. It is assumed that it is desired to be able to use either one or two valves at will. The various methods shown are applicable to any receiver using this basic circuit, with transformer-coupled L.F. amplification.



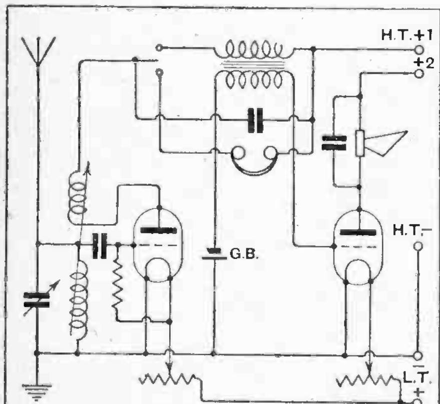
2

The simplest possible circuit, requiring only a single-pole change-over switch. The L.F. output of the detector valve is passed through either the L.F. transformer or phones. This method is only correct when a common H.T. supply is used for both valves.



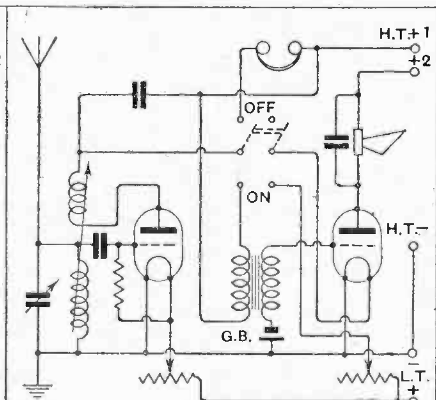
3

Separate H.T. tappings call for a slight elaboration of the preceding circuit, a D.P.D.T. switch being required. When the L.F. valve is being switched off, the H.T. voltage applied to the detector valve anode is automatically adjusted to the same value as before.



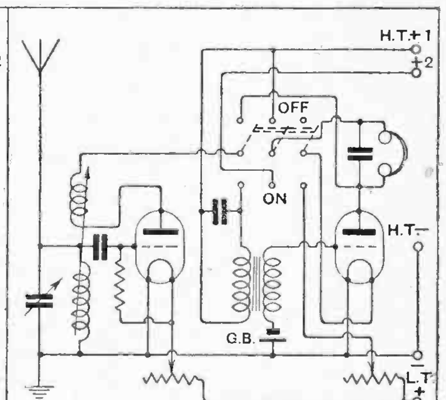
4

Another useful and simple arrangement, permitting of reception on phones with the detector valve, and on the loud-speaker with both valves. A common by-pass condenser shunts either phones or transformer primary. Note that, referring to Figs. 2, 3 and 4, it is necessary to turn off the rheostat of the L.F. valve when not in use.



5

Fig 4 is redrawn above, showing how a D.P.D.T. switch may be connected in order to obtain automatic control of the filament circuit, which is broken when the phones are in use.



6

Above is shown an elaborated form of circuit No. 3, with simultaneous control of the L.F. valve filament. The phones are transferred at the same time to the anode circuit of either the detector or L.F. valve, appropriate H.T. voltages being applied to each.

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S.

20.—Edison Signals Without Wires to Moving Trains.

SEVERAL methods of wireless communication with moving trains were proposed by different workers between 1838 and 1885, the idea having attracted attention from the earliest days of the electric telegraph. We have not space here to consider all the different systems, but will confine ourselves to a brief description of the system put into practice by the famous T. A. Edison. This system was suggested by Willoughby Smith, whose pioneer work we shall deal with in our next instalment.

Thomas Alva Edison was born on February 11th, 1847, at Milan, Ohio. He was the son of humble parents and received but little education until, at 12 years of age, he commenced work as a newspaper boy on the railways. In this capacity he contrived to while away the time on long journeys by conducting chemical experiments in a baggage van, until one day he set the van on fire, as a consequence of which he found himself without a job! However, a friendly station master taught him the elements of electric telegraphy, and Edison soon erected a line between the station and the neighbouring town, by which he conducted a regular service. He then invented a number of electrical devices, including duplex telegraphy, and later his quadruple and sextuple systems, which it is estimated effected an economy of over four million sterling in wire alone.

Thomas Alva Edison.

At 27 years of age he invented his printing telegraph, which brought him in a sufficient reward to enable him to leave the service of the railway and devote himself to research. Improvements to Bell's telephone; the invention of the microphone, the phonograph, the kinetoscope (an early form of moving pictures), the incandescent lamp, and a host of other electrical inventions speedily followed.

Influence of Early Railway Experience.

Amongst other problems that engaged his attention was communication with moving trains, his early experience on the railways no doubt emphasising the value of such a system.

In 1883 Willoughby Smith had read a paper before the Institute of Electrical Engineers, in the course of which he remarked :—" Telegraph engineers have done much towards accomplishing the successful working of our present railway system, but still there is much scope for improvement in the signalling arrangements. In foggy weather the system now adopted is comparatively useless, and recourse has to be had at such times to the dangerous and somewhat clumsy method of signalling by means of detonating charges placed upon the rails.

Signalling by Induction.

" Now it has occurred to me that induction might be employed with advantage in various ways for signalling purposes. For example, one or more spirals could be fixed between the rails at any convenient distance from the signalling station, so that when necessary intermittent current could be sent through the spirals; and another spiral could be fixed beneath the engine, or guard's van, and connected to one or more telephones placed near those in charge of the train. Then, as the train passed over the fixed spiral, the sound given out by the transmitter would be loudly reproduced by the telephone and indicate by its character the signal intended."

No doubt Edison had his attention directed to this lucid suggestion, for, with the assistance of E. T. Gilliland, he soon afterwards brought out a system that made use of the ordinary telegraph wires running alongside the railway.

The system was patented in England on June 22nd, 1885, in the joint names of Edison and Gilliland, and is fully described in their specification No. 7583. It was first used at Staten Island, U.S.A., then, a few months later, on the Chicago, Milwaukee, and St. Paul Railroad. In October, 1887, it was installed on the Lehigh Valley Railroad, where it worked very successfully.

The following account of it was given in the Press at the time :—

" The success of what is called ' railway train telegraphy ' is now assured, and October 6th, 1887, will be a red-letter day in the history of the electric telegraph. On that day a special train left Jersey City with about 230 members of the Electric Club and guests of the Consolidated Railway Telegraph Company, in order to witness the working of the system on the Lehigh Valley Railroad. Although the speed of the train often reached the rate of about sixty miles an hour, messages were sent

Pioneers of Wireless.—from and received on the train without difficulty, although the current or the 'induction' had to jump from the train to the line wires, a distance of 25ft. About four hundred messages were sent as the train ran from Perth Junction to Easton."

Although the system was thus a practical success from all points of view, commercially it was a failure. Few travellers seemed to wish to send messages while on a train journey, and after the novelty had worn off the system fell into disuse.

That Edison was convinced of the practical value of the invention is very clear, however, because he subsequently took out another patent to cover the application of his method of "aerial telegraphy" to ships for communicating with one another at sea or to land stations. "Ships at sea," he wrote, "many miles apart, will be able to communicate by means of balloon-kites soaring several feet above their decks."

NEXT INSTALMENT.
Willoughby Smith Links Fastnet Rocks with Mainland.

TRANSMITTERS' NOTES AND QUERIES

Chilean Amateurs.

We give below the list of Chilean amateurs who are working on short waves, which was unavoidably crowded out of our last week's issue :—

2AB	Jorge Bernain, San Enrique 25, Valparaiso.
2AC	D. Antonio Carbone, Alvarez 908, Vina del Mar.
2AG	Augusto Guevara, Ascensor 32, Corro Florida, Valparaiso.
2AH	Guillermo Zeller, Casilla 1840, Valparaiso.
2AK	Augusto W. Keitel, Valparaiso 784, Vina del Mar.
2AN	A. Busconi Pagani, Almirante Latorre 537, Calera.
2AP	Ricardo Vivado, Pedro Montt 525, Valparaiso.
2AR	Carlos Reiber, Casilla 3063, Valparaiso.
2AS	Leon Schlegel Pettit, Quillota 81, Vina del Mar.
2AV	Julio Chaparro, Pasaje Sto. Domingo 9, Valparaiso.
2AW	Otto Toelle Franke, Subida Caracoles 26, Valparaiso.
2BE	Ed. Guevara, Av. Libertad 636, Vina del Mar.
2LD	Luis M. Desmaras, Casilla 50 D, Santiago.
2RM	Rodolfe Mebus, Casilla 3208, Santiago.
3AE	C. Ruggero Cozzi, Augusto Matte 480, Yungay, Santiago.
3AF	Silvio Castagnetto, Echaurren 507, Santiago.
3AG	Luis M. Desmaras, Casilla 50 D, Santiago.
3AK	Henry R. Chatting, Av. Valdivieso 43, Santiago.
3AN	Juan Gachelin W, Maipu 636, Santiago.
3AO	Rodolfo Mebus, Casilla 3208, Santiago.
3AT	Manuel A. Tapia, Casilla 51 D, Santiago.
3AU	Luis Rencoret, Las Rosas 3147, Santiago.
3BD	Alejandro Pastor, Delicias 390, Santiago.
3IJ	Ismael Jaras, El Monte, Chile.
4AA	Alberto Gaete Meza, San Javier, Chile.
4AQ	Alfredo de la Quintana, Chanco, Chile.
9TC	Major R. Raven Hart, Los Andes, Chile.

Cards for Chilean transmitters not included in the above list will be forwarded if sent via Mr. Desmaras, who has kindly undertaken to forward them.

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Australian Transmitting Stations.

Mr. A. W. Watt (A 2WW), the well-known Australian amateur, draws our attention to the fact that the supplementary list of experimental stations printed in our issue of March 31st included some broadcasting and dealers' transmitting stations which should not, strictly speaking, be classed among experimental stations.

The following are "Class A" broadcasting stations, which are entitled to a proportion of the revenue derived from broadcast listeners' licences :—

A 2BL, 2FC, 3AR, 4QG, 5CL, and 7ZL (misprinted 7ZI in our list).

"Class B" broadcasting stations are not entitled to revenue; our list included the following :—

A 2BE, 2HD, 2KY, 2MK, 2UE, 3EO, 3UZ, 3WR, 4GR, 4MB, 4RN, and 5DN.

The dealers' transmitting stations are :—

A 2AG, 2LB, 2PS, 2RP, 2TB, 2ZH, 3JG, 3UD, 4BM, 4SM, 5BK, and 5LP.

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We understand that Mr. D. B. Knock, whose station G 6XG was in active operation until last February, is now in Australia and using the call-sign A 2LK. He states that he is always on the look-out for British stations, and is anxious for tests and reports on his signals.

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Danish Amateurs.

We regret that in the list of Danish amateurs, printed on page 734 of our issue of June 2nd, there were several spelling errors which, through the courtesy of a Danish correspondent, we are now able to correct, and we would ask any of our readers who have copied our previous list to note the following amendments :—

7AA	F. M. Knuth, Knuthenborg, Bandholm, Laaland.
7AT	(not 7AI), A. Lykstoft, 37, Julius Blomsgade Copenhagen.
7BX	E. Schiödte, 77, Bredgade, Copenhagen.
7BZ	C. F. Bauditz, Erikshus, Ringköbing.
7JO	J. Finsen, Thorshavn, Faroe Islands.
71W	J. Krause-Thomsen, 18, Jens Baggesensgade, Korsör.
7JS	J. Steffensen, Ehlersvej 8, Hellerup, near Copenhagen.

7JM should read **7JF**.

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New Call Signs Allotted and Stations Identified.

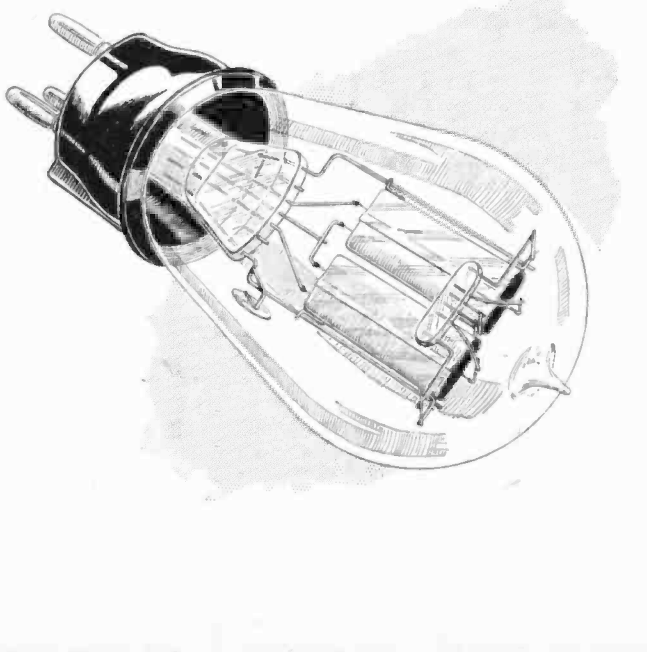
G 2BWP.—R. J. A. Kemp, 25, Cragside Walk, Kirkstall, Leeds.

G 2LJ and 2LK.—23rd London Armoured Car Company (Capt. K. Hartridge), 90, Henry Street, St. John's Wood, N.W.

G 5JI.—J. J. Smallwood, 66, Shireland Road, Smethwick, Birmingham.

G 6HU.—G. Rutherford, 103, Burbage Road, Dulwich, S.E.24.

G 6TY (ex 2BGX).—K. D. F. Townend, 3, Winthorpe Street, Headingley, Leeds. Transmits on 45 metres.



NEW FULL-WAVE RECTIFIER.

Of particularly low impedance this new Osram type U.5 full-wave rectifying valve is fitted with two flattened tubular plates and parallel connected dull emitting filaments requiring 4.5 to 5 volts. An interesting feature is the provision of a small disc attached to one of the plate supporting wires, from which the magnesium is discharged in the process of gettering.

Broadcast Brevities

SAVOY HILL TOPICALITIES

By Our Special Correspondent.

High Power Schemes.

I am able to state on high authority that the four schemes under consideration for raising the power and changing the wavelengths of broadcasting stations do not include such a scheme as that which was given publicity in some quarters last week.

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Off the Map.

In connection with the publicity a map was printed, showing the supposed situation and range of new stations. I wonder if listeners noticed that certain parts of the country—Cornwall, Kent, Sussex, Norfolk, and North Wales—were excluded from the range of any of the stations. What, then, becomes of Captain Eckersley's vision of a crystal service for a full 100 per cent. of the population?

oooo

Awaiting Results.

Later, when the experimental station which is being constructed at Daventry has been tested with medium wavelengths on high power, and the results are collated with the data given by the experiments with alternative programmes from the Oxford Street and Marconi House transmitters, it may be possible to indicate the nature of the several plans contemplated for more effective distribution; but at present nothing but harm is done by attempts to forecast a scheme which doesn't exist.

oooo

Expert Tuition by Wireless.

It is not often that prospective candidates for an examination receive expert coaching, not merely in the subject in which they are to be examined, but in the actual items that will form the examination. Listeners should therefore make a point of hearing the recital on July 24th from the Royal College of Organists. The pieces selected by that institution for the January examination, 1927, will be played by Mr. Thalben-Ball and relayed from the College on the date named, which is the occasion of the distribution of diplomas.

oooo

The Chinese Honeymoon.

Two very popular plays are to be perpetuated in the memories of listeners this month. One is "The Chinese Honeymoon," of which a radio version will be broadcast on the 12th, by arrangement with the author, Sir George Dance. The other is "Milestones," which is due for the 15th. Mr. Edward Knoblock, the joint author, is interesting himself in the condensed radio version, and it is to last an hour and a half.

oooo

Schoolboy Howlers.

Schoolboys' essays on broadcasting, submitted to the B.B.C. in connection with the schools transmissions, show a more or less detached, but none the less keen interest in wireless science.

Here are some extracts :—

How in the world Marconi invented wireless I cannot imagine, but all praise be to him.

As to the inventor there is some doubt. Signor Marconi might have invented it; other men claim to have invented it, and a man invented a valve before wireless was started.

The B.B.C. has the chief power in England, but Signor Marconi has certain rights, and he draws taxes, as being the man who made universal wireless possible.

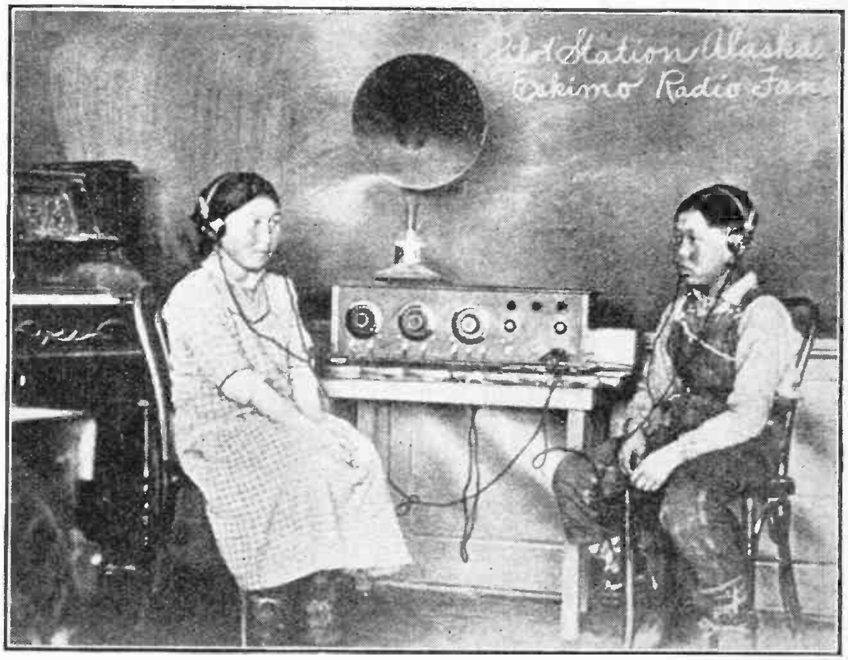
At last an announcer appears, all spick and span, and wearing horn spectacles. This is an everyday occurrence in the broadcasting station.

The first thing to be taken into consideration are the speakers. These men and women are the pick of their sex.

In one corner of the studio stands a grand piano; while in another sits an orchestra.

Not long ago a company was formed. . . . This is now at a climax.

No one as yet knows much about it (broadcasting), for it is shrouded in a veil of mystery which no one can probe. Perhaps some day a little more will be



WAS THAT ONE A JOKE ? Eskimo children caught in a pensive mood while listening to a transmission from KGO, California. The receiver is owned by the Pilot Station Government School, Alaska. The school is crowded nightly by a host of eager listeners.

known about it, but it is subject never to yield its powers completely into the hands of mortal mankind.

oooo

Daventry's Birthday.

The birthday programme from Daventry on July 27th, to celebrate the first anniversary of 5XX, will be framed in a way that will especially mark the international significance of the high-power station. Captain Eckersley has undertaken to arrange the programme. In view of the work that has been accomplished by 5XX in the past twelve months, P.P. should be a proud parent, for 5XX is essentially his child.

oooo

Brother Martin to Broadcast.

"The Vicar at the Jumble Sale" is the title of an entertainment to be broadcast by Mr. Laurence Anderson and the Roosters on July 22nd. Mr. Anderson's performances as a raconteur on the halls and over the microphone are well known, while his work as Brother Martin in Miss Sybil Thorndike's production of "Saint Joan" should have satisfied Bernard Shaw himself.

oooo

Alternative Programme Tests.

When the B.B.C. inaugurated the series of alternative programme tests and invited listeners to report on the results it was not contemplated that many thousands of people would take the trouble to communicate their experiences, but such was the interest taken in the prospect of alternative programmes that Savoy Hill was literally snowed under with letters and records of telephone calls. As no provision could be made for extra staff, the regular officials had to handle these reports in addition to performing their ordinary duties, and this involved a fourteen-hour day for several of the staff.

oooo

The Importance of the Crystal.

Three tests were arranged, *i.e.*, on Monday, June 28th, from 11.15 p.m. to midnight; Thursday, July 1st, from 6 to 7 p.m.; and on Thursday, July 8th, from 8 to 9 p.m. Special attention was given to crystal-users' reports, which will eventually be considered in conjunction with the data obtained as the result of the experiments to be carried out at the temporary high-power station now under construction at Daventry.

oooo

Several Failures.

The early reports, as was to be expected, revealed many failures on the part of crystal users to separate the transmissions from Oxford Street and Marconi House; in fact, 33 per cent. were unsuccessful.

oooo

Marconi House Not Permanent.

Two things may be accepted as definite; one is that Marconi House will not be used permanently as a transmitting station for alternative programmes or for broadcasting in any form, the other is that any new system for more effective distribution will deal only with the present waveband of 300-500 metres.

oooo

The Royal Tournament.

The ceremonial in the presence of the King of the opening of the Royal Tournament at Olympia to-morrow (Thursday, July 8th) will be broadcast from 2LO for half an hour from 2 o'clock.

oooo

Variety Programme Popularity.

Recent variety programmes have attracted a good deal of attention among listeners whose criticisms indicate that some of the material broadcast has found favour with a very considerable number of people. Last week's turns, which were most appreciated, were those of Miss Alma Barnes, who, in spite of her American accent, had a voice like a nightingale, and gave some amazing instrument imitations, and Clapham and Dwyer, two clever patter comedians.

oooo

Ropes and Yarns.

The two last-named are to appear again before the microphone on July 14th, when listeners should also hear the vaudeville star, Tex McLeod, who will spin "ropes" (whatever that may mean) and "yarns" (which is understandable). "Elsa the Wonder," who is able to sing in two voices, soprano and baritone, is in the same variety programme, with Edward Avis, America's bird impersonator, and Miss Doris Bleach and Partner, who recently appeared on the London music hall stage in syncopated solos and duets. The advance programmes show several interesting variety features of a similar nature—an encouraging sign, for there is undoubtedly a big demand among listeners for this type of programme.

oooo

A Set in Every House.

The official organ of the B.B.C. has been drawing attention to champion radio villages where the number of receiving sets compares favourably with the number of houses. In one Oxfordshire village, it is stated, every house has a receiving set. I am now anxiously waiting to see which village will be the first to boast that some houses have more than one receiving set but only one licence.

oooo

A Manx Broadcast.

On the occasion of the Tynwald Ceremony, on July 5th, when the Manx laws are promulgated in English and Manx throughout the Isle of Man, the Manchester station presents a special programme of Manx Music and folk lore. Miss May Clague (soprano), who is a native of the island, will sing the Manx National Anthem and two groups of Manx songs. Other national selections will be played by the Station Orchestra, conducted in each case by the composer.

FUTURE FEATURES.

July 11th.

LONDON.—The Band of H.M. 1st Bn. The King's Own Yorkshire Light Infantry, relayed from Granville Gardens Pavilion, Dover.
BIRMINGHAM.—Requested Classics.
BOURNEMOUTH.—Concertos and Instrumental and Vocal Feature.
CARDIFF. — Famous Singers in Famous Arias.
GLASGOW.—All British Programme.
MANCHESTER.—The Irwell Bank Prize Band.

July 12th.

LONDON.—Humour in Music and Verse. "A Chinese Honeymoon."
ABERDEEN.—Ballad and Instrumental Programme.
BOURNEMOUTH. — The Municipal Military Band relayed from the Pier.
BELFAST.—Holiday Variety.
CARDIFF.—Welsh Programme. Gems from Italian Opera.
NEWCASTLE.—The "Novos" in "Trifles."

July 13th.

LONDON.—The Geoffrey Goodhart Sextet. Salzedo (harp).
BIRMINGHAM. — Operatic Programme.
GLASGOW.—Light Chamber Concert.
MANCHESTER.—Revusical Moments.

July 14th.

LONDON.—Special Concert on behalf of the National Association of Local Government Officers, relayed from the Pavilion, Buxton.
DAVENTRY. — Daventry Calling France.
ABERDEEN.—Scottish Dance Music.
BOURNEMOUTH.—An Evening at Weymouth.
GLASGOW.—Italian Opera.
MANCHESTER.—Special Concert relayed from the Pavilion, Buxton.
NEWCASTLE. — A French Night. The Vagabonds Concert Party.

July 15th.

LONDON.—"Milestones."

July 16th.

LONDON.—Variety Programme.
BIRMINGHAM. — Light Classics. Mirth and Melody.
BOURNEMOUTH.—Choral Works and Orchestral Ballads. Two plays.
MANCHESTER.—Schubert and Schumann programme.

July 17th.

LONDON. — Brighton Competitive Musical Festival, closing concert relayed from the Dome, Brighton.
ABERDEEN.—Scottish Programme.
GLASGOW.—Glasgow Fair; Light Music and Entertainment.

REFLEX RECEIVERS.

Some Practical Considerations.

New Ideas on the Action and Design of Circuits.

By D. KINGSBURY.

NEARLY three years ago, when dull-emitter valves were rare and expensive, and accumulator charging costly, the author turned his attention to the reflex receiver as a possible means of economy. At that time circumstances made an outside aerial out of the question, and the wearing of telephones night after night had become irksome.

Much experimenting followed, which, it must be admitted, was in the nature of trial and error, until a set consisting of one "R" valve, reflexed, with crystal detector, followed by one "R" valve coupled as an audio-frequency amplifier, was evolved. It is, perhaps, only fair to say that, from the very first, grid damping by means of positive potential and resistance damping were avoided as representing poor practice.

The set was both sensitive and stable until power valves were fitted, when a fresh crop of troubles ensued which necessitated a more accurate application of the neutrodyne principle than before. Eventually, complete stability was again obtained, with increased output and better sensitivity.

The next step taken was to try to reflex both valves, and a number of attempts were made without success. Gradually, however, trial and error gave way to careful reasoning, with the result that a two-reflexed valve arrangement was conceived and built. This worked well from the moment of switching on; in fact, no connections were at any time altered, "tuning up" being limited to the adjustment of the neutrodyne condensers. Not once during its existence did this reflex emit a true audio-frequency howl, although power valves, high-step-up transformers, and ample negative bias were employed. Violent radio-frequency oscillation could be produced by reaction or by tampering with the neutrodyne condensers, which would on occasion set up interference notes to which reference will be made later.

Advantages and Disadvantages.

One of the most valuable results of the experiences briefly recounted in the foregoing paragraphs is that the author claims to be able to recognise, and state the cause of, each individual class of howl, whistle, and croak occurring in a badly designed or badly adjusted reflex set. To those who have made unsuccessful attempts in the past to build a set of this type let it be emphatically stated that *these distressing noises are not due to fundamental shortcomings*, and can, therefore, be eliminated with comparative ease once their causes have been ascertained.

Though much has been written on the subject of reflex receivers, it seems to the author that insufficient warning of the pitfalls to be associated with such apparatus has been forthcoming. It is the purpose of these notes, therefore, briefly to cover the ground indicating what has proved sound in practice and the points that require special attention.

It is perhaps worth bearing in mind that the H.F. and L.F. chains of a perfect reflex receiver would be so non-interdependent that it would be possible to use both together (the reflex), independently (simple H.F. amplification and detector, or detector and simple L.F. amplification), or simultaneously for different purposes (the duplex amplifier), *e.g.*, the L.F. chain may be amplifying the output of a crystal set tuned to Daventry for domestic loud-speaker use while the H.F. portion is being employed to search the Continent with telephones.

The chief advantage of this class of receiver is, of course, that of smaller first cost and very much reduced upkeep owing to the few valves employed. This is a real boon where facilities for accumulator charging do not exist.

The only disadvantage of which the author is aware is that of limited output, unless a separate audio-frequency amplifier is added. However, with ordinary power valves the limit is above comfortable sitting-room loud-speaker strength, so that this is not a matter which need cause us much concern.

Quality of Reproduction.

The reflex is capable of precisely the same quality of reproduction as the corresponding simple set. In this connection it should be mentioned that the only points requiring careful attention are (*a*) that the combined H.F. and L.F. inputs to the grid of any valve within the set do not overrun the sensibly straight portion of the characteristic curve of that valve, or reach the point at which grid current sets in, and (*b*) that the L.F. intervalve couplings will withstand H.F. by-pass condensers across their terminals without appreciable lowering of tone. If L.F. transformers are employed, those having unduly high ratio and insufficient primary impedance for the type of valve to be used should be avoided.

The Detector.

There is an important, if not obvious, direction in which the reflex scores, namely, that the improvement in quality of reproduction usually considered incidental to the use of a crystal may be obtained without incurring trouble due to the inherent shortcomings of this type of detector. As instances, the use of H.F. amplification in front of the crystal will ensure adequate input, a condition necessary for efficiency and faithful reproduction, the H.F. stages can be designed to retain the necessary degree of selectivity, notwithstanding the loading of the crystal, and, further, it is an easy matter to arrange for reaction to compensate for this loading if desired.

It should be noted that *the purpose of the detector is not to stabilise the set*, otherwise how can one adjust it?

Reflex Receivers.—

To be greeted by a colossal howl every time he disturbs the detector may be good medicine for the inveterate meddler, but it is neither helpful to the experimenter nor indicative of sound design. When the contact wire is lifted from the crystal all sound should cease, providing that each valve is being correctly worked and that the H.F. input in any valve is not so great that saturation or anode bend rectification occurs. Tuned to 2LO at nine miles' range on a moderately good aerial and earth, the author finds it possible to comply with this requirement if not more than one H.F. stage is in use, and when two efficient H.F. stages are operating, distant transmissions coming in at more than pleasant room loud-speaker strength cease entirely when the contact wire is removed.

The semi-automatic crystal holder in which spot hunting is reduced to the turning of a knob will be found extremely satisfactory; on the other hand, the modern "permanent" detector, while not quite so sensitive as the best galena, is usually very good.

It will be understood from the foregoing that there is no reason why a valve detector should not be used. A set that will remain stable with the crystal removed (oscillation may still be observed by rotating the condenser dials while watching a milliammeter in the anode circuit of the last valve, or listening for the usual "click") will operate quite sweetly in conjunction with a valve detector.

How Many Valves?

The number of valves to be used requires a little consideration, and in this connection it should be remembered that the effectiveness of a valve when reflexed is proportional to the *square* of its "power amplification," or voltage amplification figure, or to the product of the two, according to the type of couplings used. It is thus quite important to choose suitable valves.

One large valve (D.E.5, L.525, S.P.18 (Red Spot) or similar) reflexed with crystal detector will be found to give sufficient output for medium loud-speaker strength at, say, ten miles from the local station on a reasonably good aerial and earth, the quality of reproduction being

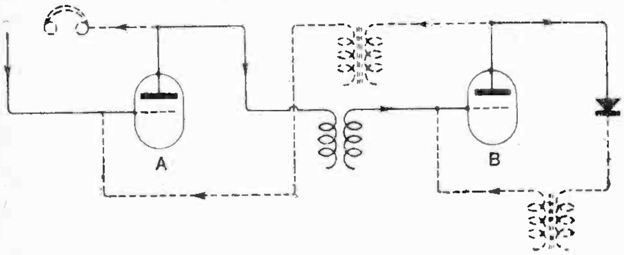


Fig. 1.—Fundamental inverse reflex circuit. The heavy line indicates the radio-frequency path. After rectification the L.F. path is shown by the dotted line. The sequence of the amplifying stages is A, B, detection, B, A.

good. With reaction it is possible to hear on telephones almost anything that is louder than the Morse, mush, atmospherics, and neighbouring oscillators. One need never allow such an arrangement actually to oscillate, as there is a very pronounced threshold period during which sensitivity is good and, when the corresponding settings of the grid and anode condensers for various wavelengths has become known, stations may be picked up with ease. Autodyne reception of weak C.W. signals is, of course, possible. A point worthy of note is that there are only two tuning controls to adjust, and that these can be operated simultaneously. "Searching" is therefore easy.

The addition of a valve functioning as an L.F. amplifier to the foregoing single-valve reflex set will produce an overpowering volume of sound when tuned to the local station; in fact, another D.E.5 is quite out of place, an L.S.5A with adequate H.T. and grid bias being necessary.

With the L.F. valve in use it is possible to bring up some distant stations to loud-speaker strength under very favourable conditions.

The addition of an H.F. stage to a one-valve reflex set materially increases the strength of signals coming

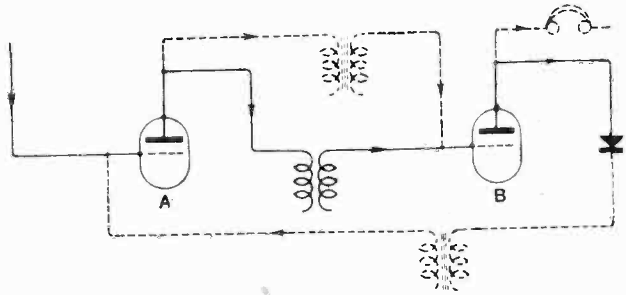


Fig. 2.—The straight reflex circuit. Here the sequence is A, B, detection, A, B

from distant stations. There are now, however, three circuits to tune, and as there seems to be no satisfactory means of operating these devices simultaneously, searching is not now so rapid.

Two valves both functioning as H.F. and L.F. amplifiers and a crystal detector will, under reasonable conditions, give extreme satisfaction; in fact, the writer is inclined to the opinion that stations which cannot be brought up to moderate loud-speaker strength with such an arrangement would be too erratic and accompanied by too much mush to render further amplification really worth while. An additional stage of H.F. might be required in cases where a useful open aerial is impossible.

If such a receiver fitted with D.E.5 or smaller valves be tuned to the local station at short range, "croaking" or some form of low-frequency oscillation will of a certainty take place. This is due to the inadequacy of the valves to deal with the enormous grid swing likely to be set up. Probably the working portion of the characteristic of the second H.F. valve is occupied by the H.F. wave which it itself amplifies before passing on to the crystal. The addition of L.F. impulses to the already fully loaded valve grid produces interference troubles. The simplest way of overcoming this trouble is to *completely* mistune *one* of the H.F. circuits.

Straight or Inverse Connections?

There are two fundamental types of reflex circuit, as shown diagrammatically in Figs. 1 and 2. If Fig. 1, which indicates the main path taken by an incoming signal through an inverse reflex, is examined, it will be

Reflex Receivers.—
seen that there is a subsidiary circuit from the anode of valve A to the grid of valve B *via* an H.F. transformer, and from the anode of valve B to the grid of valve A *via* an L.F. transformer. Now it is safe to assume that

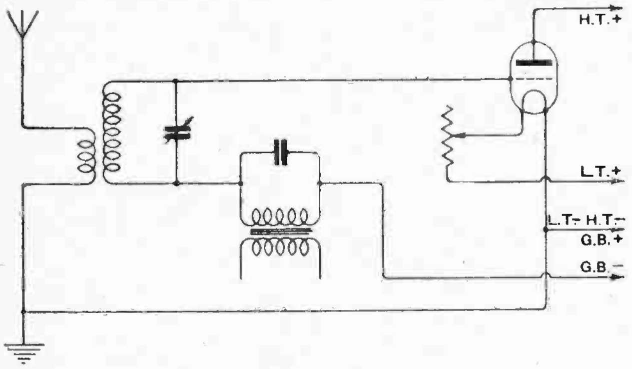


Fig. 3.—The use of a loose coupled aerial circuit permits of earthing the L.T. battery without virtually short-circuiting the L.F. transformer.

an L.F. transformer will pass a small amount of radio-frequency energy, and it is equally certain that an H.F. transformer will pass audio-frequency energy—a point very easily demonstrated by connecting one winding of such a transformer across the output terminals of a set

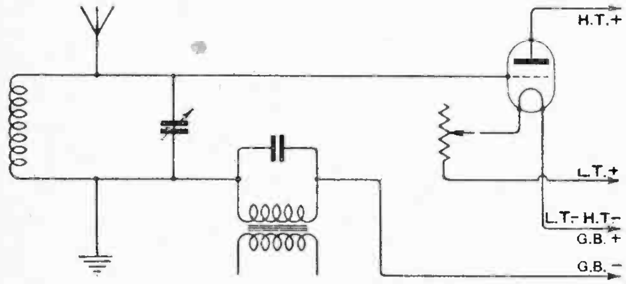


Fig. 4.—With this circuit L.F. oscillation may be produced if the loud-speaker is brought near the aerial tuning end of the set.

in operation, and connecting telephones or loud-speaker across the other winding. This subsidiary circuit, which, of course, occurs between each pair of valves in a multi-valve inverse set, is the cause of most of the ailments to which reflex receivers are prone, and because of it we

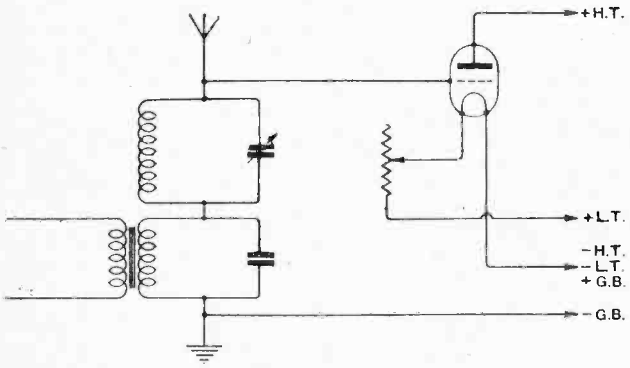


Fig. 5.—Another system of connection in which the earth lead is taken from the battery side of the L.F. transformer. Damping in the aerial circuit is increased and the added resistance cannot be readily compensated for by reaction coupling, while feeding back at audio- as well as radio-frequency gives rise to audio-frequency self-oscillation.

may state quite definitely that the inverse circuit as invariably put forward is fundamentally unsound and will not work *satisfactorily*. Unfortunately, the inverse arrangement offers certain paper advantages over the "straight," and is, therefore, much more often attempted. In practice, oscillations occur at a frequency almost outside the audible limit—a disturbance which is felt rather than heard. Other noises may be produced by interference.

Radio-frequency Amplification.

Considering Fig. 2, the corresponding diagram of a straight reflex, it will be observed that the flow of energy between the two valves is in the same direction, and it therefore need not matter how the transfer takes place.

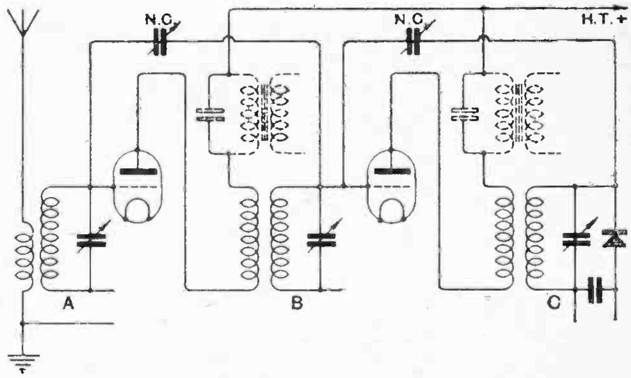


Fig. 6.—A satisfactory method of stabilising two H.F. stages of a reflex receiver.

Herein lies the strongest recommendation for the straight reflex. It should be possible, with a little ingenuity, to work in all manner of audio-frequency tone control devices, and it is not essential that the H.F. coupling shall be a tuned transformer. The scope for original design in this direction would appear to be great.

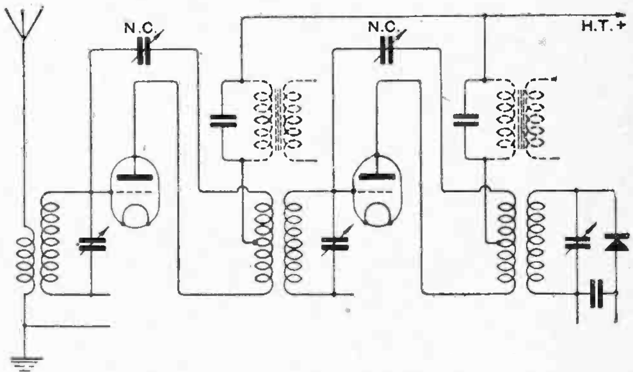


Fig. 7.—Another though less satisfactory method of stabilising. Low-frequency potentials are set up in a neutralising circuit.

The anode circuit of the final reflexed valve requires very careful consideration, as it is important (imperative if several reflexed valves are in use) that no L.F. energy shall be transferred to the detector, and that no H.F. energy shall find its way from the detector circuit to the grid of the first H.F. valve. This matter will be dealt with in a later section.

Reflex Receivers.—

Tuned transformer coupling, with provision for the neutralisation of troublesome stray capacities, is one of the best systems of H.F. amplification yet devised, and certainly lends itself to the purpose now in view. In addition to stability, such an arrangement can claim selectivity to any degree desired. Suitable transformers have been frequently described in this journal.[1]

Stray Capacity Neutralisation.

The use of a transformer between the aerial and grid of the first valve eliminates one of the chief difficulties in reflex working, in that it makes it possible to earth the batteries without incidental ill-effect. Fig. 3 shows the transformer-operated arrangement with a connection from −L.T. to earth. With the connections shown in Fig. 4 the batteries and loud-speaker (unless transformer operated) are removed from earth by the potential being generated in the secondary of the L.F. transformer. This may, and sometimes does, lead to trouble. The arrangement shown in Fig. 5 is likely to be unselective, owing to additional resistance being placed directly in the aerial circuit, and, further, extreme ingenuity would have to be used to find a reaction arrangement to counteract this resistance that did not introduce audio-frequency oscillation troubles, since both the aerial inductance and reaction coil are passing audio-frequency currents.

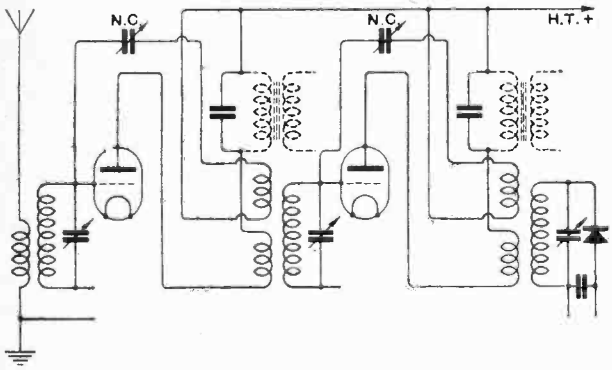


Fig. 8.—Here the neutralising winding is separated from H.F. transformer primary, and the low-frequency transformer no longer forms part of the neutralising system.

We now come to what is probably the most important factor contributing to the successful working of reflex receivers, *i.e.*, H.F. stabilisation by the neutralisation of stray capacities within the valve.

The two main forms of H.F. stabilisation connections in use to-day are shown in Figs. 6 and 7, in which L.F. transformers are shown dotted in the anode circuits to represent audio-frequency load. Consideration as to how these circuits may be applied to reflex working is necessary. The scheme indicated in Fig. 6 works well when applied to a single reflex valve, that is, with coils B and C only. Adjustment of the neutralising condenser is made with the detector contact wire off the crystal, and no difficulty should be experienced in finding a setting for this condenser. The application of the contact wire to the crystal reduces the voltage across the coil C, but also supplies a load; the circuit thus remains stable. When this circuit in Fig. 6 is expanded to include two H.F. stages, one important point arises, namely, that magnetic coupling for the purposes of reaction must not be obtained between coils B and C. Under such con-

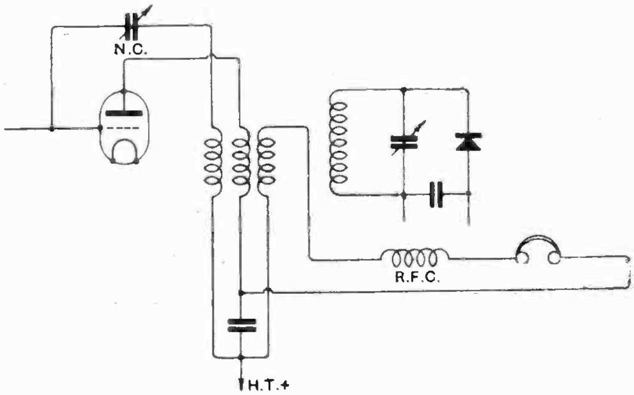


Fig. 9.—In addition to the primary and secondary coils of the H.F. transformer and the neutralising winding, an additional winding has been introduced carrying a reversed audio-frequency field to nullify the L.F. component in the H.F. coupling.

ditions the neutralisation of the first valve is upset, as H.F. potentials exist at the grid end of coil B, which have not their counterpart in coil A, and avoidable radiation is set up. There is also a slight risk of audio-frequency complications with this circuit.

Nullifying the Audio-frequency Component in Neutrodyne Circuits.

The arrangement shown in Fig. 7 has the advantage of treating each valve independently, but suffers from one defect when applied to reflex receivers. It will be seen that the necessary H.F. stabilising potential is obtained by auto-transformer action. Now the constants of the auto-transformer are such that while a counter E.M.F. closely approximating the original (but of opposite sign) will be produced at H.F., the corresponding L.F. component will be weak, so that the neutralising condenser in applying the necessary reverse H.F. potential nearly doubles the effective stray capacities at L.F., and may cause serious trouble with power valves and modern high-impedance transformers.

The remedy is to separate the neutralising winding from the primary and to connect its "steady" end to a

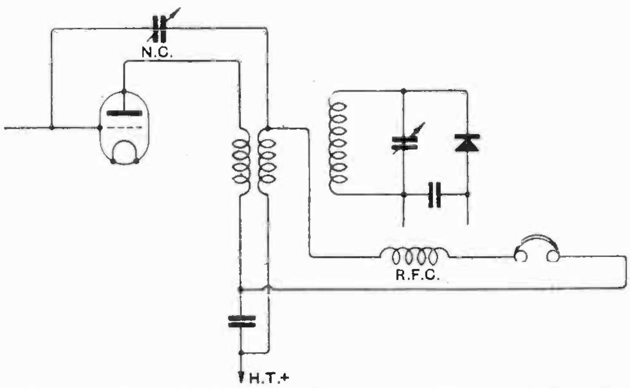


Fig. 10.—The neutralising coil is made to form part of the L.F. output circuit, and the direction of winding is such that any audio-frequency component in the H.F. transformer primary is nullified

[1] The author would direct especial attention to the transformer data given by W. James in "A Long-Range Three-Valve Receiver," *The Wireless World*, May 26th, p. 689, and June 2nd, p. 731.

Reflex Receivers.—
point outside of the audio-frequency load. This involves one extra terminal on the usual transformers, as there are now three separate windings instead of two, one of which is tapped at the mid-point. The modified connections are shown in Fig. 8.

This leaves us with the anode circuit of the final reflex valve to consider. One method of ensuring that the low-frequency component in the primary of the H.F. transformer does not affect the secondary of that transformer by magnetic coupling is to introduce a winding similar in all respects to the primary, but carrying only the L.F. component of the output, and that in the opposite direction to the primary. Further, if this winding be placed turn for turn with the primary between the primary and secondary windings, it will form an efficient L.F. capacity screen, since one end may be connected to a point of steady potential, and the audio-frequency potential across it will be extremely small. It will be necessary to insert a radio-frequency choke between the "live" end of this winding and the L.F. output circuit to avoid the absorption of H.F. energy from the transformer. The connections are shown in Fig. 9. A moment's consideration will show that this winding is a duplicate of the H.F. neutralising coil, and the two may therefore be combined This produces the arrangement shown in Fig. 10, which works well in practice and would appear to give very complete separation. Fig. 11 shows a two-valve "straight" reflex incorporating these connections.

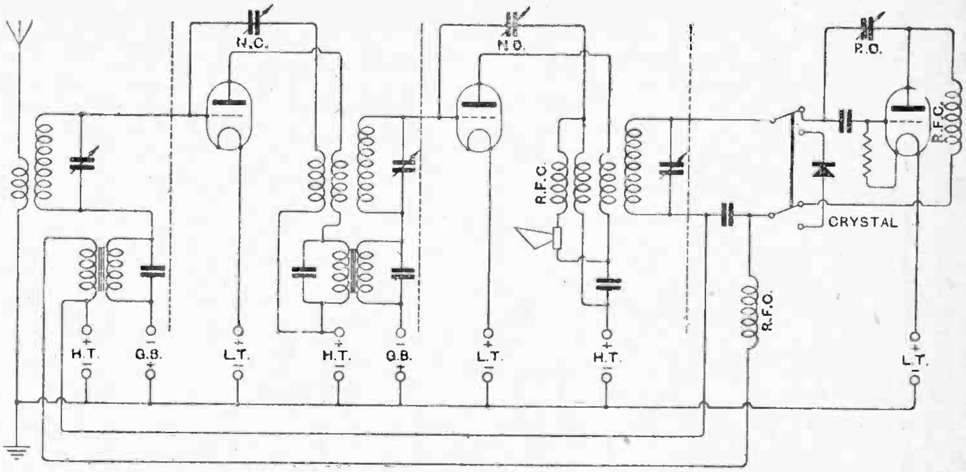


Fig. 11.—Two-valve stabilised reflex circuit combining the principles of Figs. 2 and 10.

It is worthy of note that the L.F. component nullifying device may be applied stage by stage to the inverse connections as shown in Fig. 12.

The maximum wavelength on which reflex amplification may be satisfactorily performed would appear to be exceedingly high if full use is made of some such method of separating the H.F. and L.F. components of the output of the final reflex stage. A high-pass filter might be substituted for the anode by-pass condenser which, if suitably designed, would allow the high frequency to come down to, say, 20,000 cycles (15,000 metres) without passing useful L.F. energy.

Audio-frequency Amplification.

Special consideration would have to be given to the intermediate valve couplings, but, as has already been pointed out, the straight reflex does not demand independent radio- and audio-frequency transformer coupling.

An obvious application of a good reflex receiver is in connection with the supersonic heterodyne system of reception, a local oscillator, and first detector (possibly combined in one valve) only being necessary if H.F. transformers suitable for, say, 3,000 metres are available. On paper, at any rate, we should then obtain seven-valve results with three valves and a piece of crystal.

To return to our quest for stability, there remains but one further point to consider, namely, the prevention of radio-frequency feed back from the secondary of the last H.F. transformer to the grid of the first reflex valve *via* the detector and first L.F. transformer. It will be found that if a comparatively large by-pass condenser (0.001 to 0.002 mfd.) is used to close the H.F. circuit through the detector, there will, at broadcast wavelengths, be little need for a radio-frequency choke between the detector and the first L.F. transformer primary, but it must not be forgotten that the choke should theoretically be inserted, and its absence may, through some combination of circumstances, cause trouble. If,

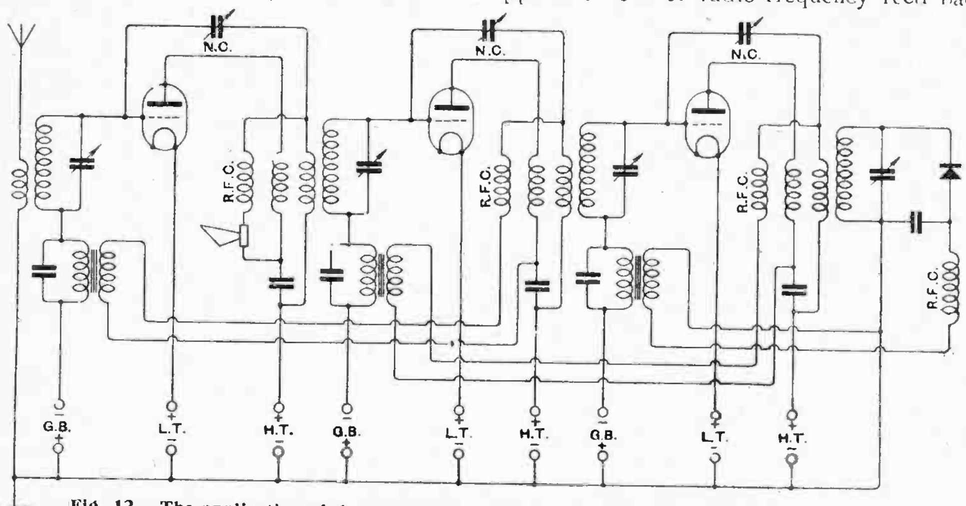


Fig. 12.—The application of the system for nullifying the L.F. component in the H.F. couplings applied to a 3-valve inverse reflex circuit.

Reflex Receivers.—
however, the condenser is removed, the most tractable set will become a veritable fiend.

Little need be said here about audio-frequency amplification. The writer awaits the appearance on the market of transformers which are definitely designed to carry by-pass condensers even at the expense of step-up ratio. Until such transformers are available, the chief recommendation, which has already been given, is to avoid those having high ratio and inadequate primary impedance.

Grid Bias.

The subject of grid bias, anode, and filament voltage has not been touched, as it has been assumed that readers sufficiently ambitious to attempt a reflex set on the lines indicated have already mastered these points. In order to avoid interference troubles between H.F. and L.F. energy components, it is most essential that the valves be operated correctly. In a straight-type two-valve reflex receiver it will be found that a D.E.5 or similar valve is capable of handling sufficient L.F. energy to produce comfortable room loud-speaker strength in addition to the second H.F. stage. If L.F. transformers of unusually small step up are being used, a D.E.5A would be more suitable, since a greater H.F. input to the detector is necessary to produce the same final output. Conversely, if more than two reflexed stages are employed, louder results will be obtainable from a final D.E.5 valve, as the H.F. input to the crystal need not be so great.

By-pass Condensers.

No values for by-pass condensers have been specified, because this matter is so largely connected with low-frequency transformer design. The writer has successfully used condensers ranging from 0.00005 to 0.002 mfd. It must be remembered that a 0.001 mfd. condenser offers a resistance of approximately 150 ohms to H.F. current at 300 metres, and it is therefore desirable, from the point of view of H.F. amplification, to use the largest condensers possible. Consideration will show that the stray capacity neutralisation scheme now proposed is only as imperfect as the inclusion of the anode by-pass condensers makes it.

If H.F. transformers are being used and they are of the usual neutrodyne pattern, it is useful to consider that the primary carries H.F. current, whereas the secondary produces what is little more than open-circuit potential. It follows that the by-pass condensers in series with the primary should be large, say, 0.001 to 0.002 mfd., while those in series with the secondary may be quite small, of the order of 0.0001 to 0.0003 mfd. In practice the best procedure would appear to be to use those condensers which are to hand and to err on the large size; then, if the tone is too low and the sibilants poor, substitute smaller condensers where possible. The difference in the tone-lowering effect of a condenser of given size when applied first to the primary and then to the secondary of an L.F. transformer may be taken as approximately equal to the square of the turns ratio, or, in other words, in the case of a 4 : 1 transformer, a condenser of 0.0001 mfd. across the secondary is equivalent to 0.0016 mfd. shunted across the primary.

Concluding Remarks.

Finally, a word as to the construction of a reflex set. If the reader will again refer to Fig. 11, it will be noticed that all the apparatus coming between each pair of vertical dotted lines is associated with the anode of the valve also included. Every precaution should be adopted to ensure electromagnetic and electrostatic isolation of each section. This is really not very difficult, since the H.F. transformers may be mounted at the "Hazeltine angle" of approximately 55° from the horizontal, the L.F. transformers may be of the iron shrouded type with earthing terminal, and, if the components are mounted in positions corresponding approximately with the diagram, the dotted lines may be taken as representing simple earth screens to overcome electrostatic troubles. Probably the best screen for the purpose is made by fixing a number of vertical wires in a plane at right angles to the front of the set and connecting all these wires to earth at one end only. In this way the minimum eddy currents and consequent loss of power will occur.

The author is conscious of the fact that much of the matter contained in this article is not new; on the other hand, originality is claimed[1] for the modified form of neutrodyne transformer and the L.F. nullifying connections, which in his own hands have proved the key to truly stable reflex arrangements. He also cannot recall having seen an emphatic statement that the unmodified inverse reflex is fundamentally unsound. Such a statement would have saved many hours of unsuccessful labour and much disappointment.

[1] Prov. Pat. 4683/26.

TRADE NOTES.

A "Blackadda" Book.

More than fifty circuits, besides much other useful wireless information, are contained in a shilling booklet, entitled: "The Blackadda Way," which has been issued by the Blackadda Radio Co., Ltd., 48, Sadler Gate, Derby.

The booklet describes the system of simplified construction by the Blackadda method, which includes, among other features, a panel with equally spaced holes into which the various "Blackadda" components can be speedily fitted.

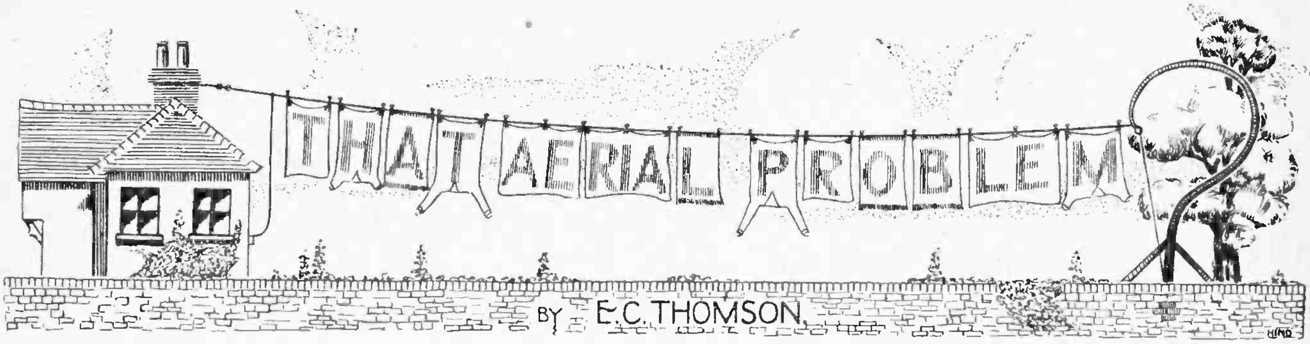
Dry Batteries from America.

From Messrs. J. R. Morris, 15-19, Kingsway, London, W.C.2, we have received an interesting brochure, descriptive of Columbia Dry Batteries, suitable for H.T. and L.T. supply, and for grid biassing. Columbia batteries are manufactured by the National Carbon Co., Inc., of New York.

An Exide Rally.

Blackpool was the venue, on June 15-16, of a highly successful conference of Exide Battery Service Agents. Many discussions took place on such subjects as the development of new designs, regulations affecting battery workshops, and improved methods of battery charging.

Such gatherings as these do much to establish valuable cohesion in an organisation like the Exide Battery Service, and should prove of ultimate value to the general public as well as to all concerned in the distribution of Exide batteries.



Reflections on an Unpleasant Possibility.

IN Melbourne a movement is on foot to rid the city of ugly aerials. There is even a proposal to create a "standard" with which all aerials would have to comply. This is rather drastic.

At the same time, while we may deplore the possibility of such an arbitrary measure in Australia, it might be worth while to take a look at the aerial question as it affects this country. Anyone who doubts the existence of an "aerial question" need only take a short walk in a London suburb or even a country village. He will soon be convinced that private aerial design is a very big question. If he pursues the matter still further, by observation and discussion, he will have to admit that the average Britisher's aerial, provided it "pulls in the stations," doesn't kink, and keeps clear of the neighbour's washing, receives rather less artistic attention than does a dustbin.

Harmless Speculations.

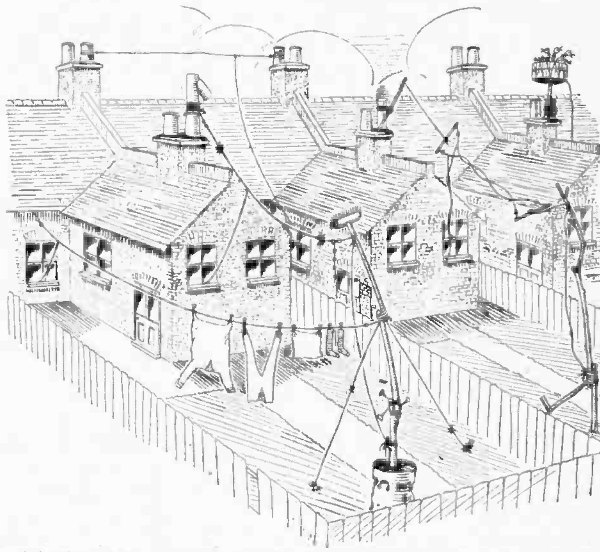
This reprehensible state of affairs seems to cause no tears. Arguments may even be adduced in its favour. There are people who will tell you, for instance, that an over-zealous attention to aerial appearances and a tendency towards standardisation would rob life of one of its innocent pleasures. If all aerials (they say) wore the same chill air of respectability and uniformity, how could we indulge in the pleasant pastime of speculating upon the personalities of their owners? It must be admitted that a delicious spice of uncertainty really does accompany the deduction that the "ham" who put up that Heath Robinson atrocity with the bent bit of larch must be a kind of Tarzan or Robinson Crusoe; and it doesn't spoil our pleasure in the least to learn subsequently that he is only an income tax clerk with a *penchant* for Wagner.

It must be conceded that standardisation would rob us of the technical howlers that sometimes decorate this green and pleasant land. We should sigh vainly for the aerial in which the horizontal stretch enjoys the lofty detachment of complete insulation from the lead-in; and we should also miss the specimen of antenna in which the insulators hang at a tangent like a string of Spanish onions.

Quite conceivably, too, if standardisation came in, we should grow tired of those trim rows of precisely inverted "L's" and yearn for the reckless soul who would launch out with a "T."

In spite of these arguments, however, there is still a case for better and neater aerials. Is it not a fact that there are many "hundred per cent." experimenters, with really good sets, sporting aerials that would bring the blush of shame to the cheeks of a clothes-prop merchant?

"Quite so," some will reply. "But don't forget that the real experimenters can afford to neglect their aerials simply because their sets *are* efficient." A very obvious point of view, but quite inconsistent. Others retort thus: "You seem to forget, O.M., that aerial efficiency and aerial appearance don't always go hand in hand." This is much more reasonable. The majority will agree that the most "genteel-looking" arrangement with the lead-in connected two-thirds of the way along the horizontal may give poorer signals than a correctly proportioned inverted "L" supported on three coupled broomsticks.



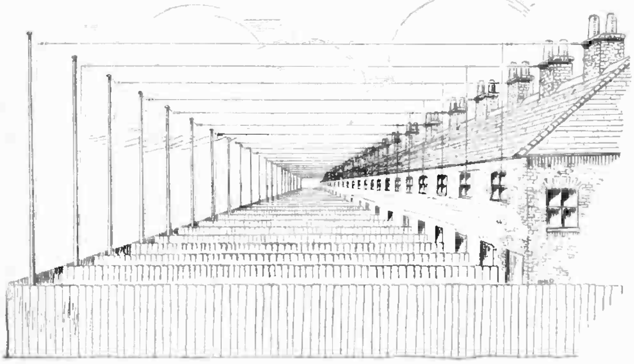
"Aerials that would bring the blush of shame to the cheeks of a clothes-prop merchant."

And yet the vexing question remains. Broomsticks and clothes-props and kindred objects are anathema to a great many who, although wireless has not yet captured their imaginations, are decent enough folk at heart. Among this group you will find creatures who cherish æsthetic ideals.

"Bother æsthetic ideals!" someone has said. But any amount of botheration will not consign them to perdi-

That Aerial Problem.—

tion. They do exist, and the question pops up: Is it right to lumber the landscape with unnecessary eyesores? The country is already dotted with *necessary* eyesores. The factory chimney and the gasometer are bad enough,



"If standardisation came in."

though they have, presumably, attained the zenith of beauty consistent with their utilitarian purpose. There is no reason why an aerial should be ugly. It can be shapely without loss of efficiency.

If wireless users do not take the trouble to improve the general turnout of their aerials, standardisation may threaten just when we least expect it. An ominous little black cloud is already gathering on the horizon bearing a strong resemblance to a Juggernaut called "Local Authority."

Local Authority.

We read, for instance, that in connection with the erection of wireless poles on housing estates, Dover Corporation is calling for reasonable "orderliness, uniformity, and suitability." And again, that the Ministry of Health, while not proposing to issue model bye-laws in regard to wireless aerials, will consider any proposals put forward by local authority. Isn't this enough to make any self-respecting amateur shudder?

It would be extremely irksome if we had to submit to the rulings of an "unwireless" borough council on questions of aerial design. Within reasonable limits every amateur will consider himself entitled to design his whole installation, including aerial, in accordance with his private desires; and if he wishes to include a counterpoise he will want to do so without the risk of giving St. Vitus' dance to a mayor and corporation.

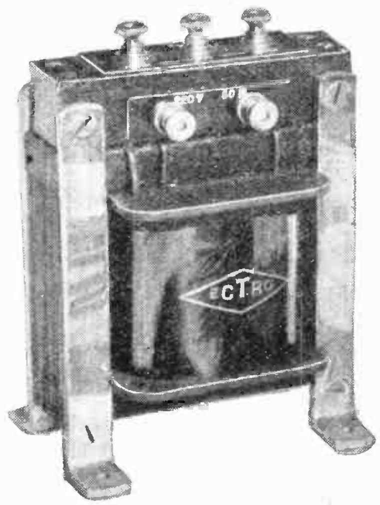
Let us look to our aerials *now*. If we don't there may be others who will.

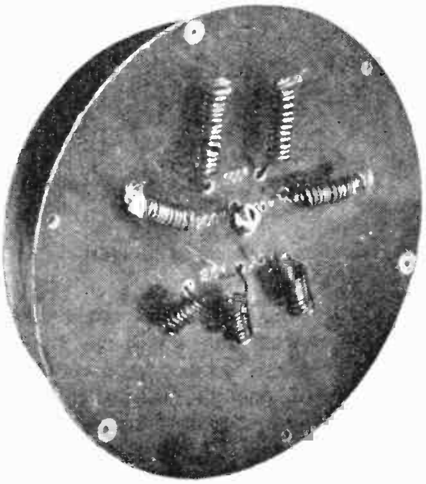
SMALL TRANSFORMERS FOR MAINS H.T.

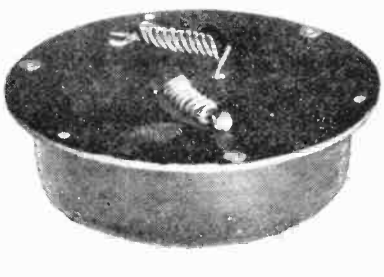
To meet the demand for small power transformers for use in the construction of H.T. battery eliminators, several manufacturers are already producing transformers admirably suited for the purpose. The amateur generally finds that transformer making requires better facilities and equipment than he usually possesses, and if he successfully masters the details of design there are many points in the process of building up which present almost unsurmountable difficulties.

The transformer manufactured by the Electro Supplies Company, 19a, Broadway, London, S.W.19, is in general outline very similar to an intervalve transformer, excepting that it is somewhat larger. The core, which is of the shell type, measures $3\frac{1}{4}$in. in height, and has a cross sectional area of nearly 1 square inch. The stampings are held together solely by clamps, so that the unsatisfactory practice of passing bolts right through the stampings is avoided. The makers supply types suitable for all usual voltages and frequencies. The filament heating secondary develops a potential of 6 volts on a load of 2 amperes. The step-up secondary is normally wound to produce 200 volts, or 100 volts each side of the mid-point tap when delivering a current of 50 milliamperes, so that it will provide on normal load a rectified H.T. potential of about 80 volts. Smoothing chokes are also obtainable of high inductance built up on a similar type of core.

Messrs. A. W. Knight, Ltd., 180, Tower Bridge Road, London, S.E.1, also produce a mains transformer. The core is of the ring type, having an external diameter of about 4in., and cross section







Commercial small power transformers providing full-wave rectification for H.T. supply.

about $\frac{11}{16}$in. × $\frac{13}{16}$in. The transformer is enclosed in a pressed iron box, and, being only about $1\frac{3}{4}$in. in depth, can be quite well accommodated under the baseboard. Leads are brought out to provide for full-wave rectification. A smoothing choke of somewhat similar design is also obtainable. It is of a ring construction, the overall dimensions being slightly less than the transformer.

SOLDERING.

The Why and Wherefore of Solders and Fluxes.

TO many home constructors soldering is something of a bugbear, and, though much has already been written on the subject, it is felt that perhaps a few further hints and explanations may be acceptable.

It may be a relief to some constructors to know that much of the difficulty they experience may be due, not to their own lack of skill or care, but to faulty materials.

In the first place, solders vary. Apart from the hard solders there are three universally recognised kinds of soft solder, all of them alloys of lead and tin.

Their classification and compositions are as follows:—

1. Coarse Solder (or Plumber's Metal.)
   2 parts lead, 1 part tin.
2. Fine, or Medium Solder.
   1 part lead, 1 part tin.
3. Very Fine, or Tinman's Solder.
   1 part lead, 2 parts tin.

The latter is what is required. It is hardest of all the lead alloys and at the same time has the lowest melting-point (about 175 degrees Centigrade).

The great point about tinman's solder is that it " runs " as soon as this temperature is reached, and when cooling solidifies at the same point. The other types do not really melt and begin to run until a much higher temperature is reached, but between this point and 175° C. they have what is referred to as a pasty stage, so that when the solder has been run into position it has to cool through a considerable temperature range before final solidification. This greatly increases the difficulty of making a really sound joint, so that the first point is to ensure that solder of the right composition is used, such that it is always either " runny " or solid and has no pasty stage.

Depreciation through Overheating.

A further point is that, after a stick has been in use, the tin is apt to burn away more rapidly than the lead, so that, to keep the solder in its best condition, it may be advisable to add a little pure tin to replace the deficiency.

If you remember when buying solder that tinman's solder should give a definite crackling sound when the stick is bent, you will probably save yourself much time and trouble when soldering-up.

Another very important point is the question of the flux used to assist the operation.

The great essential for successful soldering is the absolute cleanliness of the surfaces to be joined. They must first be filed or scraped bright and clean, but even this by itself is insufficient, for *chemical* cleanliness is also required, and however clean they may look, a film of oxide will always be present, or be in process of formation. The purpose of the flux is to dissolve this and to prevent more forming, allowing the solder to " run " freely and effect the intimate contact necessary.

The tinsmith uses a variety of fluxes for different purposes, among the commonest being *killed spirits* (which is a saturated solution of zinc choride), *resin* and *sal ammoniac*. Of these, killed spirits is probably the easiest and cleanest to use, but unfortunately it is not very suitable for most electrical and wireless work, as it tends to corrode copper by chemical action, and copper, of course, is almost universally used for electrical conductors. Resin is the most satisfactory flux from this point of view but it is far more difficult to use. Probably the easiest way for the home constructor is to use one of the many good patent fluxes on the market. Many of these contain powdered resin; they are easy to use and seem to have no bad effect on copper.

Cleaning the Iron.

A difficulty which the writer has experienced in their use is that some of them tend to make the soldering bolt very dirty. This necessitates continual careful wiping of the iron and adds a further difficulty, since absolute cleanliness is the great essential for success. A method which has been found to overcome this is to use a pot of killed spirits for cleaning and tinning the bit and to use the patent flux on the actual joint.

One word of warning as regards killed spirits may not be out of place. Killed spirits bought ready-made is rarely so satisfactory as that made up by oneself. This can very easily be done by adding zinc to a small quantity of hydrochloric acid, but care must be taken to add sufficient zinc, as a saturated solution is required. Keep on adding bits of zinc until no further chemical action occurs; that is, until a small quantity of zinc is left at the bottom of the pot without the acid acting further upon it. It is in this respect that the bought variety is usually unsatisfactory.

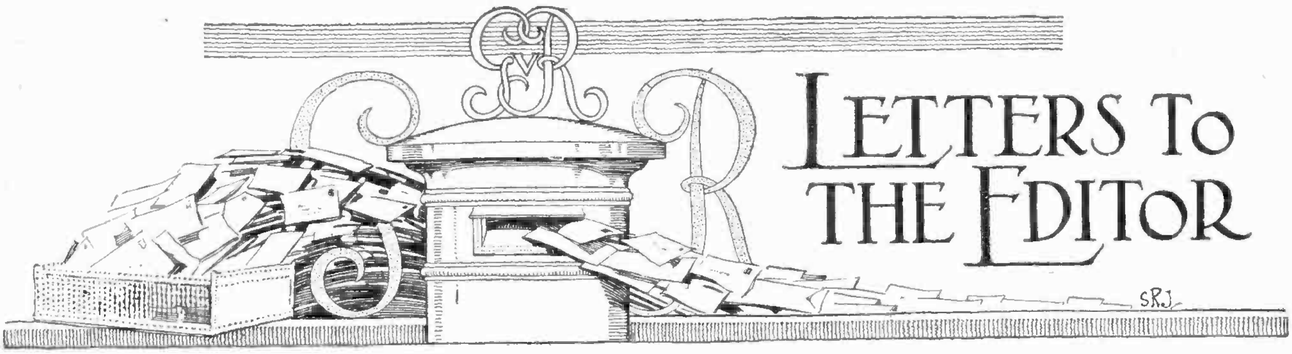
A Large Bolt Essential.

The copper bit, more generally known as the soldering iron, constitutes another pitfall for the unwary. Many constructors, and, apparently, wireless dealers too, think that a very small bit will be much easier to use for delicate and finicky work than a larger size. This is far from being the case.

The function of the copper bit is to supply the requisite heat to the job and to the solder, and the smaller it is the more rapidly will it cool off below the requisite temperature, which means that the joint has to be completed very much more quickly. For this reason a small bolt requires far more skill in use than a larger one.

The actual bolt or bit, which is merely a lump of copper pointed at the extreme end, should be of generous dimensions to allow it to retain the heat for a reasonable time; even if a small diameter is essential for close work in multi-valve sets the bolt should be long so as to give the requisite mass of metal.

P.O.L.



The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

DEFECTS IN INTERVALVE TRANSFORMERS.

Sir,—In reply to Mr. Schofield's letter in your issue of June 16th, may I say that since no manufacturers' names have been mentioned in any of my articles it is difficult to understand in what way the expression of my views casts "an unmerited reflection on the products of certain manufacturers." All the cases of transformer breakdown that have been mentioned and discussed by me have been genuine disconnections of the winding, and, as I have previously pointed out, in every single instance it has been the primary winding which was at fault. I have, of course, come across many cases in which the connecting wire from winding to terminal was broken, but it requires very little experience to distinguish this from an internal break in the winding. I can assure Mr. Schofield that the defect to which I am referring requires something more for its cure than the development of improved methods of making the connection from winding to terminal.

S.W.14. R. L. SMITH-ROSE.

Sir,—I wish to agree with Dr. Smith-Rose in his bitter complaint about transformer windings. I have had incessant trouble from this type of fault. The transformers in question are the most expensive on the market and give truly excellent results in all other respects. However, so troublesome has this fault been that I have had to change over to resistance amplification and have had no complaint to make about this method, which has never gone wrong. E. A. ANSON.

Aldbury, nr. Tring.

PORTABLE RECEIVERS.

Sir,—The replies of your correspondents to my remarks on the subject of portable receivers have been carefully perused, and I should like to add some further notes to the discussion.

I agree that the range of the set mentioned by me is not very adequate for motoring. Nevertheless, half the cake is better than none at all, and I still retain my opinion that a properly designed long-range portable is far too bulky even for the average car.

Regarding the commercial superheterodyne mentioned, I have seen this outfit, and if the ridiculously small batteries therein are considered satisfactory, "The Wanderer" and I must agree to differ.

The most important point relating to valves and holders could do with a little ventilation. My experience with 0.06 type valves goes beyond the use of one or two experimentally, as since their first appearance some thousands have passed through my hands and their vagaries are appreciated.

The very fine filament cannot be other than extremely fragile, and, due to this, it is impossible to take up stretch with a spring as is done in most other valves, the result being a filament free to vibrate and, in due course, fracture. The vibration of the filament also leads to incurable howling if the loud-speaker is placed in or near the receiver. Valves consuming 0.15 amp. at 2 volts are now available and are an infinitely superior proposition for portable work.

"The Wanderer" adduces no argument against the type of holder suggested by me, which has every feature of spring holders without their disadvantages. It is, of course, ridiculous to deprecate types in which the legs are moulded into a block as the weight of the small moulding is negligible in comparison to the valve it carries. The whole argument amounts to this: springs transmit all shocks applied, whilst sponge rubber, being naturally limited, absorbs them.

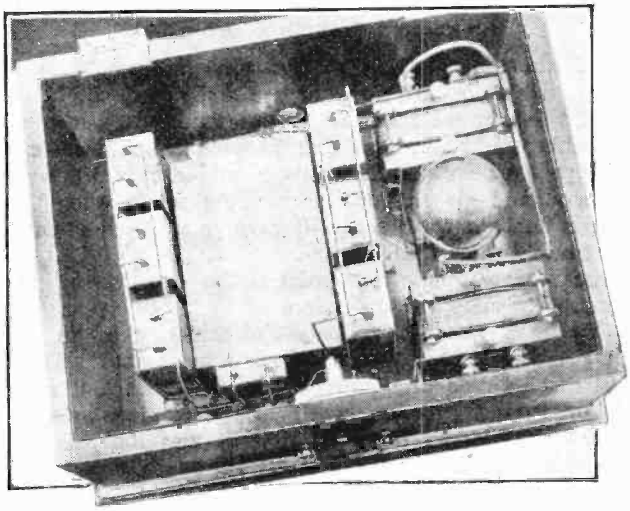
Your other correspondent mentioned a superheterodyne built into very modest dimensions; in fact, so modest are they, that I must begin to doubt the fact that it is a satisfactory proposition; this remark, of course, casts no aspersion on the receiver proper, but on batteries and loud-speaker.

Naturally, the first consideration must be reasonably decent reproduction. It is, therefore, little use to make a good receiver if it is to be coupled to one of the awful contraptions called loud-speakers I have seen fitted into portable sets.

His strictures on manufacturers are surely rather severe; it is inconceivable that all professional designers are fools and the only experts earn their bread outside the industry. Personally, having had the misfortune to deal with a large number of representative receivers made by "neat and careful" amateurs, I must regretfully stick to my opinion.

Joints and fixings that serve well in the family set may be useless in continual transit. Nevertheless, good soldered joints in conjunction with suitable arrangement of components and leads will withstand the roughest possible usage.

L. W. RUSKHAM



THE TANGENT RECTIFIER for providing H.T. from A.C. supply. Although only half wave rectification is adopted, the smoothing equipment is particularly liberal, ensuring quiet running even with a multi-valve set.

Readers' Problems

"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

A Stable and Efficient Five-valve Circuit.

I wish to construct a five-valve receiver embodying a 2-v-2 circuit with reaction on to the aerial. It is desired that the receiver be sensitive and capable of loud-speaker operation on distant stations under reasonably favourable conditions. At the same time, it is desired that the receiver cover both the normal B.B.C. and the Daventry and Radio-Paris wavelengths, and it must be equally stable on all wavelengths. I do not desire to use the neutrodyne principle if it can be avoided. C. M. F.

It would, of course, be by no means easy to construct a neutrodyne receiver to cover this large band of wavelengths, since, even if we devised special plug-in neutrodyne transformers to cover the various wavelength bands, it would be necessary to re-neutralise the receiver every time the transformers were changed. The old method of using two tuned anode circuits and stabilising with a potentiometer has long been obsolete not only on account of the large consumption of H.T. current, but also because the inefficiency of such an arrangement is now generally recognised. The amount of positive bias necessary to stabilise the H.F. valves was so great that in many cases the actual amplification obtained was less than that obtainable with one stage of H.F. without potentiometer control, whilst owing to the comparatively large grid current flowing selectivity was very poor.

There is, however, one method of using two stages of H.F. amplification efficiently and of covering a large wavelength band which has not received the amount of attention which it merits. This method was fully described in a special article appearing on page 117 of our January 27th issue, and you are advised to read this article carefully before proceeding with the construction of the receiver. We give the circuit which would be suitable to your needs in Fig. 1.

It will be noticed that the grid circuit of the first H.F. valve is tuned by means of a plug-in coil and parallel condenser, whilst in order to achieve selectivity the aerial is capacitatively coupled by means of a variable condenser. This condenser must not be considered as a tuning control, nor must it be used as such, but must be considered purely as a variable coupling between the aerial and the grid circuit. This method of coupling was fully discussed in a reply to "G. P. K." on page 542 of our April 7th issue, to which you are referred. In the anode of the first H.F. valve is connected a choke, the second anode consisting of a plug-in coil tuned by a variable condenser in the conventional manner. The presence of this choke-coupled stage separating the two fully-tuned circuits associated with the grid of the first and the anode of the second valve will effect complete stability, whilst much greater amplification will be obtained than if both valves were choke coupled. It is advisable that the control of reaction be made as smooth as possible, and for this reason the method of reaction discussed in an article on page 608 of our April 28th issue is used.

It is essential that the choke connected in the plate circuit of the first H.F. valve be of the highest possible efficiency, and it is best to make use of a choke which the manufacturers state specifically to be designed for coupling H.F. valves such as the Marconiphone choke, which covers a waveband of 200 to 4,000 metres, and need not, therefore, be made interchangeable. The choke in the plate circuit of the detector valve being only for the purpose of providing reaction effects, need not be of high efficiency, and any of the many

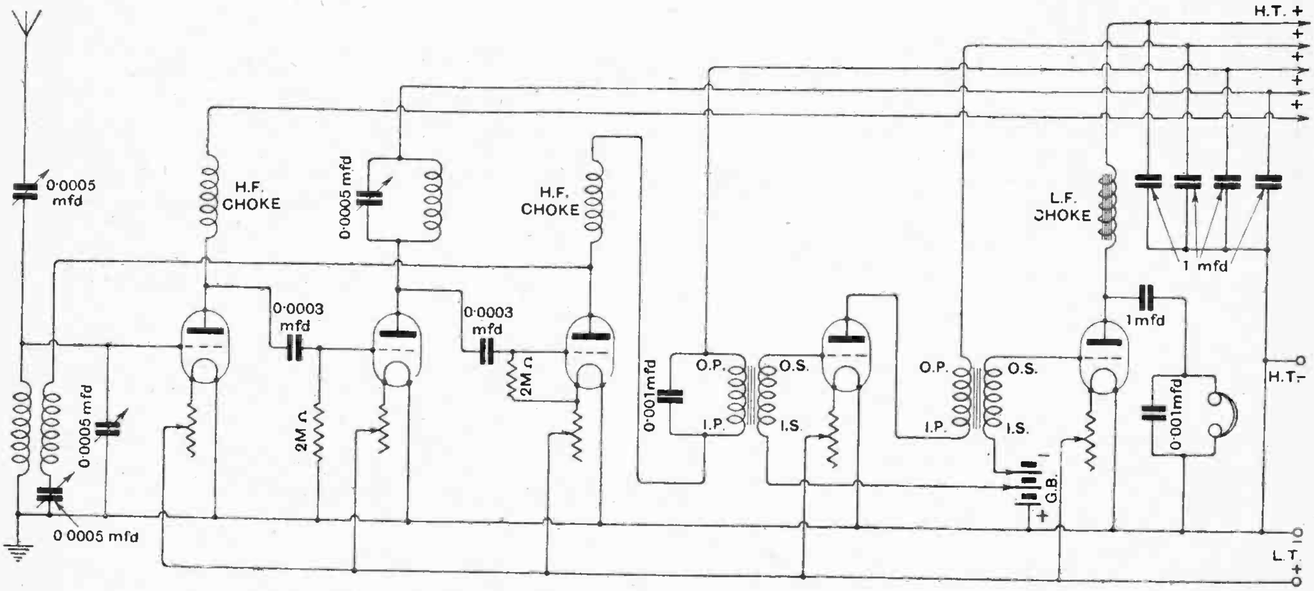


Fig. 1.—Five-valve receiver for both long and short wave reception.

H.F. chokes upon the market will serve the purpose. This choke also need not be interchanged for different wavelength bands.

The first L.F. transformer is preferably of low ratio, not exceeding 3 to 1, whilst a 4 or 5 to 1 ratio may be used in the second stage. The choke in the plate circuit of the final valve is essential if good quality is wanted, for reasons stated in the article on page 701 of our May 26th issue.

With regard to valves, ordinary general purpose bright or dull emitters may be used in the first three stages, although, in order to obtain the utmost efficiency, it would be preferable to use high amplification valves such as the D.E.5B. Similarly, in order to obtain the utmost good quality from the loud-speaker, a power valve of the D.E.5 type should be used in the first L.F. stage, and one of the D.E.5A type in the final stage.

oooo

Paper or Mica?

Why is it that a mica dielectric condenser is always specified for inter-valve coupling in a resistance of choke coupled amplifier, and yet paper dielectric condensers are specified for shunting across H.T. batteries? Usually the voltage which the latter have to withstand is greater than the former, and yet they seem to give satisfaction. Surely then it is unnecessary to use mica condensers in the other position. C. T. C.

Usually, as you state, the condensers shunting the H.T. battery have to withstand a greater voltage than the coupling condensers, and it would seem, therefore, an unnecessary expenditure to use mica dielectric coupling condensers. The point is, however, that owing to paper being a less efficient insulator than mica, there is always a danger of a minute leakage across the condenser. It must be remembered that on one side of this condenser we have a large positive potential, and if there is a slight leakage across the condenser it may cause the grid on the other side of the condenser to assume a slight positive bias which would, of course, completely ruin quality. It is always advisable, therefore, to use mica in order to obviate this. A slight leakage across the condensers shunting the H.T. battery will do no harm whatsoever, and provided that the paper dielectric does not become actually punctured by the high voltage, all will be well.

oooo

Wire-wound Resistances.

Is there any special advantage to be obtained by the use of wire-wound anode resistances in place of those constructed of other material? I ask this because I have used resistances which are not wire-wound for some time in my resistance-capacity coupled L.F. amplifier with every satisfaction, and am wondering whether I should effect any great improvement by changing over to wire-wound components. T. D. A.

When new, it is often found that composition resistances are productive of even better results than many of the wire-wound type that are upon the market. The reason is that many of the wire-wound resistances upon the market, although wound non-inductively, as, of course, they should be, are compressed into a very small space with the result that their self-capacity is apt to be rather high. The result is, of course, that not only are the higher musical frequencies shunted away and not amplified to so great an extent as the middle range of frequencies, but the overall amplification is somewhat reduced. In the majority of resistances made of composition material, self-capacity is at a minimum with the consequent improvement in tone and amplification.

Unfortunately, however, after a comparatively short period of use, the passage of steady anode current tends to disintegrate the material of which the resistances are made, and the resistance is no longer constant. Undoubtedly the best solution is to use wire-wound resistances of fairly generous proportions in which the coil is divided into sections in order to reduce self-capacity. Such a resistance was used in the amplifier described on page 480 of our March 31st issue.

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The Simplest Loud-speaker Set

I live very near to a main broadcasting station, and find that I get exceptionally loud signals from the telephones, using a crystal receiver. I desire to add a one-valve amplifier for the operation of a small loud-speaker, the requirements being moderate volume with the same purity as is given on the headphones, using the crystal set alone. It is desired also that the amplifier be as simple and as foolproof as possible. R. P. C.

Undoubtedly by far the best circuit for you to adopt is the one given in Fig. 2. This will provide enough volume for your requirements, whilst reproduction from this circuit is exceptionally pure. Furthermore, owing to the absence of any transformer, or choke, the instrument is exceptionally simple and reliable. It possesses also the virtue of being reasonably cheap, since apart from valve and batteries the only parts required are valve holder, grid leak, rheostat, and terminals. There is no need to use a variable rheostat unless it is so desired, and a fixed resister having a value suitable for the particular valve used may be adopted and a switch inserted in either filament lead.

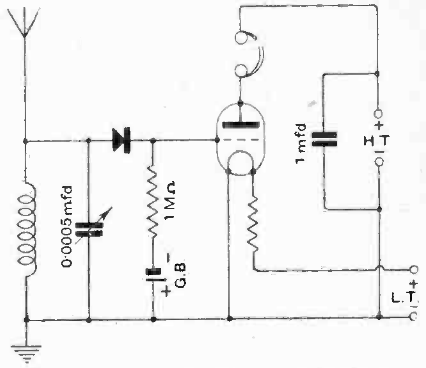

Fig. 2.—Simple circuit for loud-speaker reception of strong signals.

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Ohms or Henries.

I have recently purchased an iron-cored choke which is marked 1,000 ohms. Can you tell me whether this could be used in a choke coupled amplifier? J. D. M.

It is quite impossible to say whether this component would be suitable for the purpose unless you can tell us its inductance. The expression 1,000 ohms either means that its D.C. resistance is of this value, or that it has this value of impedance at a certain A.C. frequency. Nothing can be deduced concerning its inductance from the fact that its D.C. resistance is known, whilst if the value given refers to its impedance at a given frequency, the inductance cannot be calculated unless this frequency is known. It is most probable that the 1,000 ohms value given refers to its D.C. resistance. This is entirely valueless to us, since it would be possible to wind a choke of comparatively high inductance, and also one of comparatively low inductance, both chokes having an identical impedance at a given frequency. For wireless purposes it is useless to quote the D.C. resistance of an inductive choke, since this conveys nothing to us, the property of the instrument which we wish to ascertain being its inductance. It would be equally useless to quote a filament rheostat in microhenries instead of in ohms, for, of course, a wire-wound filament rheostat of the ordinary type inevitably possesses a certain amount of inductance, although knowledge of the value of this would be singularly unhelpful to us in ascertaining its D.C. resistance, which is what concerns us. From practical experience we should be inclined to think that your choke does not possess a very high inductance, and would be productive of very poor quality if used in a choke-coupled L.F. amplifier.

The Wireless World AND RADIO REVIEW (14th Year of Publication)

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

AN EMPIRE NEED.

BROADCASTING provides a means, such as has never existed before, for linking up large areas and even bringing different nations into mutual touch with some central point. We, in Britain, are often being accused of insularity in our outlook, and despite the fact that the British Empire extends to every corner of the globe, our broadcasting organisation has been set up to serve this country alone with really no consideration for the possibilities of broadcast reception further afield.

An article which we published some time ago on the subject of the possibilities of reception in the Colonies of transmissions from home has provoked considerable interest, and we have received communications from different parts of the Empire appealing to us to stimulate interest and consideration for the requirements of our fellow-countrymen overseas. We get used to the advantages of broadcasting at home through familiarity, and even if we were deprived of broadcasting here we still have other sources from which to obtain our news and entertainment. But it is not so in the Colonies, where the possibilities of being able one day to listen-in with a wireless set to the transmissions of the Mother Country are looked forward to with an eagerness which should stir us to a sympathetic response.

The present B.B.C. stations are scarcely suited to very long distance broadcasting, but if a transmitter were erected to operate on short wavelengths it could, no doubt, be made possible to broadcast programmes to many parts of the Empire under favourable conditions. In comparatively few cases would it be possible for individual listeners to pick up the transmissions direct, but central receiving stations of high efficiency would have to be put up which would supply the programmes from the Mother Country for re-broadcasting from local transmitters. Those who listened in would not expect too much all at once, and would be well pleased if they could receive only portions of a programme with success at first, not, of course, as we receive them in the shadow of our stations, but, nevertheless, sufficiently well to give tremendous pleasure, especially to listeners in isolated districts.

We are not sure that such a project would best be carried out as a part of the programme and organisation of the present broadcasting service. It would seem to us that it is a matter requiring the consideration and co-operation of the Colonial Office and the India Office, and we feel that steps should be taken without delay to arrive at some solution which would meet the present demands of the Colonies for a broadcasting service from the home country in which they could participate.

It would take some time for satisfactory broadcasting to the Colonies to be organised and launched, and if we delay we shall find that instead of broadcasting becoming a means of uniting the peoples of the Empire, it may become rather a menace to the Empire for the reason that the Colonies will be dependent upon the high power broadcasting stations of their neighbours, and thereby become subject to the influence of a national spirit which is not their own.

CONTENTS.

PORTABLE SUPERHETERODYNE

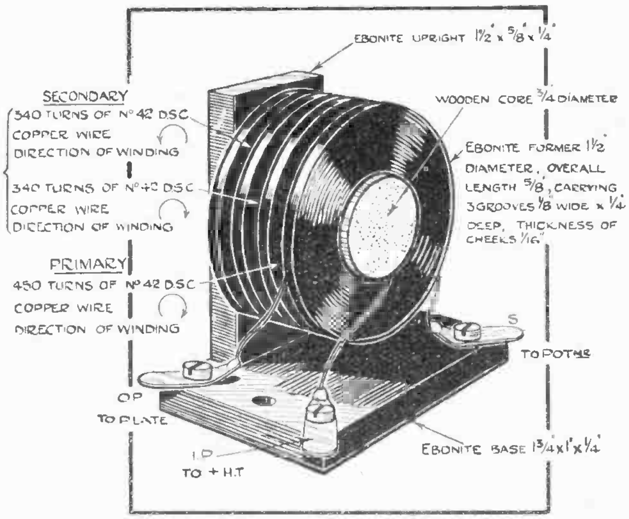
Practical Points in Design with Constructional Data.

By F. H. HAYNES.

THE time has passed which regarded superheterodyne receivers as things unorthodox, but even now it is surprising how few successful sets have been constructed. Variety of design, such as the use of a high-frequency amplifying stage before the first detector, the combining in one valve of the operations of detecting and heterodyning, and the differences of opinion concerning the number of amplifying stages, the best intermediate wavelength to adopt, and the design of the intermediate transformers, all go to give the impression that the superheterodyne is still immature. Absence of suitable components, moreover, has stood in the way of the development of easy designs.

The Straight H.F.

The progress made in the construction of stabilised H.F. amplifiers has perhaps made a greater appeal to those interested in long distance reception, because the suggestions put forward from time to time have merely necessitated modifications in existing apparatus, whilst the adoption of the superheterodyne involves the making up of new equipment. For listening to distant transmissions the relative merits of superheterodyne *versus* the multi-stage H.F. amplifier are: simplicity of adjustment, tuning being carried out on two dials only, with stability equally maintained at all settings of the dials, constancy of tuning, for the superheterodyne can be accurately calibrated, greater selectivity with directional reception, and an elevated aerial is unnecessary. Whilst it is probable that the range of reception is greater, a distant station can be tuned in with greater reliability.



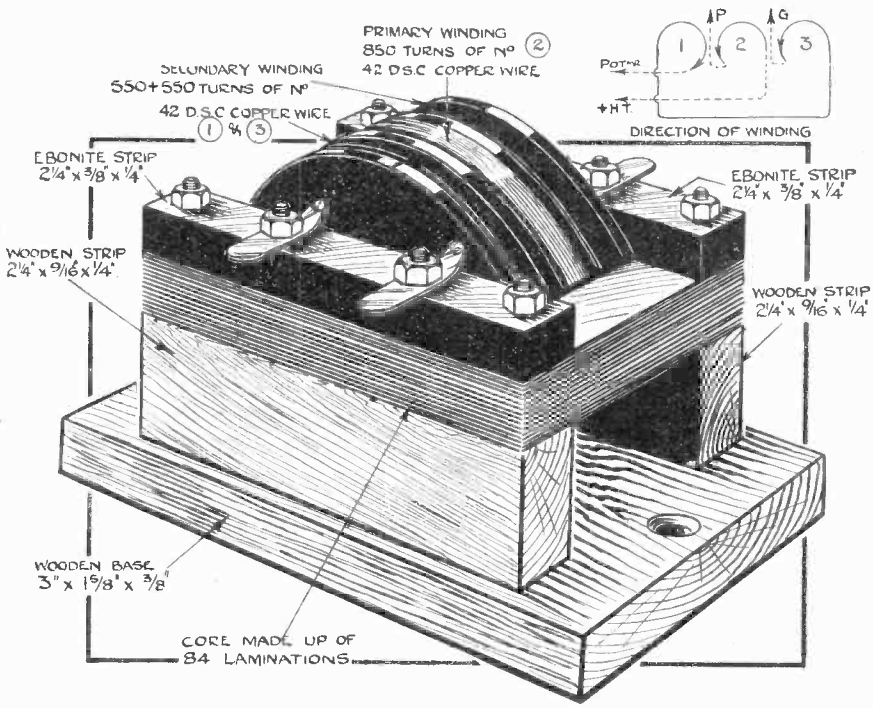
Working instructions for making up the first long-wave intervalve coupling. The primary winding in this case is at one end, though in the iron core intervalve couplings the primary is situated between the two secondary sections.

Against these advantages is the property of the superheterodyne to bring in "mush," but precautions can be taken to largely eliminate this, the increased demand on both the filament heating and anode batteries and other extra costs involved in maintaining an additional number of valves. Frequency distortion, by which is meant the inability of the intermediate amplifier to operate over a sufficiently wide band of wavelengths, is only a condition to guard against and poor quality of reception should not be accounted for on this score.

Methods of Stabilising.

Because the components associated with the superheterodyne are small, a receiver making use of six to eight valves can be accommodated in a reasonably small space. It is therefore admirably suitable for use as a portable set giving loud-speaker results with a small frame aerial and with a radius of reception exceeding 500 miles. Although the set here described is referred to as a portable, portability is merely a feature of the design, and if space is of no consequence the distance between the components can be extended.

The decision to use seven valves was arrived at after trying out at some length the several systems by which it is possible to use fewer valves. The principal concern was the heavy plate current required by a large number of valves, which was one of the reasons for limiting the long-wave amplifier to two stages, for the current passed by the valves of the intermediate stages is apt to be excessive owing to the positive grid bias required for stabilising.



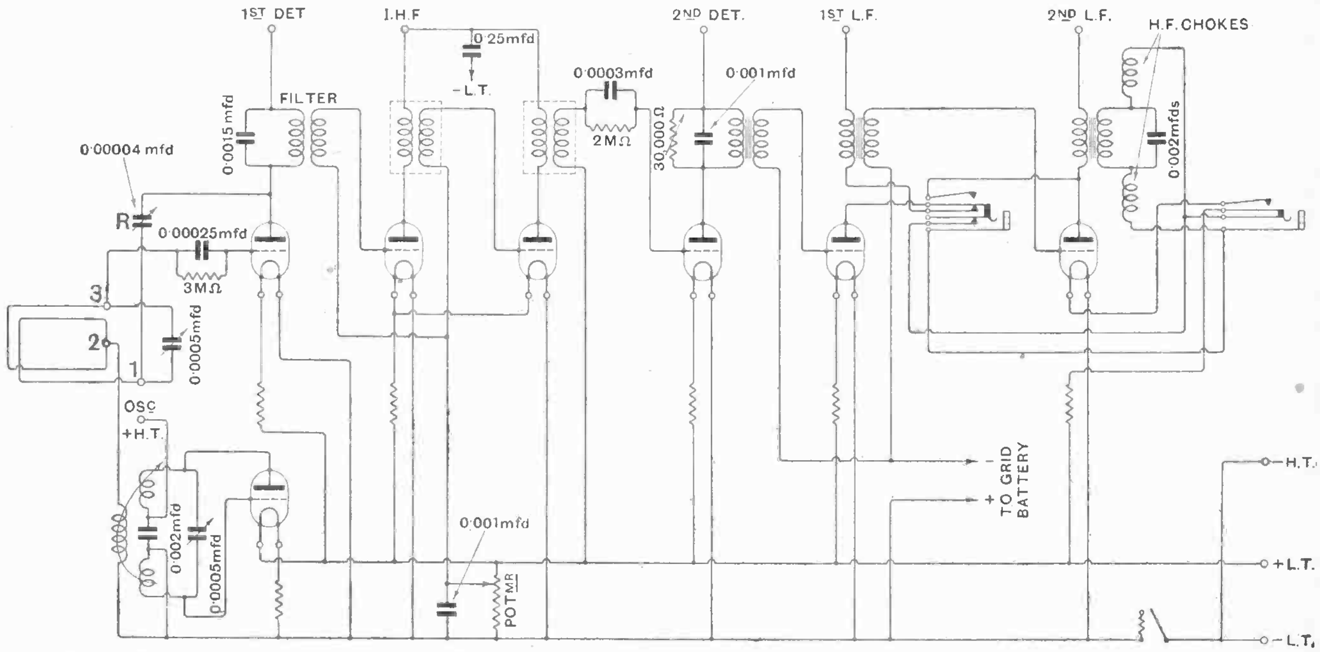
Constructional details of the intervalve H.F. transformers. The direction of winding shown in the drawing at the top right-hand corner must be carefully followed and low insulation between primary and secondary guarded against. The thin steel stampings are inserted in the former by being sprung open. Holes are provided in the corners of the stampings to accommodate the 6B.A. bolts, which should be wrapped with thin paper to prevent electrical contact across the stampings.

intermediate amplifying valves, and so effect considerable saving of current from the H.T. battery, and at the same time resulting in higher amplification. It was found, however, that the construction of transformers with critically adjusted feed back windings working through small *fixed* capacity condensers was difficult. It was an easy matter to prevent self-oscillation by this process, but the intermediate amplifier could not be brought to a critical condition just near the oscillating point without very carefully manipulating the grid and plate potentials of each valve separately, whilst no control could be provided on the front instrument to permit of critical adjustment as the battery volts fluctuated. In adopting the potentiometer method of stabilising, and by employing a moderately long intermediate wavelength, the feed current to each of the two stages is kept down to within 1.2 milliampere.

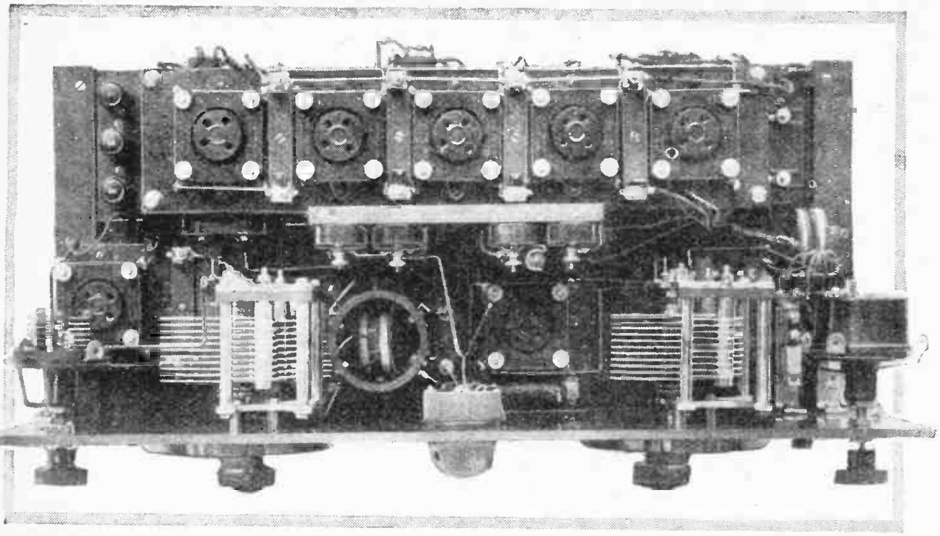
The prevention of self-oscillation in the intermediate amplifier was attempted in the process of design by overwinding the intermediate transformers with suitable turns for stabilising by the neutrodyne method. This would permit of the application of negative bias to the

Iron-core H.F. Transformers.

While discussing the intermediate amplifier, attention may be drawn here to the use of Stalloy steel stampings for the cores of the intermediate transformers. The air-core transformers having been experimented with at some length, several drawbacks became evident. However small the physical dimensions of the air-core transformers might be, interstage screening was essential to



Seven-valve superheterodyne receiver making use of separate oscillator, capacity reaction, two intermediate amplifying stages, volume control and optional second low-frequency stage.



Plan view showing the arrangement of valve holders, the oscillator coupler and the condenser rack. Strips of ebonite fitted with clips can be seen between the valve holders for accommodating the fixed value filament resistances.

avoid self-oscillation whilst very effective screening was imperative to prevent the pick up of interfering signals and mush. It was found that air-core transformers gave best results when not shunted by parallel tuning condensers, though the tuning was exceedingly critical and the changing of a valve was easily enough to put one stage sufficiently out of step to limit the range of distant reception.

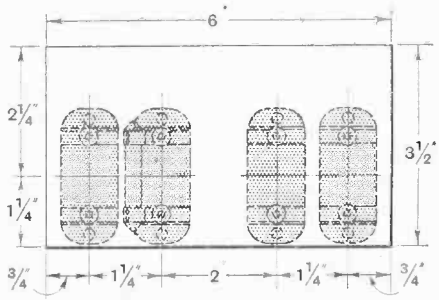
The resonance peaks of air-core transformers must be sharp to obtain a reasonable degree of amplification, a condition which is difficult to maintain when building the transformers into their screening boxes. To produce the sharp resonance required for good amplification necessitates the use of a higher intermediate frequency in the case of air-core transformers to avoid the distortion occurring as a result of cutting off the side bands.

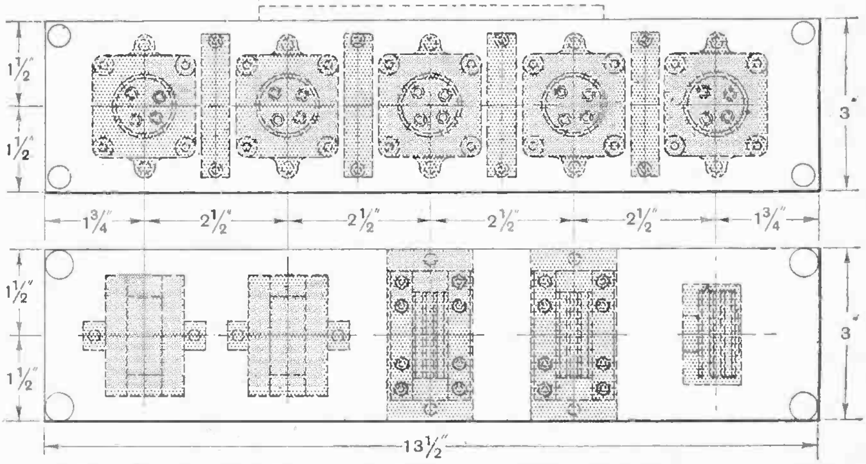
The Intermediate Amplifier.

It was found that the iron-core transformers gave higher amplification per stage, possessed flat resonance peaks, could be operated on longer intermediate wavelengths, required practically no screening, however they were assembled, and were quite free from pick up.

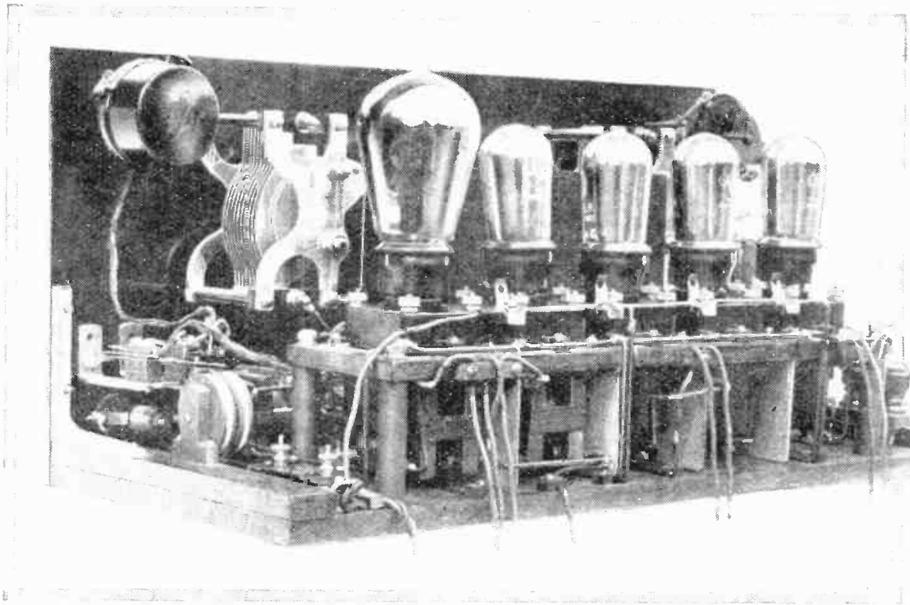
The intermediate amplifier was built up experimentally and tested as a unit making use of a tuned input filter and a wavemeter operating between 2,000 and 10,000 metres. The two transformers were of identical construction, and were made by rough test to peak at 7,000 metres. The filter circuit primary was bridged for this test with a Marconi variable condenser having a maximum capacity of 0.01 mfd., and although the tuning of the filter circuit was found to be satisfactorily sharp, the intermediate iron-core transformers could be made to operate on almost any wavelength, though maximum signal strength was certainly evident at about 6,000-7,000 metres. It follows, therefore, that small discrepancies by way of differences in the windings of the intermediate transformers are of little consequence, as is the precise wavelength to which the filter is tuned.

The writer was privileged in being afforded an opportunity of testing under similar conditions the principal American intermediate coupling transformers. Here, again, it was found that those of the iron-core type gave greater signal strength and were more manageable. An interesting point is that the value of the current passing through the primary modifies the resonance of a transformer, as can be easily shown by setting up a transformer and valve as an oscillator and observing the differences in wavelength produced with changes of H.T. potential. It will be seen when examining an iron-core transformer in this way that its resonance can be permanently affected by the current passing through the primary winding changing the properties of the core. As a result of this effect "matched" valves passing exactly equal plate current are usually recommended. For





Layout of the apparatus on the valve platform The top edge of the wooden piece which carries the fixed capacity condensers is screwed to the side of the platform in the position indicated by the dotted line.



The method of constructing and setting out the valve platform carrying the H.F. and L.F. intervalve couplings is clearly shown. The small spool on the left is the output choke. Ebonite cleats are used for securing the battery leads.

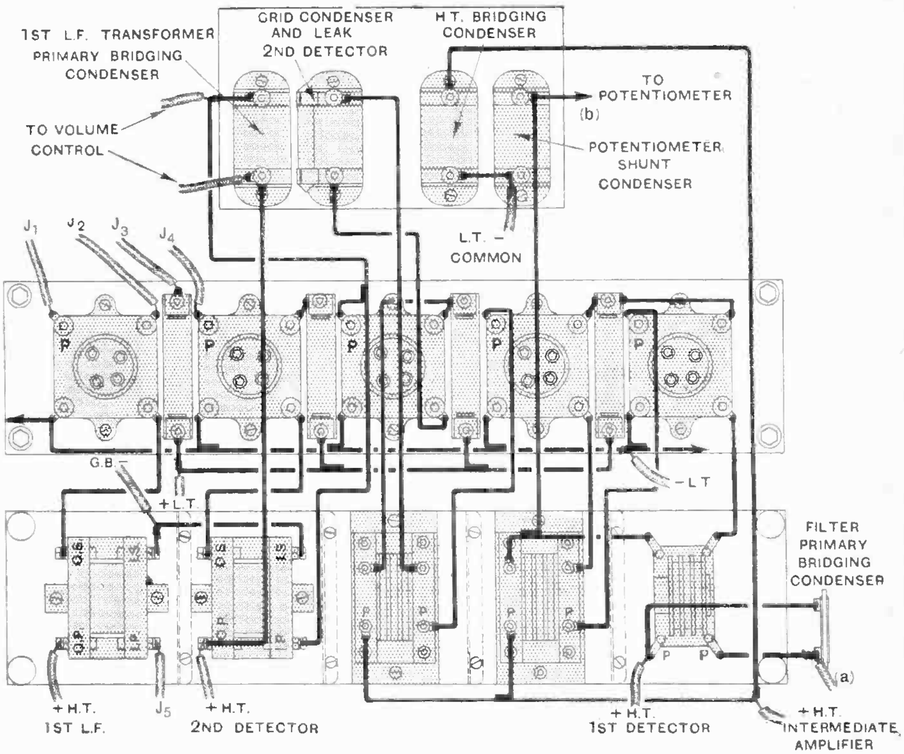
this reason, also, the filaments of the two intermediate valves are controlled by a single resistance and the plate and grid leads are common. Another observation evidenced while testing air-core transformers was that a weak signal was lost as the potentiometer adjustment approached positive, indicating that the amplifier owed its sensitiveness chiefly to regeneration.

In further reviewing the circuit adopted, it may be explained that the filter circuit precedes the two intermediate transformers, though in certain American sets the filter circuit is connected as an input to the second detector valve. Both methods were tried, and the difference as regards signal strength was quite marked, being in favour of connecting the filter first. It is probable that the filter following the flatly tuned intervalve couplings is intended to eliminate any interference which may be picked up by the intermediate amplifier.

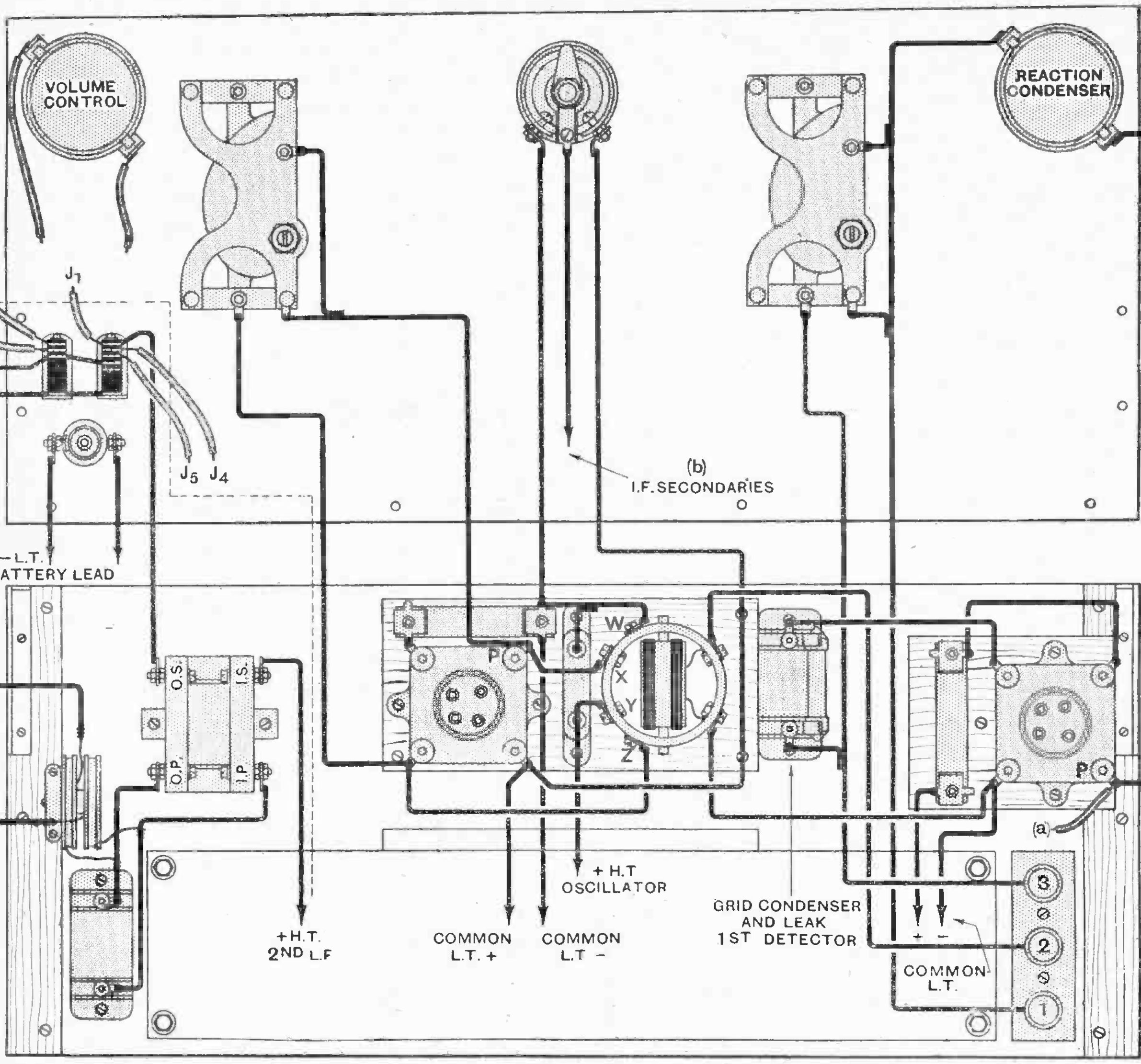
The frame aerial connects directly to the first detector valve, and, whilst appreciating that an H.F. amplifying stage in front of the detector might very effectively cut off long wave signals picked up by the frame, its adoption was definitely decided against, for to be really selective it would need to be adjusted near the oscillating point, a condition that is very difficult to bring about. An H.F. amplifier on the verge of oscillation in the presence of a local oscillator is quite unmanageable, whilst the additional tuning dial renders manipulation infinitely more difficult than operating a pair of knobs simultaneously. An aperiodic H.F. amplifier is of little use for working on the small input obtainable from the frame, and, although quite effective in increasing the strength of signal from the local station, might even decrease the range of reception, and no advantage is gained as regards improved selectivity by way of filtering out extraneous mush.

A frame aerial normally possesses low resistance as compared with an elevated aerial, but in spite of this capacity reaction will be found to be beneficial by way of increasing signal strength and sharpening the tuning. The use of a frame of large dimensions is recommended, and it is here that reaction is particularly beneficial.

Signal strength is controlled both by taking the last



Internal wiring of the valve platform. Actually all leads are quite short and are mostly hidden away beneath the board.

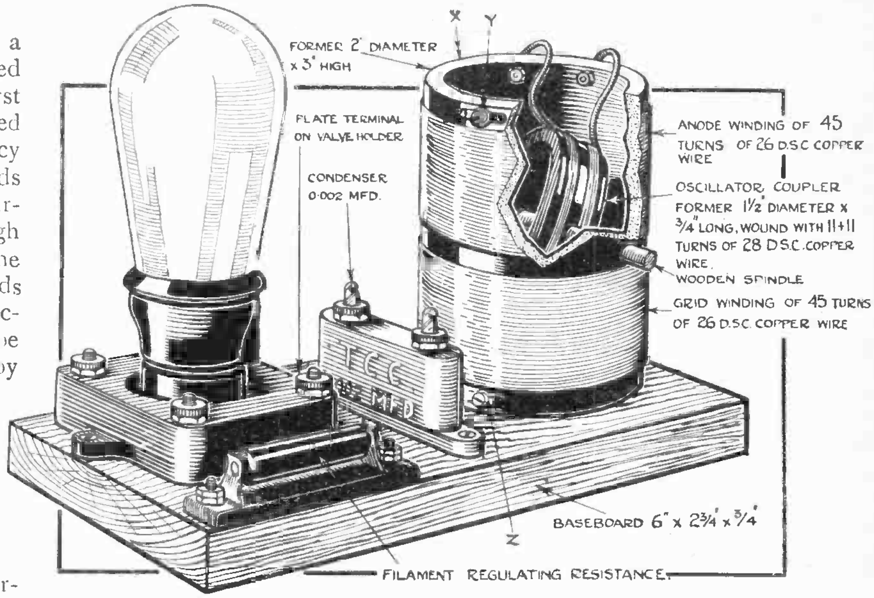


The various units are not assembled until much of the wiring has been completed. The battery leads pass to the rear of the instrument beneath the valve platform, the latter being completely wired before being assembled in position.

LIST OF PARTS.

Radion panel, 18in. × 8in. × $\frac{3}{16}$in.
Mahogany baseboard, 18in. × 7½in. × ⅜in., planed mahogany.
2 Battens, 7½in. × 1in. × ⅜in., mahogany.
Transformer platform, 3in. × 13½in. × ⅜in., mahogany.
Condenser rack, 5¾in. × 3½in. × ⅜in.
Other small thick pieces of wood for use as base pieces for first detector and oscillator equipment.
7 Valve holders (Benjamin Electric Co., Ltd.).
4 Ebonite spools for filter circuit H.F. transformers and output choke (N. V. Webber & Co., Vale Road, Oatlands Park, Weybridge).
14 doz. stampings, 1·4in. × 2·2in. overall. Thickness 0·004in. (N. V. Webber & Co.).
2 ozs. No. 42 D.S.C. wire.
Or in lieu of these transformer parts.
1 Set S-M superheterodyne transformers (Rothermel Radio Corporation of Great Britain, Ltd., 24-26, Maddox Street, Regent Street, London, W.1).
3 Ericsson intervalve transformers, ratio 2 : 1.
2 Variable condensers, 0·0005 mfd. Cyldon (Sydney S. Bird, Cyldon Works, Sarnesfield Road, Enfield Town).
Flat type fixed capacity condensers, 0·00025, 0·0003, 0·001, 0·0015, two 0·002, 0·25 mfd. Terminals, sleeving, connecting wire.
Potentiometer.
Variable high resistance, 30,000 ohms, Igranic, type 2233/2.
Reaction condenser, 0·00004 mfd., Igranic, type 2231/17.
Break jacks, Igranic, types P.68 and P.69.
Pieces of ebonite tube for constructing the oscillator coupler; also strips of ¼in. ebonite sheet for supporting the fixed filament resistances and terminals.
2 Cast aluminium brackets, 2¾in. (A. J. Dew & Co., 33-34, Rathbone Place, Oxford Street, London, W.1).
"On-and-Off" switch (The Argonaut Manfg. Co., 16, Norman Buildings, Old Street, London, E.C.1).
2 Slow motion dials.
Small quantities of Nos. 26 and 28 D.S.C. for oscillator.

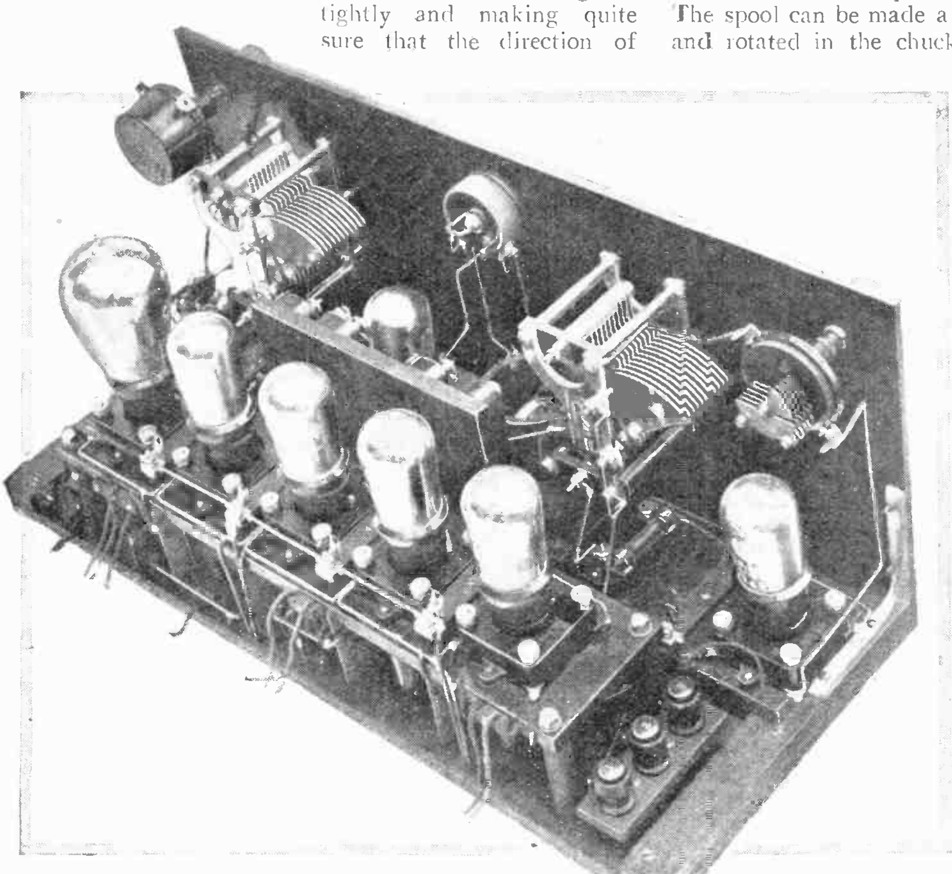
Portable Superheterodyne.—
valve out of circuit as well as by a variable shunt resistance connected across the primary winding of the first L.F. transformer. The output is fed through a transformer, radio-frequency choke coils being connected in the leads for the purpose of preventing the partial earthing which is provided through head telephone receivers, or when the loud-speaker is connected through leads of appreciable length. In this connection, also, the batteries should be spaced from earth and connected by short leads to prevent the frame acting as an earth-connected vertical aerial and becoming sensitive to long-wave interference.



Instructions for making up the oscillator. The wooden rod carrying the coupling coil fits tightly into the bearing holes in the ebonite tubes. Reference letters X, Y, and Z identify the points of connection shown in the practical wiring diagram.

Constructional Details.

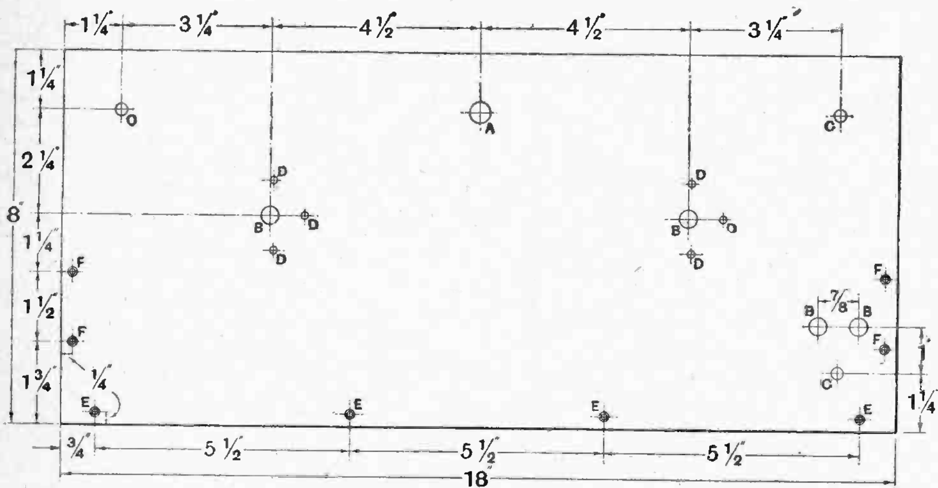
The construction of the intermediate transformers can be undertaken with very modest workshop facilities, making use of turned ebonite spools. The winding must be carried out very carefully according to instructions, watching for kinks and bared places on the wire, not winding too tightly and making quite sure that the direction of winding is the same in the case of each spool. Perfect insulation between primary and secondary is essential. The spool can be made a tight fit on to a wooden spindle and rotated in the chuck of a small hand drill. The outside ends are best terminated by tying back with cotton.



The finished set has a neat appearance, for most of the wiring which is short and direct is hidden away beneath the valve platform

In building up the core from the requisite number of stampings it will be found easier to insert the stampings from one side and then the other in sections of three. Strips of ¼in. ebonite clamp the stampings in position on wooden supports, which are in turn held to a base piece. Four tags serve as terminals secured to the ebonite bars by means of 6 B.A. screws, with heads recessed into the ebonite. In all, four spools are wound for the intermediate transformers, filter circuit and output choke, the latter being wound full in the two outside sections, winding in opposite directions with the finishing ends connecting to the break jacks.

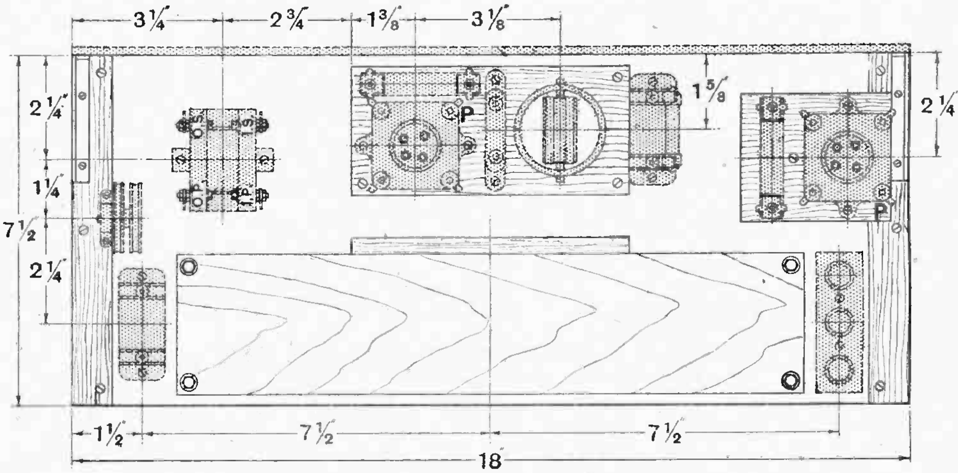
Turning again to the intermediate amplifier, the whole of this unit, together with its associated condensers, is built up, wired, and tested before being fitted to the set, the wiring being carried out



Drilling details of the front panel. Hole A accommodates the potentiometer, probably $\frac{7}{16}$"; B, $\frac{3}{8}$"; C, $\frac{1}{4}$"; D, $\frac{5}{32}$"; E, $\frac{1}{8}$" and countersunk for No. 4 wood screws; F, $\frac{1}{8}$" and countersunk for No. 6 B.A. screws. The baseboard fits flush with the bottom edge of the panel.

mainly with No. 18 in insulating sleeving, while bare No. 16 is used for linking across the filament distributing points. Compartments are formed for the transformers by zinc or aluminium spacers clamped together at one corner by means of a length of 4 B.A. rod and a number of nuts. When completed the wooden platform is supported up from the base by lengths of 2 B.A. rod passing through ½in. ebonite pillars provided with ¼in. hole.

Full constructional details for making up the oscillator unit are given in an accompanying drawing. The first detector valve, together with its fixed filament resistance, is also carried on a base piece which is, in turn, screwed down to the main baseboard. The three terminals which connect to the frame are carried on an ebonite strip raised from the baseboard by ebonite spacers. Filament resistances are carried in clips, and as a simple alternative the reader may fit up six ebonite strips with pairs of small terminals so that the resistance wire in the form of a small coil of No. 26 "Eureka" can be clamped across them.



Assembly of the various units on the baseboard.

As to valves, the writer has satisfactorily used matched D.E.2 L.F. valves right through the set, excepting for the last stage, which was a 2-volt power valve. It is useful to have available one D.E.2 H.F. valve to test if any improvement can be obtained when it is used as a first detector (the filament side of the frame connects to L.T. negative). D.E.5 type valves, with a D.E.5B. as first detector and D.E.5A. as second L.F., can be used where it is the practice to make use of 5-volt valves, and a miscellaneous set of unmatched D.E.5 valves gave very good results.

Although ample clearance is provided between the valves, it is advisable to accommodate them in some form of soft packing to prevent excessive vibration while carrying the set. A cardboard box, divided into five compartments and padded with cotton wool, will hold the valves on the platform in position, prevent damage, and almost entirely eliminate microphonic noises. Cardboard covers with cotton wool packing should similarly be used to protect the two valves which are secured to the baseboard.

Two-point and three-point sockets may be fitted at the back of the cabinet for the battery connections, separate cables being made up for running to the batteries. The small grid battery is best attached to the inside of the cabinet and connected with flexible leads. A bracket to hold the stem of a collapsible frame aerial can be secured to the side of the cabinet, and extension leads passed through from the frame terminals.

It is not advisable to accommodate the batteries as part of a portable superheterodyne set, the total unit being too heavy to handle. For home use secondary battery type H.T. is recommended, while a reliable battery testing voltmeter is an essential accessory, often revealing that loss of range is due to a fall in the value of the anode potential.

IN NEXT WEEK'S ISSUE.

TWO-RANGE SELF-CONTAINED PORTABLE.
QUARTZ CRYSTAL OSCILLATORS.
DETERMINING THE TRACK OF WIRELESS WAVES OVER THE EARTH'S SURFACE.

RADIO-TELEPHONY in the AIR

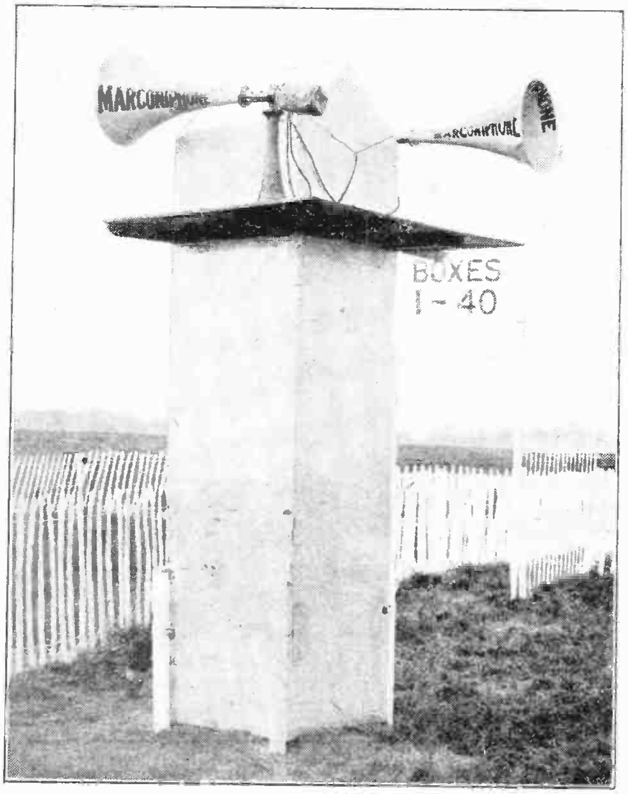
A BROADCASTING TRIUMPH AT HENDON

Speech Amplification Achievements at the Royal Air Force Display.

OF the many thousands of people at Hendon Aerodrome on Saturday, July 3rd, who witnessed the thrilling evolutions of a squadron of Grebe "Fighters," now flying in line with wing tips nearly touching, now breaking into fan formation with the precision of a squad on the parade ground, a surprising percentage were probably only half aware that history was being made in more than one direction. If the occasion was a triumph for aerial dexterity, it was no less a triumph for radio-telephony and land-line broadcasting. Without the aid of radio-telephony the closely co-ordinated movements of the air squadron would have been impossible, and the fact that the public were able to follow closely almost every instruction given from the R.A.F. ground station and from the squadron-leader during the exhibition flight was entirely due to the extraordinarily efficient public address system.

The demonstration of the use of radio-telephony by a Home Defence Fighter Squadron in dealing with air attacks was provided by the No. 25 R.A.F. Squadron commanded by Squadron-leader A. H. Peck, D.S.O., M.C. Each of the nine craft engaged was fitted with a telephony transmitter and receiver.

Soon after the "Alarm" had been given the squadron rose with a deafening roar, flying in close formation towards the north. Almost immediately the voice of "Fantail" (the ground station) was heard in the loud-speakers distributed throughout the various enclosures extending over a mile. "Hallo, Mosquito! Fantail calling; can you hear me? Hallo, Mosquito! Fantail over."



Twenty super loud-speakers were erected on R.A.F. pylons distributed throughout the aerodrome

Then followed the unmistakable roar of the 385 h.p. engine, only three feet from the microphone in the squadron leader's plane.

"Hallo, Fantail! Your speech is very good."

The nine planes appeared to shrink as the distance increased.

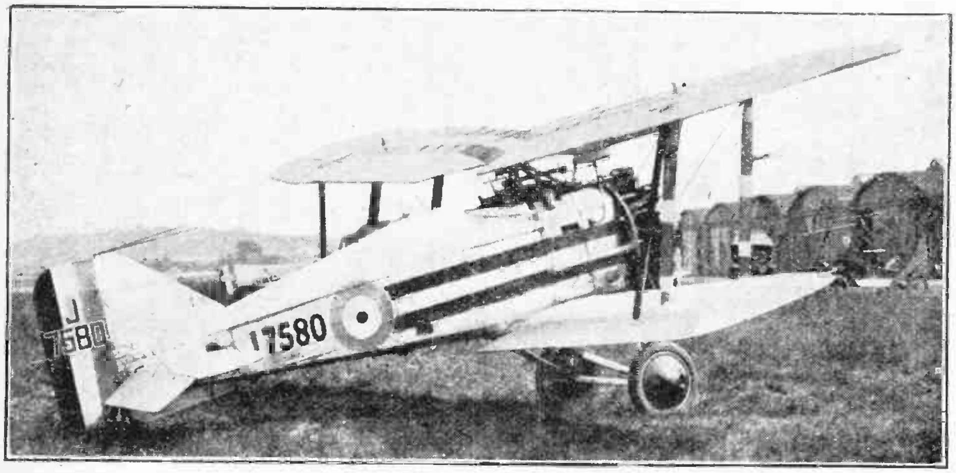
"Hallo, Mosquito!" barked the loud-speakers. "Fantail calling. Squadron will right about turn. Fantail over."

A few crackles, a sound like the closing of a circuit, and then:—

"Hallo, Fantail! Your message received. Hallo, Mosquitos! Squadron will turn about." And on the word "Go!" the little cluster, wings flashing in the sunlight, was seen to break up. Each plane executed a half-loop, toppled for a moment as if about to crash on its neighbour, righted itself and swiftly returned to its position in the newly formed squadron. During this and other hair-raising manœuvres, the telephony from both ground and air was clearly decipherable on the loud-speakers.

To secure such a triumph of speech distribution, enabling nearly 100,000 persons to listen-in, twenty super loud-speakers were employed, operated by eighty power valves. The whole of the control was effected from a room in the aerodrome hotel, which

Radio-telephony in the Air.—
housed practically all the apparatus. Elaborate precautions were taken to prevent any possibility of breakdown, and every facility was provided to effect instant communication between the various engineers scattered throughout the aerodrome.



The squadron-leader's Grebe "Fighter." The transmitter and receiver are fitted permanently on shock absorbers just behind the engine. The call sign of the leading plane was "Mosquito One." Note the aerial extending from tail to wing tips.

The loud-speakers were distributed on six pylons erected for the purpose, each pylon being fitted with a telephone communicating with the control room, and also a short ladder for easy access. All cables connecting up this system of loud-speakers were "dug-in" the ground, approximately one foot below the surface, "cab-tyre" cable being used throughout. Over fourteen miles of cable were employed. The cables were run in two main trenches, each cable passing through junction boxes in the pylon on its way to the next. This system provided for an interchange of cables should any one fail. In addition to this precaution one spare pair was provided in each trench.

The loud-speaker system was provided for—

(1) Relaying the band music to the various enclosures outside the ordinary radius of the band.

(2) Making important announcements.

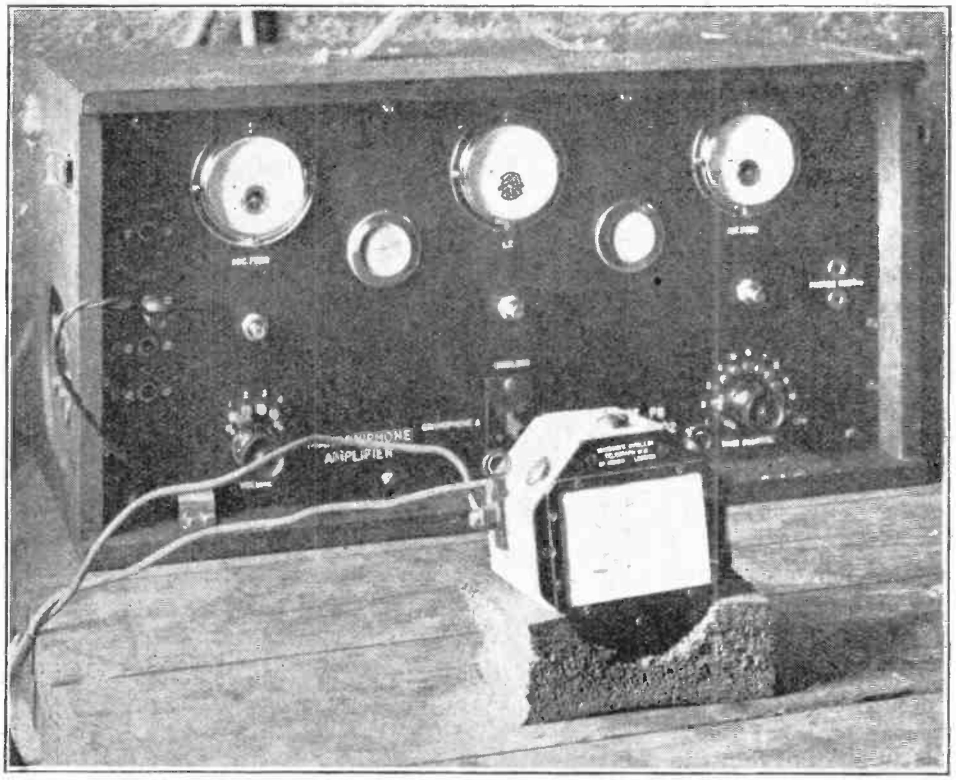
(3) Relaying the wireless telephone messages passing between ground and air, and from the leading plane while the squadron was in flight, these messages being addressed to the individual pilots as well as to the ground station.

The band music was picked up by a Marconi-Reisz microphone and amplified by a two-stage amplifier; the signals were then passed via overhead lines to the control room in the aerodrome hotel.

Announcements were made in a special room adjoining the control room. The former was specially damped with felt to eliminate echo, and was fitted with a Marconi-Reisz microphone. Signalling arrangements between announcer and control engineer were carried out by coloured lamps, one by means of which the announcer asked for "Microphone on," while the answering light indicated a "live microphone."

Messages from the air were picked up at three points and relayed to the control room via land lines. The receiver positions were: (1) Bentley Priory Aerodrome, (2) Old Hendon, and (3) The Hotel, Hendon Aerodrome.

"Fantail," the R.A.F. ground station, which maintained telephonic communication with the squadron while in flight. The signals were picked up by wireless and passed by land lines to the control room for amplification in the loud-speakers.



The Marconi-Reisz microphone and two-valve Marconiphone amplifier in the announcer's room. A similar equipment was installed under the bandstand for picking up music from the R.A.F. band.

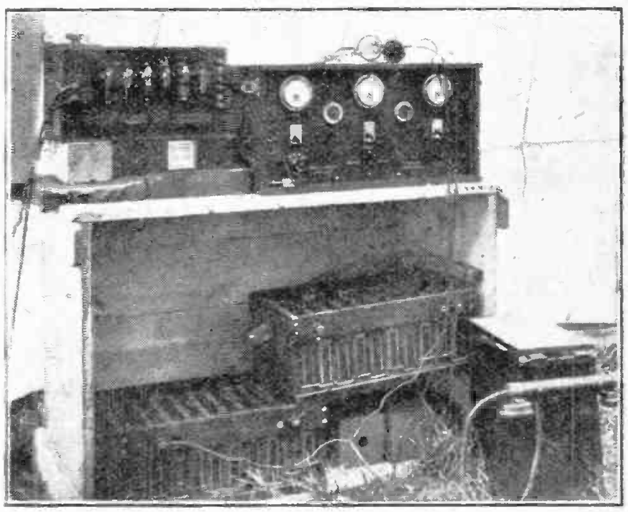
Bentley Priory, being some five miles from Hendon, was chosen for the main receiver station, on account of reception there being particularly good both as regards quality and volume and, most important of all, as regards interference. (It will be remembered that last year air signals were completely wiped out by local interference.) Bentley Priory station was equipped with a Marconi six-valve tuned transformer Aircraft short-wave receiver, which operated a new type Marconiphone two-valve Microphone-Line amplifier. The signals were then passed over Post Office land lines *via* Bushey Heath, Stanmore, and Colindale to Hendon Aerodrome, a second and interchangeable line being provided as a spare and for engineers' communication. Of the remaining two stations, one was fitted with an R.A.F. superheterodyne receiver, and the other with a Marconi model similar to the one at Bentley Priory: both were connected by overhead lines to the control room. Each operator had instructions to receive constantly and to avoid tuning adjustments as far as possible. By this method the control engineer could select from the three receivers the most stable and clearest signal, and, by having a total range of 200 to 1 volume control at his disposal, could compensate for reasonable variation in signal strength. It is interesting to note that the signal strength from the machine varies considerably when its course is being altered.

The Control Room.

The signals, viz., band music, announcements, and wireless signals, after passing through their subsidiary amplifiers, were passed into the control room to a single Marconi "B" three-stage studio control amplifier. This five-valve instrument formed the main volume control amplifier, and was fitted with a variable-tone adjustment device mainly in order to compensate for the tone-lowering effect of the land lines. The amplifier output was then coupled to three other "B" amplifiers wired in parallel. Of these three, two modulated four single-stage eight-valve power banks, while the third formed a separate modulation for the amplifier feeding the loud-speakers in the Royal Enclosure. By means of this system, all the loud-speakers were controlled simultaneously by one amplifier, the adjustments on the other three being fixed on test. The field or magnetising circuits of the loud-speakers were operated from the control room, sufficient pressure being applied at the latter end to overcome voltage drop along the line.

Power for the amplifiers was supplied by means of six banks of Exide W.H. high-tension accumulators, each bank furnishing a pressure of 360 volts, the total feed current being approximately $1\frac{1}{4}$ amperes.

The music from the R.A.F. band was broadcast without a hitch, and announcements were loud and clear.

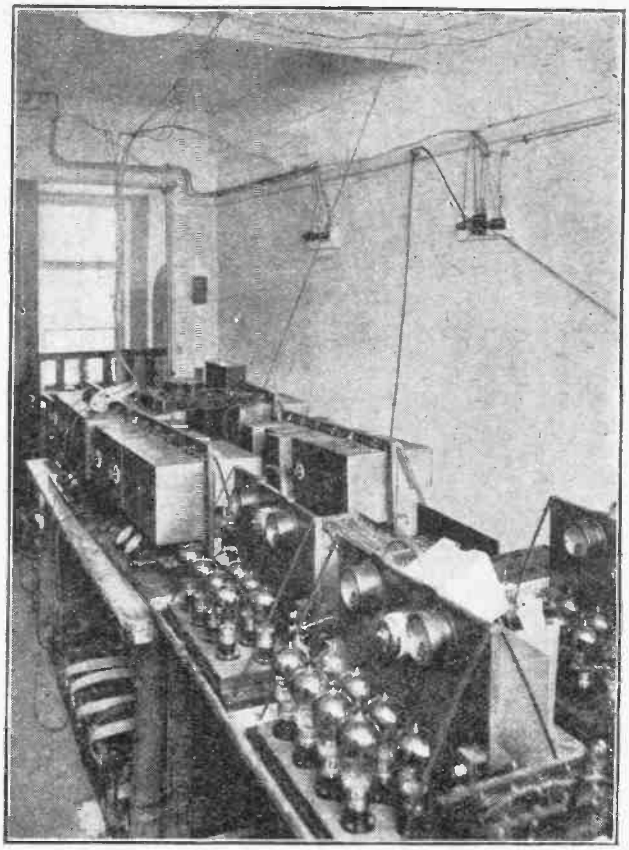


In a tent at Bentley Priory, showing the receiver and line amplifier. The receiver is a Marconi tuned H.F. transformer model for short wave work, and the amplifier is a two-valve microphone-wireless-line instrument.

Radio-telephony in the Air.

Wireless telephony signals were furnished in event No. 2 by the various Bristol fighters competing. The best signals at first were from the hotel receiver, but after the first two minutes a change was made to the Old Hendon circuit, on account of slightly better quality. Signals were clear throughout, and no interference was experienced. Engine noise from the aeroplanes was surprisingly small.

In event No. 5, when No. 25 Fighter Squadron, under Squadron-leader Peck, demonstrated the use of radio-telephony in dealing with air attacks, both ground and air signals were good, but the latter were somewhat marred by oscillation, in spite of a special wavelength and an unusual amount of secrecy. Atmospherics were very bad, and Bentley Priory receiver, while not picking up oscillation interference, suffered badly from atmospherics. The greater part of the reception was, therefore, taken from Old Hendon.

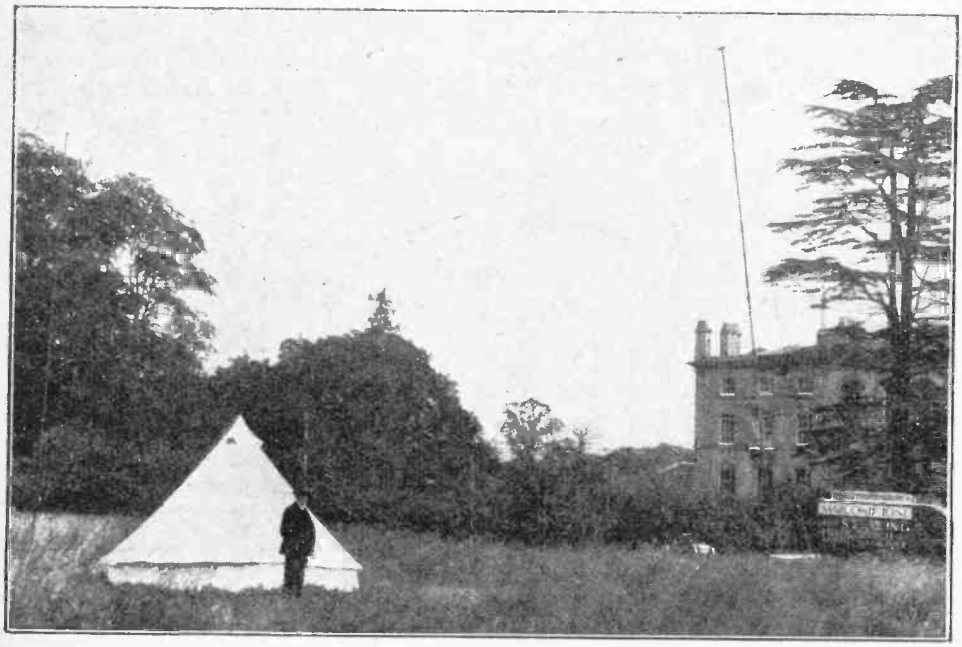


A glimpse of the control room at Hendon, showing the control and power amplifiers.

Radio-telephony in War.

The whole event aroused the greatest interest, and the Royal Air Force deserve every congratulation for introducing the innovation. The use of a public address system served to demonstrate the progress made in aircraft telephony in a way which would have been utterly impossible with many pages of printed explanation.

While the use of wireless telephony on this occasion was the means of providing a pleasant series of thrills to an eager crowd on a peace-time afternoon, the lesson which it taught has a direct bearing on war. With the wireless organisation and equipment now possessed by the Royal Air Force, the approach of hostile aircraft to within striking distance of our great towns is rendered increasingly difficult. Not only can radio-telegraphy and telephony be employed to give early warning of an approaching raid; it can also be a formidable weapon in the hands of the defenders during an actual conflict. No amount of visual signalling could have brought about the perfect cohesion and unity exhibited by No. 25 Squadron on Saturday week, and it would appear that the enemy's best plan for upsetting the schemes of a defensive squadron would be wholesale jamming. Here, again, selectivity and the use of short waves constitute a more or less effective reply, and it is interesting to note that the wavelength used in the R.A.F. Display was in the neighbourhood of 90 and 100 metres. Atmospherics, of course, may play their part, but experience shows they are not insuperable.



The Marconiphone Company's short-wave receiving station at Bentley Priory. This was connected by Post Office land lines, via Stanmore, Edgware, and Colindale, to the control room at Hendon. Note the supports carrying the land line from the tent.

INTERVALVE TRANSFORMER CORES.

Permeability of Iron under Speech Amplifying Conditions.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

THE permeability of iron sheets depends upon the magnetic conditions of operation. In large power transformers a mass of practical data has been collected, so that it is possible for the designer to predict their performance with a relatively high degree of accuracy. The conditions of operation of these transformers is in general comparatively well known and in many cases relatively simple. The currents are purely alternating and there is no asymmetry due to D.C. polarisation. The values of the currents are large enough and there is sufficient energy available for accurate measurements to be taken without upsetting the conditions of operation.

When we come to intervalve transformers the conditions are so complex and the dimensions and currents so small that direct measurement is apt to be dangerous, *i.e.*, the influence of the instruments would affect the performance of the transformer. Instead of a pure alternating current there is a polarisation due to the anode feed current to the valve passing through the primary. In general the polarisation (D.C. magnetisation) will exceed the alternating magnetisation due to the signal currents.

During an investigation into the magnetic condition of certain transformers it was necessary to determine the

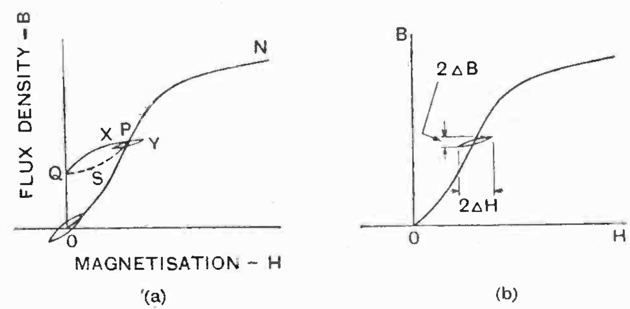


Fig. 1.—Hysteresis loops and B–H curves for the iron in an intervalve transformer under D.C. and A.C. conditions.

permeability when a large polarising current passed through the primary. Before giving the results obtained it will be well to consider the conditions under which the iron functions in an intervalve transformer.

Suppose we subject the transformer to a pure alternating magnetisation of small value, say that used in a bridge method of measuring the inductance. The iron will traverse the small hysteresis loop round the origin O in Fig. 1 (*a*). Let the A.C. be removed and a steady magnetisation applied which takes the iron to the point P. Again apply the A.C., and the iron is taken round the small loop XPY. The major axis XY makes an acute angle with the magnetisation curve OPN. Now remove both the A.C. and the D.C. The iron comes down the full-line curve PQ to the B axis where H is zero. On again applying the D.C., as would be the case in an intervalve transformer when the H.T. battery is connected, the iron travels up the dotted curve QS to the point P. The effect of A.C. is the same as before, *i.e.*, the iron traverses the loop XPY. The actual practical case is somewhat different, because in many instances switching off is accompanied by oscillation of the transformer, so that the position of the point Q is problematic.

There is no necessity at the moment to indulge in a detailed description of the vagaries of the iron under the above conditions. We shall, therefore, take the subsidiary loop in Fig. 1 (*b*) to represent the state of affairs in an intervalve transformer when a steady alternating voltage is applied to the grid of the valve. The influence of the iron at any instant depends upon the slope of the loop. This is clearly variable, so that the permeability of the iron is also variable. In fact, under such conditions it is known as the *differential permeability* and is quite different in value from the static or ordinary permeability.

Differential Permeability.

Now, variation in permeability is usually associated with the introduction of alien frequencies (harmonics), *i.e.*, distortion. There is an exception to this effect, and no alien frequencies arise if the loop is elliptical. In practice, if the variation ΔB [1] is not too large, the effect of the alien frequencies relative to the fundamental is small. Moreover, the little loop can be regarded as a straight line whose slope $\Delta B/\Delta H$ is the differential permeability. It is this quantity which has been measured in the experiments described herein. Obviously, at the origin O the ordinary and differential permeabilities are identical.

There is one point which deserves to be mentioned. If the H.T. battery should accidentally be shorted on the primary or the secondary of the transformer, the iron will be driven to saturation, provided the battery is in a healthy condition. The differential permeability and, therefore, the inductance of the transformer will be reduced appreciably. The best method of restoring the iron to a more normal state is to pass an alternating current whose R.M.S. value is equal to the direct current which did the damage through the winding in question, and gradually reduce its value to zero. Switching off the A.C. before its value is very small will not secure the desired result.

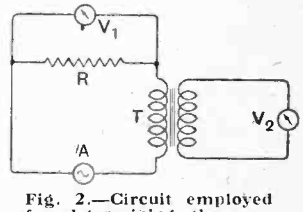


Fig. 2.—Circuit employed for determining the permeability of Stalloy sheets in a transformer core made with lap joints. R is a non-inductive resistance of 8,000 ohms; T, transformer under test; A, sine wave alternator; V_1 and V_2, electrostatic voltmeters.

Two sets of experiments were carried out: (*a*) with pure A.C., (*b*) with A.C. superimposed on D.C.

---

[1] $2\Delta B$ is the total variation between the +ve and −ve maxima of the alternating current.

Intervalve Transformer Cores.—

polarisation. The circuit for the determination of the A.C. permeability is shown in Fig. 2. The alternator A giving a sine wave is held at constant speed and varying currents sent through the primary of a large transformer, constructed from Stalloy sheets 18 mils in thickness, by altering the field excitation. The current—being quite small—was measured by taking the volt drop across a

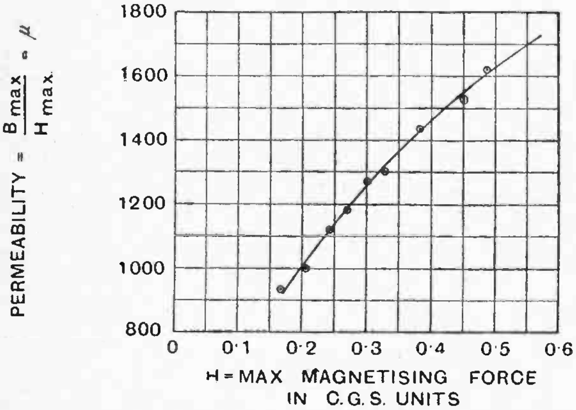


Fig 3.—Curve plotted from results obtained with circuit in Fig 2.

resistance using an electrostatic voltmeter. The voltage across a search coil on the transformer was secured in the same way.

The permeability was calculated in the following manner from well-known magnetic formulæ :—

$$V_{R.M.S.} = 4.44afnB_{max.} \times 10^{8}$$

$$\text{or } B_{max.} = \frac{V \times 10^{8}}{4.44afn} \quad . \; . \; . \; . \; . \; . \; . \; (1) \text{ where}$$

V = R.M.S. voltage across search coil,

a = cross-sectional area of iron (excluding insulation between sheets),

f = frequency in cycles per sec.,

n = turns on search coil,

$B_{max.}$ = maximum flux density in iron.

$$H_{max.} = 1.414 \cdot \frac{4\pi n_1 I}{10l} \qquad [\text{N.B.}—1.414 = \sqrt{2}.]$$

$$= \frac{1.78 n_1 I}{l} \quad . \; . \; . \; . \; . \; . \; (2), \text{ where}$$

$H_{max.}$ = maximum magnetising force on iron under A.C.,

n_1 = number of turns on primary,

I = R.M.S. current in amperes = $V_1 V_1 / R$

l = equivalent mean length of magnetic circuit,

$$\mu = B_{max.}/H_{max.} \quad . \; . \; . \; . \; . \; . \; . \; (3)$$

where μ = alternating current permeability.

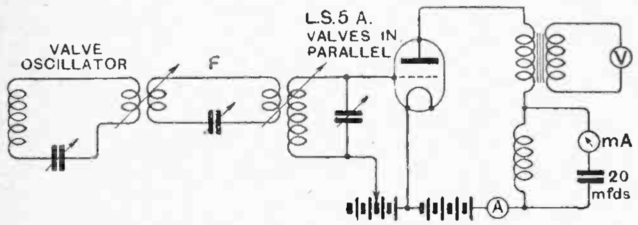


Fig. 4.—Circuit for determining differential permeability. V is an electrostatic voltmeter and A the D.C anode feed meter.

The results of the tests are plotted in Fig. 3. Due to eddy currents, the values are appreciably less than those under static conditions. The differential permeability was ascertained by means of the circuit illustrated in Fig. 4. A valve oscillator is set to a frequency of 500 cycles and loosely coupled to a filter circuit, F, which in turn is coupled to the tuned circuit on the grids of a bank of L.S.5A valves. In the anode circuits of these valves is connected the transformer under test. A search coil is used to ascertain the transformer voltage due to the alternating current. A choke paralleled by a milliammeter in series with a large condenser is used to measure the alternating current. The choke passes the anode feed or polarising current, whilst the alternating current, taking the path of lesser impedance, flows through the ammeter and condenser. The impedance of the choke at 500 cycles is 200 times that of the condenser, so that the A.C. through the former is negligible.

Experimental Precautions.

The voltage on the search coil as measured by the electrostatic voltmeter was held constant, thus giving a constant value of ΔB the flux change. Readings of the alternating current were taken for varying amounts of polarisation. The latter was graded by altering the number of valves in parallel. The voltage change across the transformer was about 10 per cent. of the H.T. volts, so that the valves worked on the linear portions of their characteristics. Any asymmetry immediately shows up in

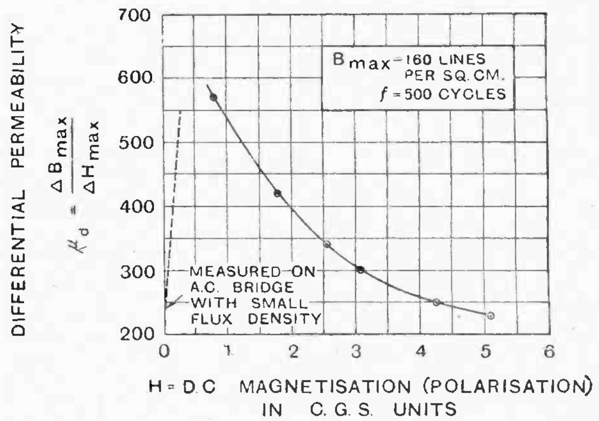


Fig. 5.—Results of tests made with the circuit in Fig. 4, showing the differential permeability of 18 mil Stalloy sheets for different values of polarisation

the anode feed when the oscillator is switched on, for the current will change.

The conditions of test are portrayed in Fig. 1 (*b*), and the results are given in Fig. 5. The differential permeability has an optimum value somewhere around H = 0.5, *i.e.*, this is the best value of polarisation. The exact value was not found, owing to experimental limitations. The change in B, *i.e.*, ΔB, was much larger than that which obtains in the ordinary type of valve transformer at 500 cycles, but the curve of Fig. 5 illustrates the general trend of events in such transformers. In the transformer under test the differential permeability at zero polarisation measured at very low flux density on an A.C.

Intervalve Transformer Cores.—bridge[2] is of the same order as that when the polarisation is from 4 to 5 C.G.S. units, *i.e.*, 3 to 4 ampere-turns per centimetre. It may be of interest to remark that there was just a slight increase in differential permeability at 250 cycles over that at 500 cycles, and little change when ΔB was 320 instead of 160 lines per square centimetre.

A simple calculation on a 2.7 : 1 " Ideal " transformer may be useful. Assuming the voltage change on the grid of the power valve (to which the secondary of the transformer is connected) to be 27 volts R.M.S., the voltage on the primary of the transformer will be 10 volts R.M.S., and at a frequency of 50 cycles the value of ΔB is 130 lines per square centimetre,[3] which is of a similar order to that used in these tests. It is clear from formula (1) that for any given voltage on the primary the flux density increases with decrease in frequency. This will tend to keep up the inductance of the primary at low frequencies, where it is most wanted.

[2] At $B_{max.}$=160 lines per sq. cm., the permeability might have been greater than that found by the A.C. bridge.

[3] This would hold for public address work if such a transformer were used prior to the last bank of power valves.

CALLS HEARD

Sheffield.

(May, 1926.)

America :—2GK, 1AAO, 2CV, 2KK, 1ABZ, 1AE, 2EAK, 2BBX, 2ATC, 3MV, 2ACQ, 2AGQ, 1CKP, 2CVP, 8SF, 1YD, 1AAD, 1BQT, 1CAW, 2BOX, 1YB, 1BZP, 4HU, 1CMX, 2ARM, 4QY, 8AOL, 2KW, 4OY, 2ACS, 2MK, 2LD, 2ALN, 3LW, 1VY, 1BYT, 8CH, WIZ, 2HA, 1MY, 1CF, 2CUA, 1RN, 2CZR, 2KM, 2DA, 7BBW, 1BWN, 2MD, 2AGZ, 1XM, 8AMU, 1BQN, 1AYD, 2CXD, 1ASU, 2FF, 1AWE, 2CXL, 1JL, 1AAN, 1BCA, 1BKR, 1APX, 1BHM, 1CRE, 2AGB, 5UK, 2ND, 1AHV, 3TC, 1AFO, 8IRG, 2KX, 2AHK, 2JB, 2ALW, 2AIB, 3SSE, 8BT, 8ARG, 9ADK, 2Z, 8ZAE, 8JY, 4IT, 1NX, 2AHM, 9XI, 9ZA, 8AX, 8JQ, 1BEF, 9EIJ, 9EV, 4FT, 2AAE, 8EH, 1SW, 5YB, 4PR, 1SI, 1BES, 8ADG, 1BEB, KEL, 4VS, 4PF, 2OW, 4NI, 4CU, 5ZAZ, 8RH, 3BMS, 8XE, 4IR, WLL, 3CJN, 2AIE, 2WR, 2ME, 2IHN, 4PK, 4WQ, 21HM, 2NF, 4SL, 1CH, 1KL, 2ACP, 1AHX, 1ACI, 2AHG, 1KK, 1BKE, 2EV, 1BTF, 1UW, 1AOI, 1ADS, 1OB, 4AG, 9EEV, 4WG, 3BNU, 1ATV, 3AGC, 4CL, 1AAY, 8RH, 4AIT, 3AFQ, 1XV, 4IZ, 1CMF, 1CLM, 1CMX. France :—8VX, 8JN, 8HU, 8IRK, 8EZ, 8JF, 8GSN, 8JR, 8BU, 8LC, 8GI, 8KF, 8PY, 8RVR, 8CA, 8DP, 8CM, 8SAX, 8UDI, 8PEP, 8NA, 8TOM, 8LZ, 8SSZ, 8NOX, 8SSY, 8URN, 8VO, 8SSW, 8TBY, FW, 8LMH, 8DL, 8PGL, 8GSM, 8JRT, 8GO. Brazil :—1IB, 1AX, 1BI, SNI, 2AB, 1AL, 1AK, 1IA, 1BC, 1BD, 1AN, 1BH, 1AD, 1QA, SNM, 1AF, 2AA, 1AR, 1BB, 1AW. Sweden :—SMUK, SMTN, SMUA, SMSJ, SMWS, SMWR, SMVL, SMTH, SMVG, SMSY, SMZS, SMUV, Belgium :—B7, S5, Y8, 4YZ, B2, M8, 4SS, Z2, E1, M2, G33, S4, K44, G8, S6, 4QQ, K6. Holland :—OBL PCMM, ORM, PCLL, OGG, OPM, OBX, OWW, PCK4, OBA, ORB, 2PZ, PC2, PCPP, OAM, OHB, OWC. Italy :—1FC, 1GW, 1AX, 1CO, 1ER, 1CH, 1AP, 1SRA. Poland :—TPAI, TPXX, TPAX. Finland :—2ND, 2NL, 2CO, 1NA, 2NX. Argentine :—FF9, DB2, FC6, AF1. Norway : — LA1B, LA1SE, LA1E, Germany :—L4, O2, 4GA, 4FL, W3, P4. Canada :—1AR, 2AX, 1DD, 1EA, 1ED. Spain : — EAR21, EAR17, EAR31, EAR2. New Zealand :—2AC, 4AM, 4AC. Australia :—5KN, 4VS. Austria : — WA. Switzerland : — 9XA. Portugal : — 1AE. Madeiro : — 3FZ. India :—DCR. Various :—YST, BZC, 1TA, NORB, NIDK, KWS, NTT, TUN2, SGL, AQE, NBA, AGB, IMEF, OCNG, AF8EF, SWS, PT5, BXW, SQ1Q, TUK, OCDJ, KEGK PJC, SKA, OCDB, ICD, NRK, LPX, RCRL, FUT, XC5I, PX1.

(0-v-1) On 15 to 80 metres.

A. S. Williamson.

Dulwich, London, S.E.24.

Belgium : — O7, 4US, S5, U14, AU4, 4YZ, P7, D8, G4, J2, H6, S2, E9. Holland :—ORB, NOW, OKO, PCK4, PB7, PCUU, OWC, OTN, PCPP, 2PZ. Switzerland :—9XA. Germany :—P6, C4, J1, W9, B7, KPL, Y4, 1KU, 4ZM, O2, KLO, J2. Italy :—1SRA, 1CH, 1NC, 1GS, 1BK, 1CT, 1PK. Sweden :—SMVH, SMVG, SMSR, SMXU, SMUA, SDK, SMSG, SMYU, SMWS, SMZS, SMUK, SMDA. Finland :—2AB, 2NM, 2ND, 2CO, 2BS. Spain :—EAR3, EAR28, EAR24, EAR18, EAC9. Luxembourg :—1JW, 1FL. Norway :—1A, 4X. Denmark :—7JS, 7BX. Portugal :—1AE. Madeira :—3GB. Java :—PKX. Honolulu : — KLO. Poland : — TPAX, TPAV, TV1A, TPAI. Russia :—RRP, RCRL, MGSP. U.S.A. :—4SV, 21HM, 2QB, 1XV, 2MC, 4AN, 1CQ, 1BK, 9ES, 9RN, 4TF, 2AP, 2MK, 1CZ, 1MEF, 1MUK, 1ACI, 3ANL, 1BJ, 2CTN, 8DHX, 1UC, W1R, W1Z, WGY. Brazil :—1AD, 1IB. Cuba :—2BY, AQE. Porto Rico :—4KT, 4UR. Bermuda : — BER. Canada : — 2AG. Various :—G33, 12BB, CS 1OK, M2K, X GB2, EGN, 1AZ, PJC, YS 7XX, AGB, MAROC, PARL, NOT, 6YX, PI 1CW, CD8.

G. Rutherford (6HU).

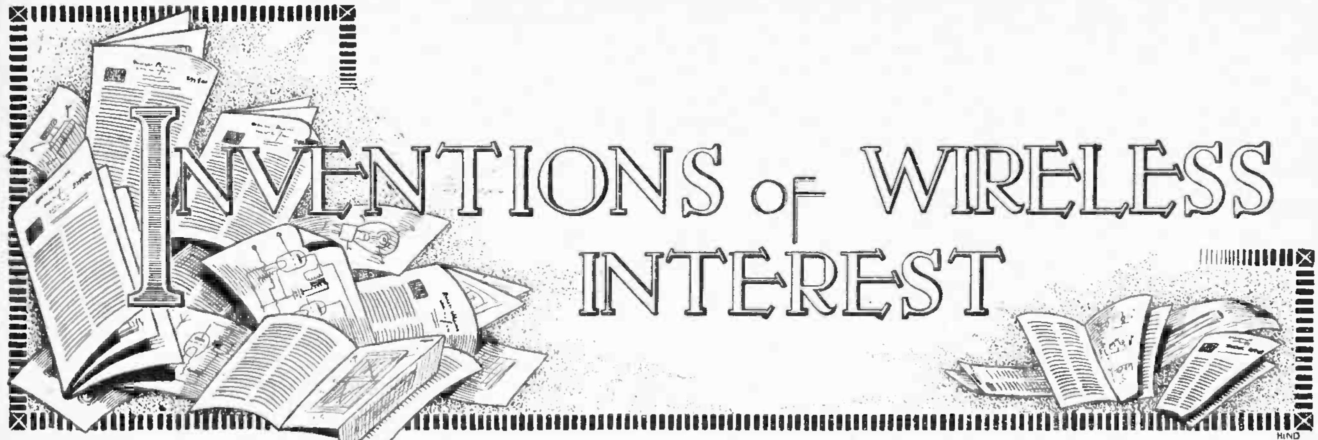
Hale, Cheshire.

(May 30th-June 11th.)

U.S.A. :—1AWE, 1AFO, 1ALW, 1AAH, 1AKZ, 1AKF, 1AEP, 1AZD, 1AAO, 1AKM, 1ARM, 1AAY, 1AAF, 1AHV, 1AOF, 1BZP, 1BAD, 1BEB, 1BLF, 1BYX, 1BZK, 1BXH, 1BHM, 1BCC, 1CIB, 1CAW, 1CMF, 1CCZ, 1CW, 1ED, 1FF, 1GA, 1GN, 1JE, 1MU, 1MY, 1MV, 1IZ, 1RA, 1VA, 1XCH, 1UW, 1ZK, 2ATC, 2ATS, 2AGB, 2APV, 2ARM, 2AMZ, 2ANM, 2AAH, 2ASM, 2ATK, 2AHM, 2BBX, 2BYX, 2BEZ, 2CXL, 2CYX, 2CNF, 2CRB, 2EV, 2GX, 2KG, 2LE, 2MM, 2ME, 2NZ, 2TB, 2ZV, 3AY, 3AHL, 3AGC, 3BMS, 3BUV, 3BWT, 3BGJ, 3BMZ, 3CC, 3HG, 3TB, 3TR, 3WF, 4AAO, 4BY, 4BK, 4CL, 4EE, 4GI, 4LL, 4NI, 4PI, 4HU, 4TR, 4XL, 4ZA, 5AAJ, 5AQ, 5HY, 5YB, 5ZAI, 6FC, 6CQA, 8ALY, 8AVL, 8AC, 8AHL, 8ATC, 8AOL, 8AGQ, 8BYK, 8BAB, 8CAU, 8COB, 8DRR, 8EW, 8TW, 8WA, 8WY, 8ZA, 8ZAE. 9AVJ, 9BPB, 9CJ, 9CV, 9DUV, 9DK, 9DPJ, 9QR, 9WI, 9WO. Africa :—DA1CW, DA1TA, 2KC. Argentine :—AF2, BA1, CB8. Australia :—2CM, 2DJ, 2GQ, 2LK, 2LM, 2TM, 2YI, 3BD, 3BM, 3BQ, 3EF, 3XO, 7CS, 7CW. Brazil :—1AD, 1AM, 1AP, 1AX, 2AB, 9QA. Canada :—1AM, 1AR, 3BY, 3KP. Chile :—2AB, 3AT. Mexico :—1J, 1N, 1AA, XC51. Maderia :—P3OR. Cuba :—8KP. Panama ?—RXY. Porto Rico :—4JE. New Zealand :—2AC, 2AE, 2XA, 4AA, 4AC, 4AJ, 4AM, 4AN. Sweden :—SWS, SKA, SGC, SGL, SGT.

(Reinartz and Superheterodyne.) Wavelength 14-90.

G. L. Brownson.



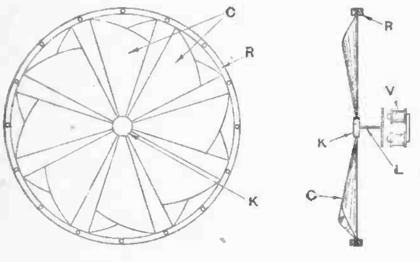
INVENTIONS OF WIRELESS INTEREST

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25 Southampton Buildings, London, W.C.2, price 1/- each.

Multiple Loud-Speaker Diaphragm.
(No. 233,356.)

Conv. Date (France), May 3rd, 1924.

British Patent No. 233,356, granted to the Société Française Radio Electrique, describes the construction of a rather interesting type of loud-speaker of the diaphragm type, that is, one in which no horn is used, the diaphragm being of



Multiple cone loud-speaker diaphragm (No. 233,356).

considerable area. Instead of using a single surface of material the diaphragm comprises a number of small cones C formed from sheets of stiff paper, the bases of the cones being clamped to a solid ring R, which is supported by some form of bracket and baseboard, while the apices of the cones are fixed to a small plate K. This plate is joined by a link L attached to the diaphragm of an ordinary form of telephone receiver V. The specification states that although the diaphragm comprises a number of independent sectors it vibrates substantially as a single area, owing to the fact that the small cones are comparatively rigid near the centre of the ring R, greatest flexibility occurring at the bases of the cones.

o o o o

Four-electrode Reflex Circuit.
(No. 238,550.)

Application date (United States), August 15th, 1924.

The British Thomson-Houston Co., Ltd., describes in the above patent specification a practical system whereby a four-electrode electron discharge device, particularly one of the negative resistance or pliodynatron type, is employed for the simultaneous amplification of both radio and audio-frequency currents.

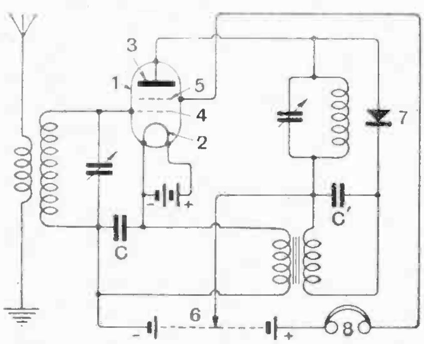
In the example shown the valve 1 is provided with two grids 4, 5, interposed between the filament 2 and plate 3.

The grid 4 serves as a control grid and the grid 5 serves as an anode for receiving impact electrons emitted from the plate 3. A source of potential 6, which is connected in the circuits between the filament 2 and plate 3 and grid 5, furnishes suitable values of potential for application to electrodes 3 and 5 to produce a negative resistance in the plate circuit by reason of the emission of impact electrons from the plate 3.

By suitable adjustments the negative resistance produced in this way may be made great enough to compensate for the losses of the system, without at the same time causing the production of oscillations.

Received radio-frequency currents are amplified by the valve 1, rectified by the crystal detector 7 and the audio-frequency currents produced by rectification fed back to the imput circuit through the transformer T.

The telephones 8 are connected between the grid 5 and H.T. battery positive C and C[1] are high-frequency by-pass condensers.

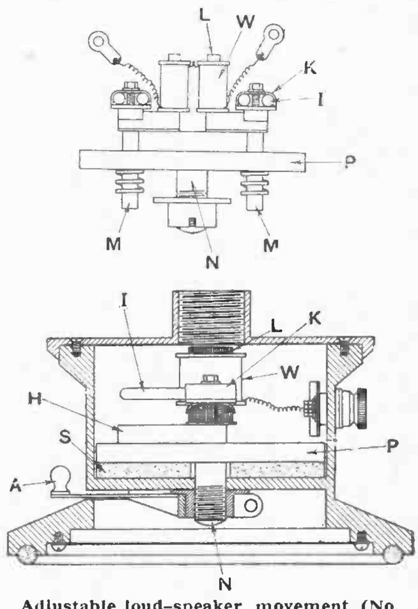


Four-electrode valve and crystal reflex circuit. (No 238,550.)

A Loud-speaker Detail.
(No. 251,151.)

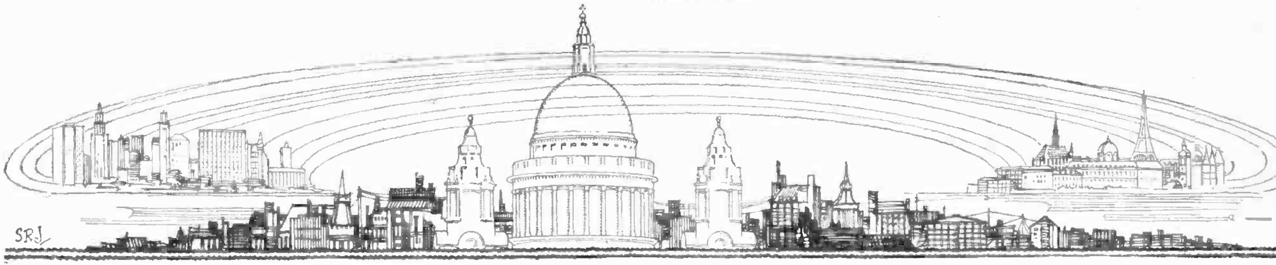
Application Date, August 6th, 1925.

J. Piquart describes a loud-speaker in which the permanent magnet H is of the horse-shoe type, and has attached to it laminated pole pieces L which carry the usual windings W. The horse-shoe magnet rests on a plate P,



Adjustable loud-speaker movement (No. 251,151).

which, in turn, lies upon a pad of sponge rubber S. The plate P carries a stud N, which co-operates with an arm A, so arranged that rotation causes the plates to move up and down inside the containing case. Another feature of the invention is the inclusion of a number of thick iron wires I, which are clamped in the form of a horse-shoe between the two pole pieces with a clamping device K. The whole system is further secured and controlled within the casing by means of helical springs working over two projections or studs M in the base of the plate.



CURRENT TOPICS

Events of the Week in Brief Review.

LARGEST STATION IN EUROPE ?

At Langenberg, near Cologne, what, it is stated, will be the biggest broadcasting station in Europe, is rapidly approaching completion. It will supersede the Dortmund and Elberfeld radio stations, which have up till now been used for the Rhine and Ruhr districts, and which do not permit of the use of crystal sets, on account of their low power. The new station will have a power of 60 kilowatts and will enable owners of crystal sets to hear everything sent by Langenberg within a radius of over a hundred miles.

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WIRELESS COMPETITION.

"Competition in the wireless world—at sea," says our contemporary, the *Journal of Commerce*, "is shown in the recent advances in the field of development covered by the Radio Communication Co. I saw their admirable apparatus on the new motorship 'Carnarvon Castle,' and heard they had fitted out half of Furness Withy's fleet . . . and other notable units. Marconi is the pioneer of wireless, but, fortunately, he has never tried to be a monopolist."

oooo

ULTRA-MODERN MUSIC.

During the recent experimental broadcasting of two simultaneous programmes by the B.B.C., a listener succeeded in hearing two pieces of music being played together. The effect of antagonistic keys, complicated discords, and interwoven rhythms would have delighted the most ardent of Stravinsky's admirers.

oooo

A LICENSING QUESTION.

We would draw the attention of readers who are still uncertain about the scope of their receiving licences, to the official reply given by Viscount Wolmer in the House of Commons. "A wireless receiving licence entitles the licensee to use more than one set of apparatus on premises wholly in his occupation. A separate licence is necessary for apparatus in each tenement or flat in separate occupation."

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DIRECT SERVICE TO INDIA.

It is anticipated that the stations which are being erected in Bombay for the Indian Radio Telegraph Company will be opened for public service in the course of the next few months, thus linking up India direct with Great Britain. Mr. C. Picot has been engaged as traffic manager.

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BIRDS MISLED BY WIRELESS.

The supposed disturbance of the ether by wireless waves is held accountable for a multitude of occurrences. It is stated that birds are singularly affected in places where there are many wireless stations, and that doves especially experience a difficulty in finding their way home. If this is the case, it is just as well that Noah did not erect a wireless installation in the Ark.

oooo

THE LATE MR. ALFRED GRAHAM.

We regret to announce the death of Mr. Edward Alfred Graham, the well-known head of the firm of Alfred Graham & Co., which occurred on Tuesday, June 15th, following a severe operation. Mr. Graham, who was only 45 years of age, succeeded his father, the founder of the firm, in the control of the business in 1904.

MUSIC AND MILK.

A wireless enthusiast in Cincinnati claims that a special early morning programme, broadcast for the benefit of dairymen, would increase the production of milk, but warns us that most good cows do not like "jazz." Possibly that type of music entered into the composition of the historic "Tune the old cow died of."

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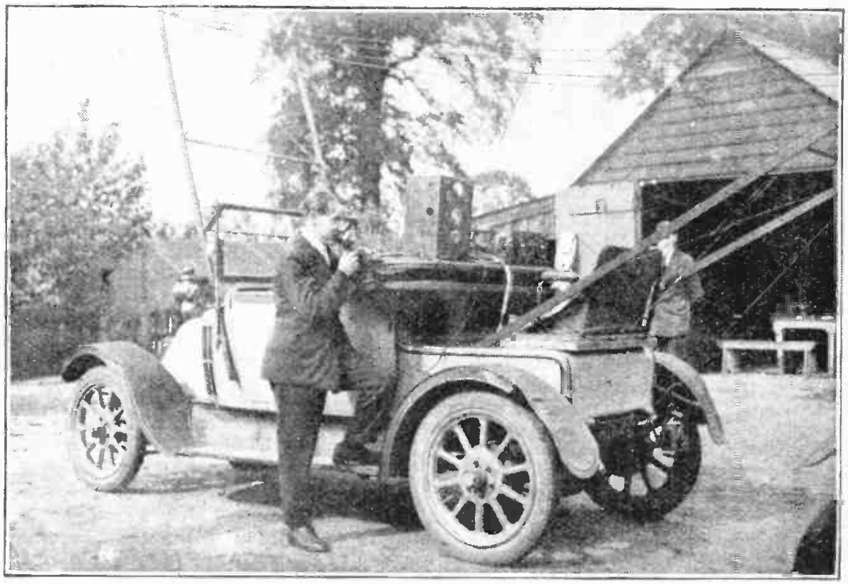
TRAVELLING TELEPHONY STATION.

The photograph on this page shows the mobile set participating in the experiments conducted last week by the Tottenham and North Middlesex Wireless Societies. Light wooden struts braced with wire guys support a four wire aerial and a centre down lead connects directly to the change over switch. The transmitter is that described in *The Wireless World* of August 12th, last, and uses D.E.T.1. valves. The short wave receiver is a Rothermel product. Power was derived from an M-L generator running from Exide car type batteries.

The station worked very well and when



TELEPHONY FROM A CAR. The mobile transmitting and receiving equipment which proved a great success in experiments conducted last week by wireless societies in North London. Speedy relief was obtained when a wireless S.O.S. was sent out reporting a tyre burst !

a burst occurred in one of the back tyres an S.O.S. giving exact location was sent out, and received immediate promises of help from the fixed station of the Tottenham Society some three miles to the north, and the North Middlesex Society six miles away to the south. Before the breakdown gang arrived, however, several locals hearing the call had made for the scene of the disaster.

Further outdoor experiments have been arranged.

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THE WEATHER AGAIN.

An American expert attributes the cool days in June, which, apparently, were not confined to the European side of the Atlantic, to the heavy discharge of polar ice and to sun spots and consequent reduced solar radiation. Amateurs may, however, take some consolation in the reflection that cool evenings generally cause improved reception, though it is predicted that we are to have many cool days in July, and that next year there will be no summer at all!

A French scientist, M. Paul Painleve, on the contrary, is stated to be of the opinion that wireless is to be blamed for bad weather. "If you introduce radiotelephonic emissions into a tightly enclosed room where the air is absolutely transparent," he is reported to have said, "in a moment little drops of water will begin to form on your face." According to our own experience, this phenomenon depends largely on the nature of the programme.

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SHE SHALL HAVE MUSIC WHEREVER SHE GOES.

The yacht "Venture," which has been built for Mr. R. C. Robb for a three years' cruise, is fitted with a special Marconi installation, which is an adaptation of the standard lifeboat set transmitter and a special receiver to include broadcast reception.

The great increase in broadcasting stations throughout the world will make it possible for the yacht to receive broadcast music and news during the greater part of the voyage, and will add materially to the pleasure of cruising.

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NEW BROADCASTING STATIONS.

There will soon be very few countries outside the range of broadcasting. New stations are being erected in Bombay and Calcutta by the Indian Broadcasting Co., Ltd. Venezuela and Salvador have each their respective station. The Swedish telegraph authorities are erecting a high-power installation at Motala, pending the completion of which the old station at Karlsborg has been fitted for telephone transmission. A French company is about to erect a broadcasting station at Heni-Bagtche, near Stamboul, while relay stations are rapidly springing up in Europe and Asiatic Russia.

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A SYNCHRONOUS TRIO.

Three instrumentalists recently broadcast a joint radio recital from Minneapolis. The violinist was playing in St. Paul, Minn., the organist in the city of Minneapolis, and the 'cellist in the transmitting station eighteen miles distant. Each wore inter-communicating headphones and a perfect ensemble was maintained. We must admit that we have occasionally heard trios and quartettes, in which the individual performers appeared to be as widely separate without the connecting headphone links.

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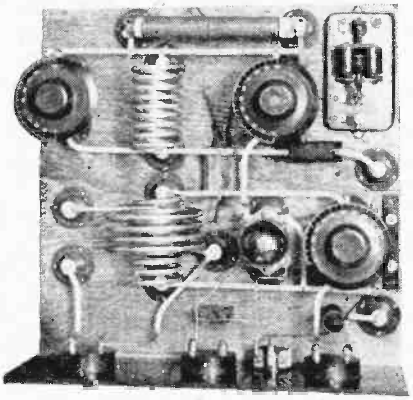
NEW EUROPEAN BROADCASTING STATIONS.

The Norwegian wireless station of Porsgrund, which works on a wavelength of 434 metres, and at present uses a power of only 100 watts, is to be replaced in the near future by a more powerful transmitter. The new station will operate on a power of approximately 1 kilowatt.



PROGRESS IN U.S. SHORT WAVE DESIGN. The novel short-wave receiver built by Edward Manley, an American amateur, for use on a natural history expedition to Greenland. Note the air-spaced coils.

The old transmitter is to be removed to Rjukan. The Norwegian broadcasting authorities have also in contemplation a new station at Frederikstad.

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A CORRECTION.

In the article entitled "A.C. Mains Unit" in last week's issue, in referring to Leslie Dixon and Co. the name should have been given as Electradix Radios, the address of the London Showrooms being: 218, Upper Thames Street, London, E.C.4.

WIRELESS AT WESTMINSTER.

By Our Special Parliamentary Correspondent.

Increase in Broadcast Licences.

In reply to questions by Sir Harry Brittain last week, Sir William Mitchell-Thomson stated that the number of wireless licences issued shows a steady increase, but it is impossible to say to what extent the increase is attributable to the practice of broadcasting notices concerning the use of unlicensed sets. These notices are broadcast periodically because the owners of unlicensed sets sometimes profess, when questioned, to be unaware of the legal obligation to obtain a licence, though this is, of course, no excuse in case of a prosecution.

The number of persons prosecuted for the use of unlicensed wireless apparatus since the passage of the Wireless Telegraphy (Explanation Act) last autumn was 296. Up to the present it had not been necessary to prosecute any person more than once. The maximum penalty imposed was £10 in addition to £10 costs.

In reply to Mr. Day, the Postmaster-General said that authority had been given to the British Broadcasting Co. to conduct a series of tests in the simultaneous transmission of different programmes from two stations in close proximity. The tests were not yet completed, and it was not yet possible to make any statement as to their result.

BOOKS RECEIVED.

We have received from the International Office of the Telegraphic Union at Berne sheets 3 and 4 of the official map of radiotelegraphic stations (1926). Sheet 3a comprises Greenland, Iceland, Norway, Sweden, Finland, Northern Russia, Northern China, and Alaska. Sheet 3b, the South Atlantic and Indian Oceans, with the eastern coast of South America, Africa, India, Straits Settlements, Borneo, the Philippine Islands, and Western Australia. Sheet 4 comprises the Pacific Ocean with the eastern half of Australia, Japan, New Guinea, the Pacific Islands, and the western coast of North and South America.

The price of each sheet is 2 frs. 50 (Swiss), post free.

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"Motor Cycles and How to Manage Them," by the staff of *The Motor Cycle*, 324 pp., and over 360 diagrams and illustrations. Published by Messrs. Iliffe and Sons, Ltd., price 2s. 6d. A new and revised edition.

British Standard Glossary of Terms used in Electrical Engineering, issued by the British Engineering Standards Association. (Publication No. 205-1926.) Pp. 263. Published by Crosby, Lockwood and Son, London, price 5s. net.

ITEMS FROM THE TRADE.

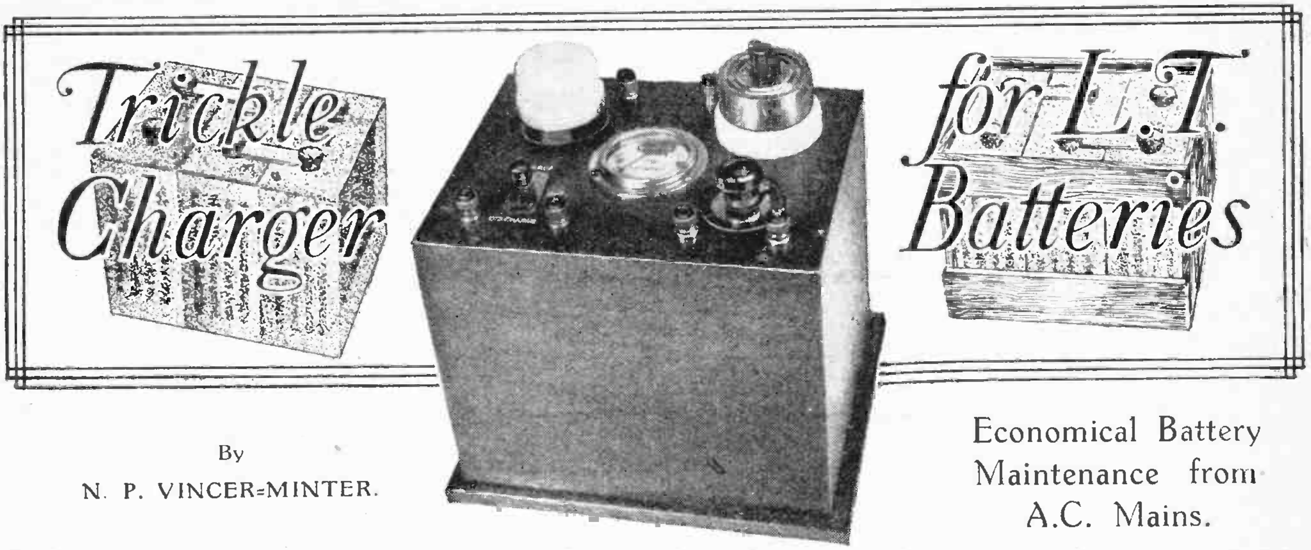
Condenser Prices Reduced.

Messrs. Wilkins and Wright, Ltd., Utility Works, Kenyon Street, Birmingham, wish us to state that the prices of their variable condensers, which appeared on page 862 of our June 23rd issue, in the Buyers' Guide to Component Parts, have now been reduced.

The Newey Condenser.

In the Buyers' Guide included in the issue of June 23rd, relating to variable condensers, the well-known Newey condenser, manufactured by Pettigrew & Merriman, 124, Tooley Street, London, S.E.1, was omitted. The condenser is of novel design, being driven by a central pinion operating on a pair of segments connected with two sets of rectangular brass plates. The instrument is of attractive appearance, the shape and movement of the plates producing an almost true square law effect.

Trickle Charger for L.T. Batteries



By
N. P. VINCER-MINTER.

Economical Battery Maintenance from A.C. Mains.

ONE of the first desires which comes to every man who has bought, made, or otherwise acquired a wireless receiver complete with loud-speaker in an attempt to extract entertainment from the broadcasting programmes is to charge his accumulator from the electric light mains. He feels, not unnaturally, that it is very tantalising to have an excellent source of power at his elbow and then, through lack of the appropriate knowledge, to have to carry a heavy accumulator to and from the charging station. He resents also the fact of being compelled to constantly contribute to the support of the ever-receptive proprietor of the charging station, when (so he argues) he could, if he only knew how, do the job more cheaply at home, since, of course, he very well knows that the majority of dealers undertaking this job use the public supply mains for the purpose, and, moreover, are not philanthropists. Unfortunately, his enquiries among his "expert" friends usually lead to the totally erroneous idea that, provided his house is fitted with a D.C. supply, the home charging of accumulators is simple and straightforward, and no special expensive apparatus is necessary, a few carbon lamps being the only requisites. On the other hand, he learns that if he has A.C. mains the matter is much more complicated, a not inconsiderable sum having to be laid out in the purchasing of a transformer and rectifying apparatus, which are by no means trouble free. If, therefore, his house is fitted with A.C. he probably gives up the project forthwith, whilst if, on the other hand, he has the misfortune to have D.C. mains, he probably purchases the necessary lamps, and all goes merrily until the quarterly account comes in and he finds that, for the sum expended in charging his accumulators at home for three months, he could have got it done at the local depot for a year. He is, in fact, almost, but not quite, induced to revise his opinions concerning the character of the local dealer. The explanation is, however, very simple.

Let us assume that we have 250-volt D.C. mains and an accumulator of 20 ampere-hours actual capacity, which means that a current of 2 amperes will have to be passed through it for 10 hours, or a 1-amp. current for 20 hours (it comes to the same thing) in order to charge it. Now volts multiplied by amperes gives us wattage, and, obviously, if we are using 250 volts to push 2 amps. through an accumulator, we are using a power of 500 watts. The Board of Trade Unit, which is the basis on which charges for the consumption of electrical energy are made, represents a power of 1,000 watts used continuously for one hour, more usually known as the kilowatt-hour, which is obtained very simply by multiplying together the number of watts we are using and the time in hours during which we are using them. If, therefore, we are using a power of 500 watts for 10 hours, it is obvious that we shall consume 5 units of electricity, which at sixpence per unit will cost 2s. 6d. a price which even the most hardened dealer would hesitate to charge. How, then, can the dealer charge accumulators and live? Very simply, as we shall now see.

Charging from D.C. Mains.

Although we used a power of 500 watts to charge our accumulator (assuming it is a 6-volt accumulator), the power used in actually charging the accumulator was not greatly in excess of 12 watts, the remaining 488 watts being unavoidably wasted, for the simple reason that actually only a little over 6 volts is needed to overcome the back pressure of the accumulator and push the necessary 2 amps. through it, the remaining 240 volts or so having to be deliberately thrown away by dropping them across a bank of lamps, or some other form of resistance, the energy being wilfully wasted in heating up the aforementioned resistance. Now it is straightway obvious that if we have, say, a 120-volt accumulator, or, in other words, twenty 6-volt accumulators in series, and connect them up to our mains for charging purposes, we shall have to have a voltage somewhat in excess of 120 volts to overcome the back pressure of the battery and push the charging current through, and so shall have to wastefully drop rather less than 130 volts instead of over 240 volts, across an external resistance. In other words, we are usefully employing about 240 out of our total of 500 watts instead of only about 12 watts as before. If we

Trickle Charger for L.T. Batteries.—

have forty 6-volt accumulators to charge, giving a total of 240 volts, we shall have less than 10 volts to drop wastefully across the external resistance, and shall be usually using 480 watts, almost the whole total of the 500 watts taken from the mains. In ten hours, therefore, at the same expenditure as in the case of a simple 6-volt accumulator, we have now been able to charge forty accumulators for 2s. 6d., the cost which we previously estimated for one accumulator. It requires no

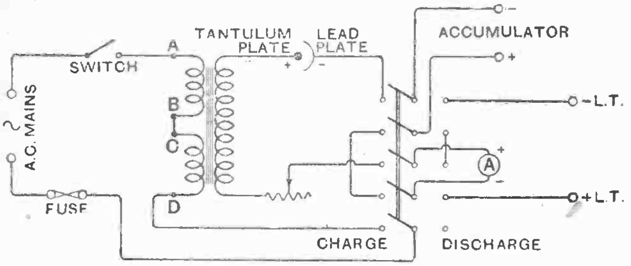


Fig. 1.—The theoretical diagram. Note specially the ammeter connections.

great mathematical calculation to realise that this works out at only three farthings per 6-volt accumulator! It will be seen, therefore, that any change of excessive benevolence laid at the door of the local "charger" is, as in the case of many other apparent philanthropists, not justified.

Economical D.C. Charging.

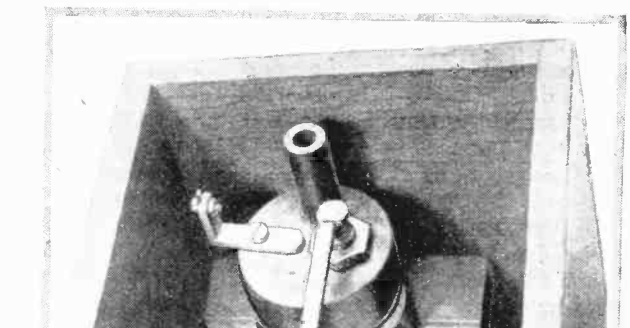
The important fact has emerged, therefore, that, provided the total voltage of the battery to be charged is not greatly less than that of the mains, then the use of D.C. mains for charging becomes an economical proposition. It is equally obvious that the user of 120-volt mains is in a more fortunate position than those whose mains are of higher voltage, since if he *does* decide to charge a single 6-volt accumulator through a bank of lamps it will not cost him so much, since there are less volts requiring to be dropped across the external resistance. If the public supply mains were 12 volts, then, of course, the position would be ideal, but, unfortunately for wireless users, they are not. Similarly, if our 6-volt valves, such as the D.E.5, which require a power of 1½ watts at 6 volts 0.25 amps., took their 1½ watts in the form of about 200 volts and 7½ milliamps., we should also be in an ideal position, because not only could we use a 200-volt accumulator, but, because of the small current required, we should be able to use an ordinary H.T. accumulator and should thus economise in two ways, first by the fact that the voltage of the battery approaches that of the mains, and secondly because in any case the charging current is small, which brings us on to the subject of H.T. accumulators. It is perfectly economical to charge these from D.C. mains. Let us take the case of the usual 60-volt 1 ampere-hour H.T. accumulator being charged from the 250-volt mains which we have already considered. The battery will be charged by the passage of a current of 0.1 ampere for 10 hours; 0.1 ampere at 250 volts gives us twenty 25 watts power, which, if used for 10 hours, represents a quarter of a Board of Trade Unit, costing 1½d.

It should be pointed out also that, with the addition of a simple smoothing system, any device made for the charging of H.T. accumulators from D.C. mains is equally suitable for supplying anode current direct from mains to receiver, and a receiver designed for operating directly from D.C. mains has recently been described in this journal.[1] *Verb. sap.*

Power and Lighting Mains.

Now it might happen that, at a time of slack trade, the local charging station had only about three batteries on charge, and, as we have seen, this would still mean a cost of 2s. 6d. for charging, or, in other words, tenpence per battery, which at a charge to the public of 1s. 6d. leaves the unfortunate local "charger" with a bare 80 per cent. profit, which would never do. This impending financial calamity is averted, however, by having a separate "power" meter installed, whereby the charge made by the electric light company is only about 1d. per unit. Now anybody can have a separate meter installed in their house for power supply to electric cookers and heaters (the charge for which is usually about 1d. per unit) without the necessity of actually installing heaters, etc. It will be seen, therefore, that the cost of charging our L.T. battery would be reduced from 2s. 6d. to 5d. —a fairly economical price. To this must be added the rental of the meter, which, however, is usually only about 2s. 6d. per quarter. No extra wiring is entailed, the same main leads into the house being used. The only alternative to householders with D.C. mains not desirous of adopting this scheme is to purchase a D.C. rotary transformer which performs the function of stepping down the voltage *economically*, in the same manner as

[1] *The Wireless World*, June 30th, 1926, page 879.



Interior of cabinet, showing method of fixing the tantalum cell.

Trickle Charger for L.T. Batteries.—
in the case of A.C. mains and a static transformer. A D.C. rotary transformer virtually consists of a 250-volt motor driving a 10-volt dynamo, the two instruments being combined into one. A good instrument can be obtained for about seven guineas, and can be thoroughly relied upon to be trouble-free and to require no skilled attention. The cost of charging the accumulator will be about the same as in the case of the power mains.

There is another method of charging accumulators from D.C. mains which is frequently advocated, but which is of very little use to the average householder. This consists of breaking one of the mains at a convenient point, such as the fuse box, and inserting the accumulator so that all current normally used in the evening for the supply of light is compelled to pass through the accumulator and so to charge it. In this manner the accumulator may be charged for nothing, the price paid for the charge being represented by a very slight diminution in the light obtained from the lamps, owing to the fact that the 6 volts back pressure of the accumulator is subtracted from the voltage of the mains. Now it is fairly safe to say that, in the average small household, there are only about two 60-watt lamps burning *continuously* during the evening, and at this period of the year they are probably burning only two hours nightly. A 250-volt 60-watt lamp consumes about one-quarter of an ampere, and so, with two lamps in use, a current of ½ ampere will be passing, which means that it will take 40 hours to charge the accumulator, or, in other words, about three weeks at this time of the year. It would seem, therefore, that the many D.C. charging "switches" upon the market cannot offer a useful solution to the problem to the average reader. For hotel proprietors, however, or for our ducal readers residing in their ancestral castles, where a very large number of lights are burning simultaneously during the evening, the scheme is undoubtedly an ideal solution to the problem. In small houses, which *do* make use of small electric cookers, it is, of course, an excellent scheme to place the accumulator in series with the supply mains, because a suitable current of 2 or 3 amperes will be passing, and the slight diminution of heat from the cooker will be negligible. It should be pointed out that, although the charging current of the average H.T. accumulator is small, it must not be forgotten that the back E.M.F. of 60 volts will have to be subtracted from the mains voltage, and a very serious diminution from the light supply would occur if this system were employed. However, as has already been pointed out, it is perfectly economical to charge an H.T. accumulator in series with a lamp in the ordinary manner.

It will be seen, therefore, that in the case of D.C. mains, apart from dukes, hotel proprietors, and similar members of the aristocracy, there are only two solutions to the problem, namely, either a power meter must be installed, or a D.C. rotary transformer purchased. To conclude on the D.C. question, it might be mentioned, for the benefit of those readers who are members of the plutocracy and can therefore afford to charge from a bank of lamps, that full particulars for calculating lamp resistances will be found on page 510 of the March 31st, 1926, issue of this journal under the heading of "What's Watt."

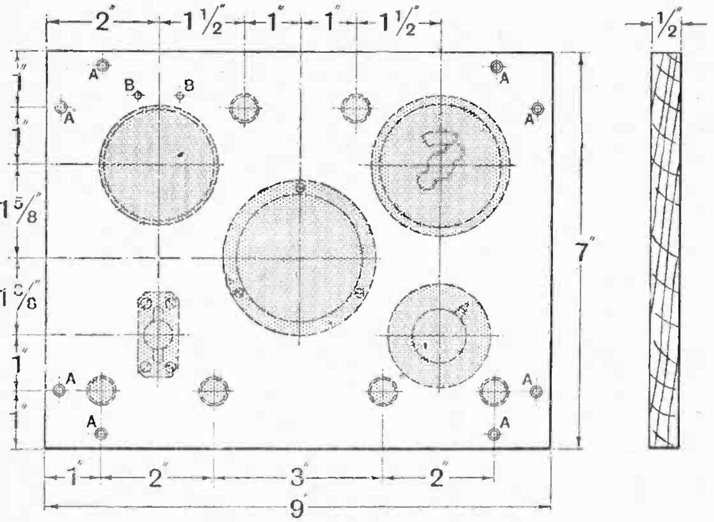


Fig. 2a.—Details of layout of top of panel.

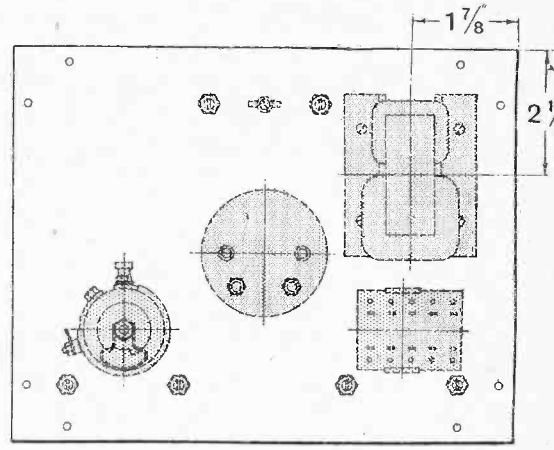


Fig. 2b.—Details of layout of underside of panel.

Charging from A.C. Mains.

Now with regard to A.C. mains, it will be found that the problem presented is quite a different one. We are no longer concerned with economy, this being easily attainable, whilst, on the other hand, the reliability and "foolproofness" of charging from D.C. mains cannot be said to apply greatly to A.C. mains. In the first place, we find that A.C. is extremely tractable. The voltage of our mains does not matter greatly, because by means of a simple transformer we can at once change the voltage upwards or downwards to any value we require. In the case of reducing the voltage of A.C. mains to the required value for L.T. accumulator charging, we actually reduce the voltage in an efficient manner, so that the actual wattage available we put into the accumulator is almost equal to the actual wattage taken from the mains, unlike the case of D.C., where the greater part of the wattage taken from the mains had to be dissipated across an external resistance. The case is thus analagous to the use of the D.C. rotary transformer.

LIST OF COMPONENTS.

1 Tantalum rectifying cell (Radio Accessories, Ltd.).	*1 Fuse cut-out (G.E.C.).*
1 Power transformer for above (Radio Accessories, Ltd.).	*1 Five ohm rheostat (Cosmos).*
1 Ammeter with 0-1 scale (Sifam).	*2 Terminal clips (Burndept).*
1 Five-point double-throw switch (Burndept).	*6 Terminals (Belling Lee).*
1 Tumbler switch (G.E.C.).	*1 Cabinet to dimensions given.*

Approximate cost - - - - £4 15s. 0d.

There we did the same thing, except that the A.C. transformer is cheaper, and, owing to its containing no moving parts, is more reliable. Actually there are certain losses in the A.C. transformer, so that we do not get quite so many watts out of the secondary as we put in the primary, but, provided a well-designed and constructed transformer is used, these need not be serious. Now a transformer can, of course, be constructed at home, and articles giving full details have already appeared in this journal, but it should be emphasised that the construction of a power transformer is not a matter of merely following closely a rule of thumb, and unless the would-be constructor is an experienced amateur it is definitely advised that this component be obtained from a reliable firm. Apart from the fact that the losses in a home-constructed transformer may be so high that charging costs are considerably augmented, it will probably be found that, after a time, one of the windings burns out, and in the end the capital expenditure will be found to be greater than if a good instrument had been purchased in the first place.

Choice of a Rectifier.

Having transformed our voltage down to the required value, it is now necessary to provide a rectifier. Undoubtedly the best and most efficient rectifier is a suitable two-electrode valve. It is silent and reliable and an efficient rectifier, but has just one drawback, and that is that it does not last for ever. One very well-known two-electrode valve, for instance, is priced at 25s. and has an advertised life of 1,000 hours. It will, of course, deliver a charging current of 3 amperes to our accumulator and thus charge it at ten hours, but will obviously only last for 100 charges, at the end of which time we must be prepared to face the expenditure of another 25s., although with care our valve may last much longer. This means that 3d. must be added to the cost of the current used in each charging operation, this sum representing valve depreciation. It should be pointed out that the valve filament is, of course, lit from an additional secondary winding on the transformer. In the case of a very large accumulator requiring a 5-amp. charging rate, such as are often brought into charging stations, a large and more expensive valve must be purchased. Another most excellent device is the rotary converter. In this instrument the voltage is just stepped down to a suitable value, and the output of the transformer used to drive a small A.C. motor, which in its turn drives a small D.C. dynamo, the two instruments being, however, modified and made as one machine. This is a very reliable and economical method. The capital outlay is large, a good machine costing as much as a D.C. rotary transformer, although it is to be noticed that much less expensive machines operating on more or less the same principle are now making their appearance. Another rectifying device frequently used is the vibrating rectifier. This instrument is usually very noisy and not to be recommended unless made with great precision, as it is liable to be put out of adjustment by a sudden jar.

Electrolytic Rectifiers.

It will be seen, therefore, that all the devices we have so far considered have either been expensive, either in initial outlay or in running costs, or have been unreliable. There remains the chemical rectifier. Now the usual charge laid against the chemical rectifier is that it is messy and malodorous. In the case of the ammonium phosphate rectifier it cannot be denied that there is considerable justification for the charge when a charging current of 2 amperes or so is taken. If the current is reduced to a matter of milliamperes, however, things are different, and the ammonium phosphate rectifier becomes efficient and reliable and is thus very suitable for the charging of H.T. accumulators. There is, however, another form of chemical rectifier employing a tantalum and a lead electrode emersed in a solution, the main constituent of which is ordinary accumulator sulphuric acid. If a heavy current of several amperes is passed through

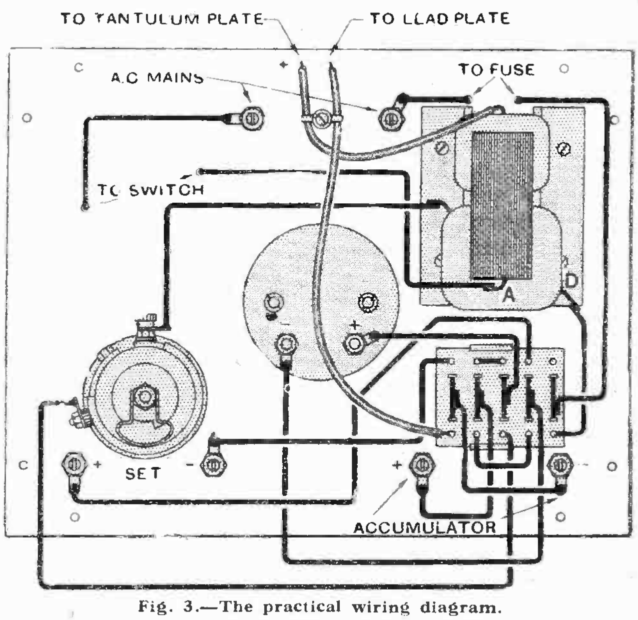
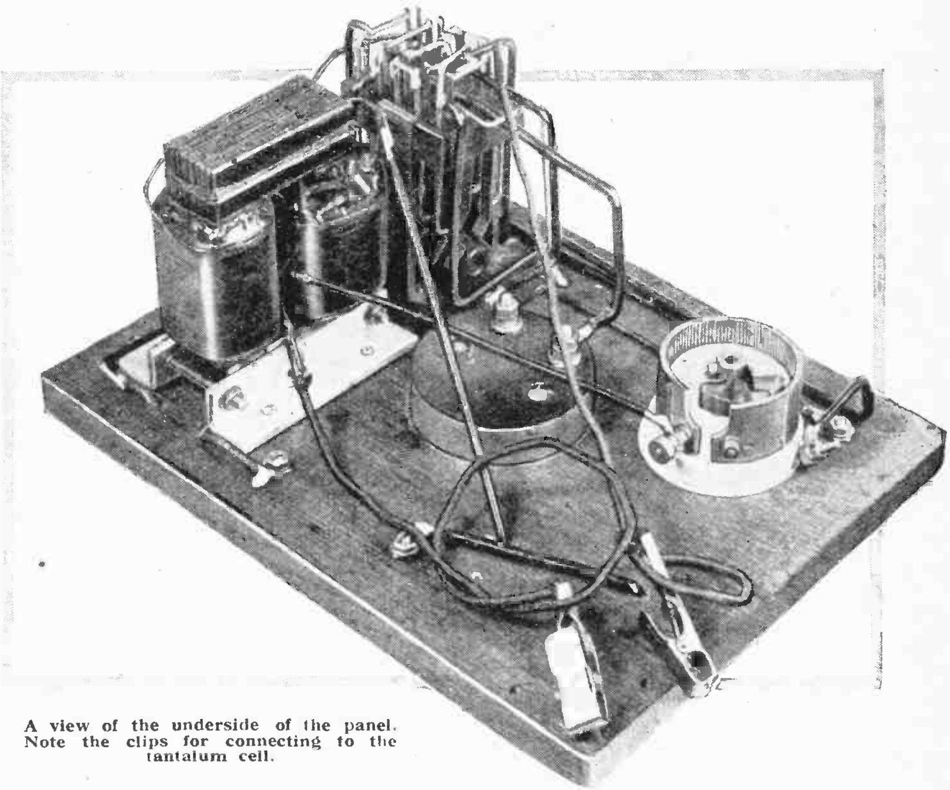


Fig. 3.—The practical wiring diagram.

this instrument, it behaves much better than other chemical rectifiers, but still its behaviour can be very much improved by not permitting the charging current to exceed half an ampere. Now this would mean obviously that our accumulator will take 40 hours to charge fully. If, however, we could arrange that our accumulator was

Trickle Charger for L.T. Batteries.—
never fully discharged, but that immediately on the conclusion of the programme it was removed and attached to the charger and left there all through the night and the following day it would be fully charged. It would be irksome to be constantly connecting and disconnecting the battery from charger to set, but we can very easily mount the charger in a cabinet with a suitable switching arrangement and with leads permanently connecting to accumulator, to the L.T. terminals of the receiver, and, by means of a plug, to a convenient lamp holder, so that a simple movement of the switch would transfer the accumulator from the L.T. terminals of the receiver to the mains *via* the charger. This is precisely what the writer has done in the present instrument. He, unfortunately, cannot suggest any solution to D.C. users other than those he has mentioned in this article, but for A.C. users he submits the following instrument as the most practical solution to the problem. Trickle chargers, as these devices are aptly named, are in almost universal use in America, they not necessarily being of the tantalum type, since small valve trickle chargers with a current-carrying capacity of half an ampere are also in great vogue. These chargers, and components for making them, are on sale in great number and variety in America, since, of course, A.C. at 110 volts 60 cycles is standard throughout practically the whole of the U.S.A. Thus American manufacturers can produce them in great quantity, they not having to market a variety of types for different mains voltages and periodicities, and also not having to contend with the D.C. problem as in this country.



A view of the underside of the panel. Note the clips for connecting to the tantalum cell.

Constructional Details.

The transformer and tantalum rectifying cell used in this unit are obtained from the same makers. It will be found that the primary winding which connects to the mains is wound in two sections with four terminal connections labelled A, B, C and D. If the mains are anywhere between 200 and 250 volts, the two sections of the primary are placed in series by connecting A and D to the mains, and joining B and C, whilst if the mains are of 100 to 125 voltage, A and C and B and D are joined together respectively and coupled to the mains. Since the writer has only 240-volt mains available, he has connected the instrument so as to be suitable for these mains, but potential constructors should first ascertain the voltage of the mains and then act accordingly. The charger will function satisfactorily on any of the mains periodicities normally supplied in this country. The rectifying cell as supplied by the makers requires filling only with sulphuric acid, such as is used for accumulators, and will comfortably accommodate a current of 0.5 amp. without any trouble. An ammeter with a scale reading of 0 to 1 amp. is so connected that on putting the switch over to the "charge" position this instrument is in series with the accumulator, thus indicating the value of the charging current. The rheostat should be adjusted until the meter reads 0.5 amp. If a 6-volt accumulator is to be charged, it will be found necessary to turn the rheostat full on to obtain a charging current of this value, whilst with a 2- or 4-volt accumulator a certain amount of resistance will have to be left in circuit. The charging current should not be allowed to exceed 0.5 amp., or no good will be done to the rectifying cell. Upon placing the switch over to the "discharge" position the accumulator with the ammeter still in series will be connected to the L.T. terminals of the set. The meter will then register the total current being drawn from the battery by the valve. No fear need be entertained of there being an undue voltage drop across the ammeter, even using 2-volt valves, because although it costs but twenty-five shillings the resistance of the meter is only one-twentieth part of an ohm. The connections to the switch should, however, be carefully noted, since it is necessary for it to reverse the polarity of the ammeter connections on changing over from "charge" to "discharge." The switch used has a central zero position which breaks all connections, including the transformer primary. As a safety precaution an additional tumbler switch and also a fuse is included in series with the mains. Do not forget that, when charging, the tantalum or positive elec-

Trickle Charger for L.T. Batteries.—
trode of the cell must be connected to the positive terminal of the accumulator.

The design of cabinet is a matter in which a wide individual choice can be exercised. A vent pipe is attached to the cell for the escape of any gas generated by the cell, and it is advisable to extend this vent through the side of the cabinet by means of a piece of rubber tubing as has been done by the writer, since, of course, if the gas is allowed to escape into the cabinet the wiring will quickly become corroded. It should be pointed out that the flexible wires connected to the cell each terminates in a clip, so that these wires may be rapidly detached if it is required to move the top panel, since the cell which is suitably fixed to the bottom of the cabinet is the only component not mounted on the top panel.

With regard to the charging of H.T. accumulators, of course, it is obvious that the main need is for a transformer giving a different output voltage, since, of course, valves, electrolytic cells, and other rectifying devices, are the same as before. Since we are rectifying only a small current, however, we can use valves with quite small emission, even a small receiving valve of the D.E.5 type being suitable, and, of course, if a chemical rectifier is used, the cell can be made much smaller. It is advisable, however, never to have a greater difference of potential than 50 volts across any chemical rectifying cell, and it will be necessary, therefore, to use two or more in series. An instrument designed for charging H.T. accumulators from A.C. mains can, with suitable modifications, be used for supplying anode current direct to the receiver as the case of D C. previously mentioned

In conclusion, the writer would add that this charger has given every satisfaction, adequately attending to the needs of a six-valve superheterodyne receiver using D.E.5 type valves throughout.

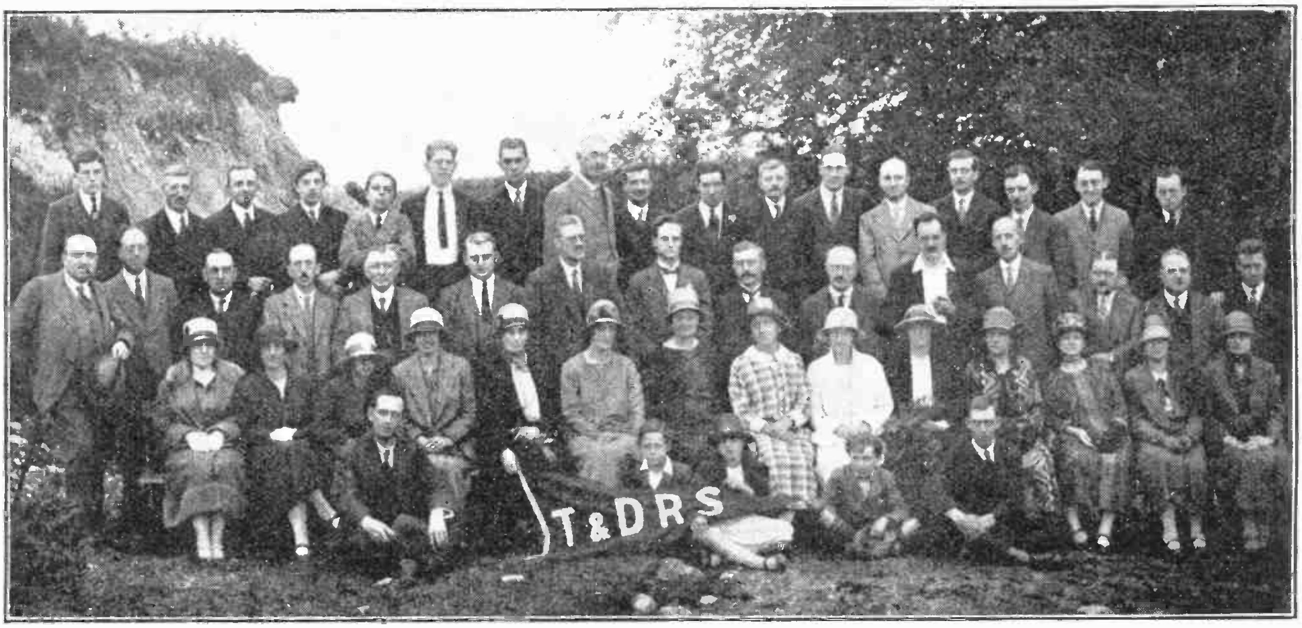
RECEPTION OUT OF DOORS.

Successful Gathering at Taunton.

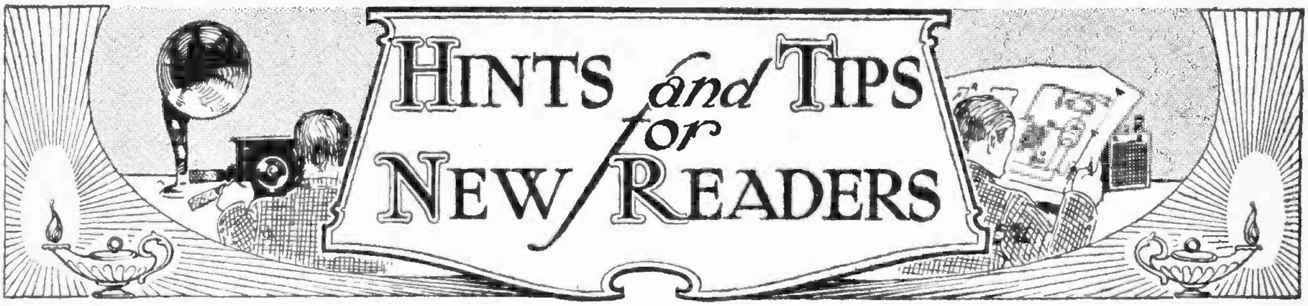
AN open-air wireless gathering, the first of its kind in the Taunton district, was held with great success by the Taunton and District Radio Society at Corfe Hill on Monday evening, June 21st. More than fifty members and friends journeyed to the hill, where several aerials were slung in preparation for the reception of different broadcast programmes. Five receivers were employed, including a four-valve portable set and a superheterodyne operated by Captain E. S. Pink.

Soon after the party arrived, Cardiff and Bournemouth were tuned in clearly, but, unfortunately, after eight o'clock, little variety could be obtained, as a simultaneous programme was broadcast from London. The concert provided from the Chenil Galleries, Chelsea, was received exceptionally well. After the weather forecast and local news from Cardiff the announcer addressed a special message to the Society, expressing the hope that the weather was kind and that the meeting had been thoroughly successful.

During the remainder of the Summer the Society hope to organise further gatherings of the same kind, and their example in this direction might be copied by other clubs. The Hon. Secretary is Mr. E Scott Setterington, 61, Addison Grove, Taunton.



WIRELESS IN THE OPEN AIR. Members and friends of the Taunton and District Radio Society photographed on the occasion of a recent wireless gathering at Corfe Hill. Excellent loud-speaker reception was obtained from the Bournemouth and Cardiff broadcasting stations



A Section Devoted to the Practical Assistance of the Beginner.

RESISTANCE WIRE.

A convenient gauge wire to use for winding anode or similar resistances is No. 45 "Eureka," which has a resistance, in round figures, of 100 ohms per yard (actually 108 ohms at 60° F.); 1,000 yards of single silk covered wire of this gauge weighs slightly over $1\frac{1}{4}$ oz. Provided that a constant tension is maintained, to prevent the formation of kinks, the wire is not difficult to handle.

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A REFLEX REINARTZ RECEIVER.

It is not generally known that the popular Reinartz tuner may, with a slight modification, be adapted to a dual-amplification circuit, with crystal detector. The most obvious manner of carrying out this alteration is shown in Fig. 1 (*a*), which, unfortunately, involves the use of unearthed L.T. and H.T. batteries, which is often a disadvantage in circuits of this description. If an attempt is made to earth the batteries (as shown by the dotted line), the result will be a direct short-circuit of the secondary winding of the L.F. transformer, rendering the set inoperative.

The simplest way of overcoming the difficulty is shown in Fig. 1 (*b*). Instead of a continuous winding, with tappings for grid, filament, aerial, and reaction condenser, a coupling coil should be constructed with a separate aerial winding, wound over the earthed end of the grid section L. The reaction coil, L_1, is an extension of this latter winding.

The high-frequency transformer may be constructed in accordance with individual requirements, bearing in mind the probable necessity of the introduction of some artificial stabilising device if it is so arranged that the tuned circuit is only slightly damped by the crystal. This stabilising may very simply be carried out by winding the reaction coil already mentioned in the *opposite* direction to that of the grid winding of which it forms a continuation. It will then be found that an increase in the capacity of the reaction condenser R.C. from its minimum setting will have the effect of stopping the tendency towards self-oscillation which will become evident when grid and plate circuits are brought approximately into tune.

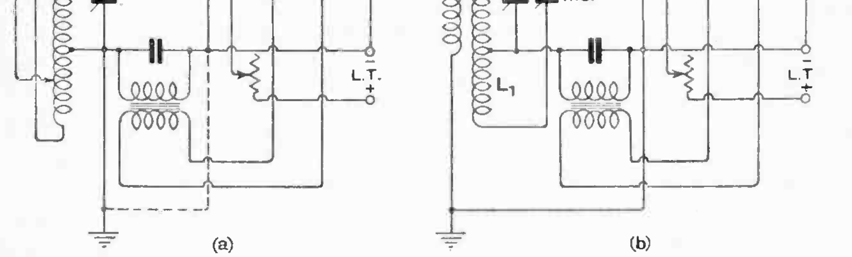

Fig. 1.—Methods of earthing the batteries in reflex Reinartz receivers.

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MATCHING VALVES AND COUPLINGS.

The fact that components, such as intervalve coupling transformers (both high- and low-frequency), anode resistances, chokes, etc., should be chosen with due regard to the characteristics of the valves with which they are to be used is continually being impressed upon the amateur. This is excellent advice, and should always be heeded if the best possible results are to be obtained. It seems, however, that there exists among beginners a good deal of uncertainty as to the exact meaning of the expression that a stated component is suitable for use *with* a given type of valve, some readers assuming that reference is being made to the valve immediately following the component.

This is a complete misapprehension; the fact is that, failing a direct statement to the contrary, such remarks always apply to the valve in whose anode circuit the particular component under discussion is to be connected.

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AERIAL WIRE.

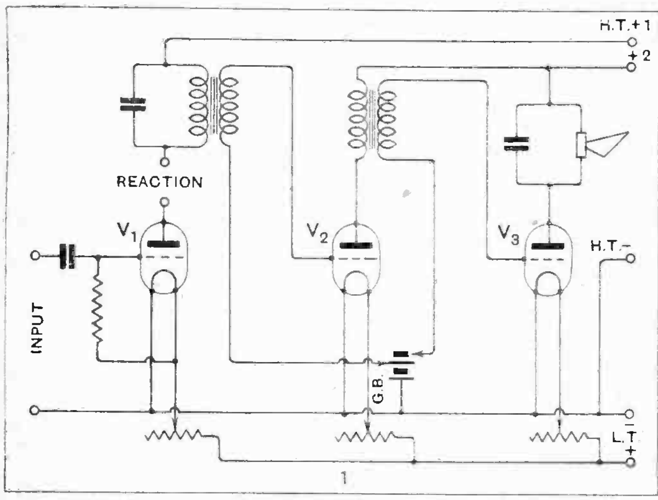
It seems probable that the conventional aerial cable, with seven strands of No. 22 copper wire, which is now in such general use, is really unnecessarily heavy for its purpose, from the electrical point of view, and that a lighter material might often be used with advantage when there is any doubt as to the strength of the masts and other supports. The resistance of a single wire as fine as, say, No. 18 S.W.G., is certainly small in comparison with the average earth connection (and even with the average aerial tuning coil), and for a short span, at any rate, there need be no hesitation in using it, apart from considerations of mechanical strength. A slightly heavier conductor, such as Nos. 16 or 14, might be preferred on this account, and, indeed, is largely used in America.

Solid wire is not so easy to work with as is the stranded variety, but little difficulty will be encountered if the horizontal and vertical portions are stretched after being cut roughly to size. This remark is particularly applicable to bronze wire, which otherwise is almost ideal for an ordinary aerial. No. 16 is a good gauge to use.

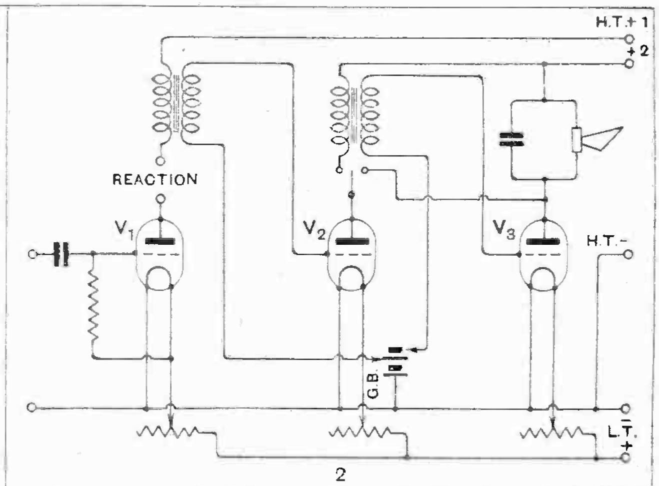
DISSECTED DIAGRAMS.

No. 36.—Switching a 2-stage L.F. Amplifier.

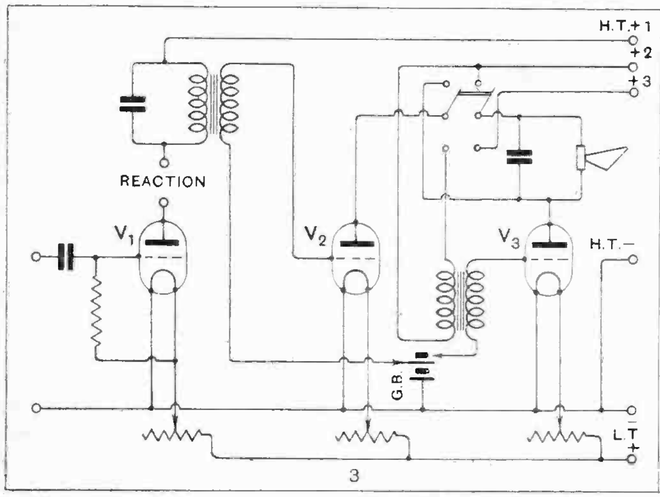
Various practical switching arrangements, whereby different numbers of valves may be used at will, are shown below. The parts of the circuit preceding the detector valve have been omitted for the sake of clearness. In Figs. 2 and 3 the filament circuit of the third valve may be controlled by an extra blade on the switch. In Fig. 4 it should be noted that the second grid battery (G.B.2) is at high potential, and must be carefully insulated.



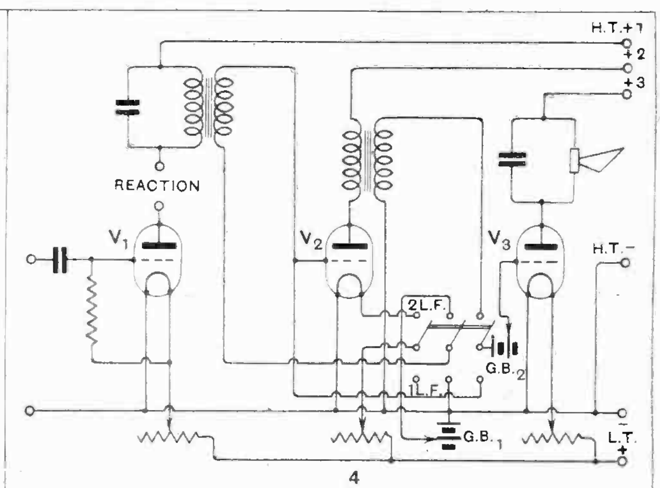
The basic circuit diagram, without switching. The valve marked V_1 is operating as a detector, while V_2 and V_3 are, respectively, first and second L.F. amplifiers. Provided that these two valves are supplied with the same H.T. voltage, it is a simple matter to eliminate the latter—



—by fitting a single-pole change-over switch in such a way that the anode output of the first L.F. valve is passed through the loud-speaker (or phones) instead of through the transformer primary. With this arrangement and the following one, it is necessary to switch off—



—the filament of the valve not in use by means of its rheostat. In the circuit shown above, it is assumed that the valves V_2 and V_3 have widely different characteristics, requiring different H.T. voltages. The appropriate change of voltage is made automatically by the second blade of the switch.



This arrangement, which permits of the elimination of the first L.F. valve (V_2), has several advantages. The loud-speaker is always in the anode circuit of the last L.F. valve (V_3), the characteristics of which are presumably specially suited for this position. The filament of V_2 is controlled by the switch.

WIRELESS CIRCUITS
in Theory and Practice.
16.—Grid Rectification.

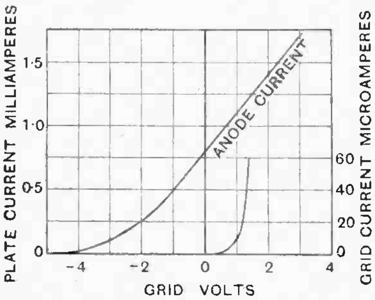
By S. O. PEARSON, B.Sc., A.M.I.E.E.

ON account of its greater sensitiveness to weak signals the grid method of rectification is used to a much larger extent than simple anode rectification explained in the last instalment. Rectification can be effected on the grid or input side of a valve because an electron current will flow between the grid and filament if the potential of the grid is made positive with respect to the negative end of the filament. When the grid is made positive it attracts some of the electrons which are emitted by the filament, these electrons passing *via* the external circuit back to the filament, and so constituting the grid current. Increasing the plate potential causes the electrons to be drawn off from the filament with greater velocity, with the result that fewer of them are captured by the grid, and the grid current is reduced. Thus, for a given positive grid potential the grid current is reduced as the plate voltage is increased.

Grid to Filament Conductivity.

In general, there is no grid current whatever for grid potentials below that of the negative leg of the filament, but in some types of valves a small amount of grid current will flow even when the grid is slightly negative. According to the usual notation of direction, the current flows from the grid to the filament inside the valve, and from the filament to the grid in the external circuit; under no circumstances will the current flow in the reverse direction. This unilateral conductivity is made use of for obtaining grid rectification.

The curves of Fig. 1 show the plate current and grid current for various values of grid voltage for a typical



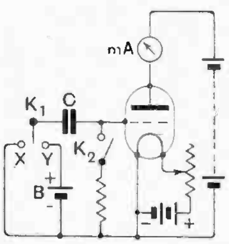


Fig. 1.—Plate current and grid current curves for a 3-electrode valve for a constant anode voltage.

Fig. 2.—Simple circuit for illustrating the principle of grid rectification.

receiving valve. It will be noted that the grid current is small compared with the plate current. To make the valve act as a rectifier on the grid side, a small condenser is connected in series with the grid lead and the oscillations are applied to the grid through this condenser. But before considering the actual conditions required for reception of telephony, it will be helpful if the principle of the rectification is explained by describing one or two simple experiments which can be carried out quite easily with very simple apparatus.

The arrangement referred to is shown diagrammatically in Fig. 2, where an ordinary receiving valve is connected up with a milliammeter (mA) in the plate circuit and a large condenser C of about 1 mfd. or more in series with the grid lead. A two-way switch on key K_1 and a battery B of, say, 2 volts, are provided and connected as shown. By means of the switch K_2 a high resistance may be connected between the grid and the negative leg of the filament. First of all, let the switch K_2 be open and the key K_1 be over to the contact X, so that the left-hand side of the condenser is at the same potential as the negative leg of the filament (zero potential), and suppose that the condenser contains no charge, the two sets of plates being at the same potential. Then the grid will also be at zero potential and the corresponding plate current shown by the curve of Fig. 1 will be 0.8 milliamp.

Mechanism of Grid Rectification.

Now suppose that the switch arm K_1 is suddenly switched over from the contact X to the contact Y, thus making the potential of the left-hand side of the condenser two volts positive with respect to the negative leg of the filament. As there is as yet no charge in the condenser the other side of it and the grid of the valve will also have their potential raised by two volts when the switch is changed over from X to Y. The result is that, the grid voltage being now +2 volts, the plate current suddenly increases to 1.4 mA, as shown by the upper curve of Fig. 1. But this is not all; the lower curve of Fig. 1 shows that a grid current of 20 microamps will immediately commence to flow, its direction being from the right-hand side of the condenser *via* the grid to the filament thus causing the right-hand side of the condenser and the grid gradually to lose their positive potential. The grid current would keep on flowing with diminishing value until the potential became zero and the plate current had again fallen to 0.8 mA. The cycle of operations is clearly shown at (a) in Fig. 3, where the grid potential is plotted against time. At the instant denoted by AA′ the switch K_1 is changed from X to Y, the grid potential suddenly rising from zero to +2 volts. The voltage immediately begins to fall until it again reaches zero. The condenser is now charged, having a potential difference of 2 volts between its plates, the grid side being at zero potential and the other side at +2 volts.

Now, suppose that the switch K_1 is suddenly changed back again from the contact Y to the contact X. This will bring the left side of the condenser C back to zero potential, and at the same time drop the potential of the

Wireless Circuits in Theory and Practice.—

grid from zero to −2 volts. Since no grid current flows for negative values of grid potential, it follows at once that the charge in the condenser will remain there, and the grid will remain at −2 volts indefinitely (unless the insulation is bad). In the diagram the line BB' indicates the instant at which K_1 is changed over from Y to X, the graph indicating that after this instant the grid voltage remains steady at −2 volts. In consequence, the plate current will now be reduced to 0.25 mA and will remain at this value.

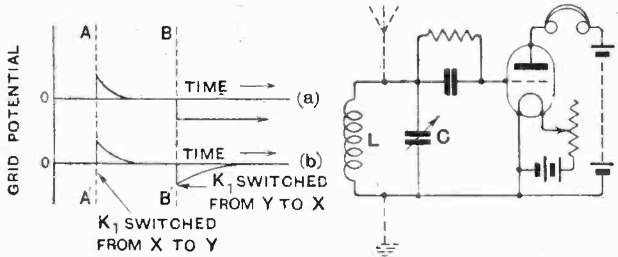


Fig. 3.—Variation of grid potential in the circuit in Fig. 2. (a) without grid leak, and (b) with grid leak.
Fig. 4.—Typical detector valve circuit employing grid rectification.

The above indicates the principle upon which the high-frequency oscillations are rectified; when an oscillating voltage of constant amplitude is applied to the grid through a condenser the rapid reversals of the voltage are equivalent to vibrating the arm of switch K_1 rapidly backwards and forwards between the contacts X and Y. But in the reception of telephony the amplitude of the oscillations to be rectified is varying all the time according to the wave shapes representing the sounds, and to reproduce these low-frequency variations in the plate circuit it is necessary that the mean grid potential shall vary in accordance with the amplitude of the oscillations.

Function of the Grid Leak.

In the arrangement considered above we have seen that the charge accumulated in the grid condenser cannot escape, and therefore the low-frequency variations would not be reproduced at all. So a high resistance must be connected between the grid and filament to provide a path for the condenser charge to leak away as soon as the applied oscillations cease. This is introduced in the circuit of Fig. 2 by closing the switch K_2.

If now the same experiment is repeated, as described above for the circuit without the grid leak, it will be found that as soon as K_1 is switched back from Y to X the charge on the condenser will commence to leak away through the grid leak resistance, and the voltage of the grid will again become zero. The series of values of voltage passed through by the grid in switching from X to Y and back again to X is shown at (b) in Fig. 3.

Under actual conditions of rectification for telephony the accumulation and dissipation of the charge in the grid condenser has to be effected very rapidly in order that the mean grid potential shall follow the contour of the amplitude of the H.F. oscillations, and therefore the capacity of the grid condenser has to be quite small, depending to a certain extent on the wavelength of the oscillations received. Usual values of capacity range from 0.0002 to 0.0003 mfd. Also the resistance of the grid leak must be of high value or insufficient charge would be accumulated in the condenser during application of an oscillation. On the other hand, the leak resistance must not be too high or the charge will not leak away rapidly enough when the oscillations decrease in amplitude and the signals will be badly distorted.

Rectification of Modulated Waves.

When the oscillations to be rectified are obtained from a tuned circuit, such as that denoted by L C in Fig. 4, it is usual to connect the "grid leak" directly across the grid condenser as shown. Suppose that a high-frequency oscillation of gradually increasing and decreasing amplitude is produced across the tuned circuit L C, then the actual variations of grid voltage will be somewhat like those shown at A in Fig. 5. It will be noted that as the amplitude is increased the *mean value* of the grid voltage falls, so that the positive peaks of the oscillations extend only just beyond the zero line. During these short intervals, when the grid voltage becomes positive, grid current flows, and it is this current which lowers the mean value of the grid voltage. Owing to the presence of the grid leak, the positive peaks extend further to the right of the zero line than they would do if no leak were provided. It is also due to the presence of the grid leak that the mean potential of the grid rises again as the amplitude of the oscillation is decreased. The corresponding variations of plate current are shown at B, and it should be noted that the mean value of the plate current is *decreased* as the amplitude of the oscillations is increased.

To get true reproduction the change in the plate current should be directly proportional to the change in the amplitude of the applied oscillations. That this is obtained over quite a limited range of amplitudes only is made clear by reference to the curves of Fig. 6, where, as in the case of anode rectification, the mean plate current is plotted against the amplitude of the applied oscillations. The readings were taken with the aid of the potential divider described in the previous instalment and for the same valve. As the test frequency was only 50 cycles per second it was found that the grid condenser should have a capacity of at least 0.05 mfd.,

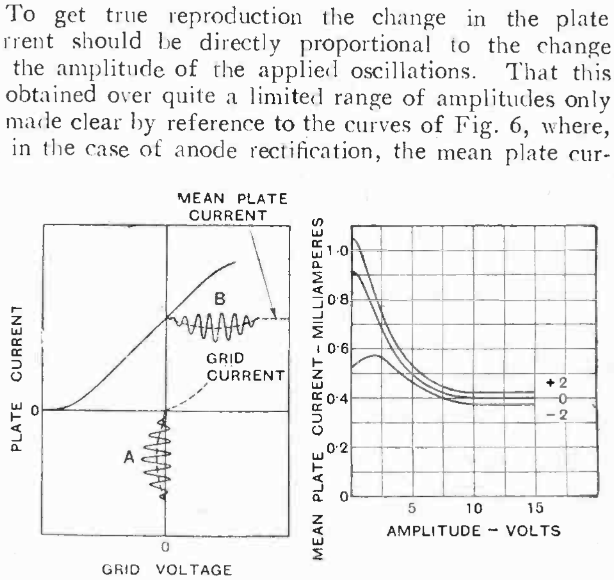


Fig. 5.—Diagram illustrating the rectification of modulated waves.
Fig. 6.—Curves showing relation between oscillation amplitude and mean plate current for different values of grid bias.

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larger values making no perceptible difference. Each curve corresponds to a definite value of steady voltage applied by means of a grid battery, not on to the grid itself, but on to the opposite end of the leak resistance from that connected to the grid (see Fig. 4).

Correct Grid Bias.

The top curve and the middle curve of Fig. 6 were obtained with a grid bias of +2 and zero volts respectively, and it will be noted that both of these curves slope downwards right from the start, and thus for all amplitudes of applied oscillation the plate current is less than the normal value. The bottom curve, however, where the grid bias was −2 volts, slopes upwards at first, becomes horizontal when the amplied oscillation is about 2 volts, and then begins to slope downwards for higher amplitudes of voltage. The conclusion is that for grid rectification a *negative grid bias should never be used*, the best results usually being obtained when the grid bias is slightly positive. The hump in the lower curve is due to the fact that no grid current can flow until the applied oscillation has reached at least 2 volts, and thus up to this point no grid rectification will occur; also the negative bias causes the valve to operate at the lower bend in the anode characteristic curve and anode rectification occurs, accounting for the initial upward slope of the curve. At the middle of the hump, where the curve is horizontal, the grid rectification is exactly neutralised by the anode rectification, and at this point the valve fails to act as a detector.

For telephony, where modulated high-frequency waves are employed, the reproduction will only be true if the amplitude varies over a range represented by the straight portion of the A.C. characteristic. The two upper curves of Fig. 6 are nearly straight over a limited range only, namely, from about 0.5 volt to about 3 volts. For signal amplitudes above about 5 volts operation occurs round the bend in the curve, and considerable distortion of the signals will result.

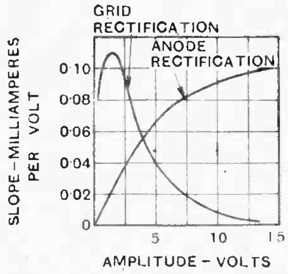
The steeper the curve over the operating portion the more efficient will be the rectification, and it is important to note that the straight part of each curve is the steepest part. For grid rectification, then, the valve is more efficient on moderate signals than on strong ones, and since there is practically no bend at the upper ends of the curves, the extent to which the carrier wave is modulated is not of great importance.

Time Lag.

If an oscillation of constant amplitude is suddenly applied to the grid, through the grid condenser, the resulting charge collected by the condenser can only be accumulated gradually because a charge in a condenser represents a certain amount of stored energy, and similarly when the oscillation is suddenly cut off the charge cannot leak away instantaneously. This means that a certain amount of *time lag* is inherent in the leaky grid-condenser method of rectification, and precautions must be taken to make this time lag as small as possible. The smaller the capacity of the grid condenser the shorter will be the time lag, in direct proportion, but the capacity must not be too low or its reactance will be so high that the oscillating voltage will not be efficiently passed on to the grid of the valve, and the strength of the received signals will be diminished. The grid condenser should have a capacity of not less than about 0.0002 mfd.

The presence of time lag in a circuit of this sort introduces a certain amount of distortion of the signals by rounding off all the sharp corners and peaks in the low-frequency wave. This is one of the disadvantages of grid rectification, compared with simple anode rectification or crystal rectification.

The popularity of the leaky grid-condenser method of rectification is due to the fact that, compared with anode rectification, it is very much more sensitive on weak signals. The efficiency of the valve as a rectifier in each



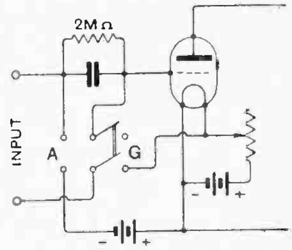


Fig. 7.—Curves showing relative efficiency of grid and anode rectification.
Fig. 8 —Switching from anode to grid rectification.

case is represented by the *slope* of the corresponding A.C. characteristic, for a given amplitude of oscillation. From the A.C. characteristic curves, given above for grid rectification (middle curve, Fig. 6), and in the previous instalment for anode rectification (top curve, Fig. 4), the slopes in milliamperes per volt have been found for various amplitudes of applied oscillation and plotted as curves in Fig. 7.

Comparative Efficiency of Grid and Anode Rectification.

These two curves give a direct comparison of the rectification efficiencies of the two methods for various signal strengths for modulated waves. It will be noted that for grid rectification the valve acts most efficiently for signal strengths or amplitudes of oscillation ranging from about 0.5 to nearly 4 volts, and that for amplitudes above 4 volts the efficiency as a rectifier falls off very rapidly. On the other hand, for anode rectification the efficiency increases continuously as the signal strength is raised, and the valve does not become really efficient as a rectifier until the amplitude of the applied oscillations has reached at least 4 volts.

From the foregoing it is clear that for receiving weak signals or for circuits where no high-frequency amplification is employed before the detector valve (unless the receiver happens to be very close to the transmitting station) the grid method of rectification is the more suitable, whereas for strong signals or where considerable H.F. amplification is used, the anode method of rectification will give better results. In both methods the truest reproduction will be obtained at those amplitudes where the efficiency is greatest, because the steepest part of each A.C. characteristic occurs where it is straightest.

Since it is very often required to operate a valve detector over a wide range of signal strengths, it will be found

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a great advantage to be able to use either method at will according to the strength of the signals being received. This is quite easily effected by providing a switch for short-circuiting the grid condenser and leak when anode rectification is required, but if this is done means must be provided for introducing the necessary negative grid bias when changing over to anode rectification. A suitable switching arrangement is shown in Fig. 8, where a double-pole two-way switch is employed.

Where the tuned anode method of high-frequency amplification is employed before the detector, there is no choice but to use grid rectification if condenser coupling is used. The only alternative is to use direct coupling by means of an extra high-tension battery, this battery being connected in place of the grid condenser, with its negative pole to the grid of the detector valve and its positive pole to the plate of the preceding valve. The voltage of this battery is very critical, and must be just sufficient to give the grid of the detector the necessary mean potential to effect efficient rectification. For this reason the method is not recommended.

"GOODS ON APPROVAL."

Accepting Apparatus for Trial.

By H. A. SHARMAN.

THE law on the subject of goods sent on approval or on sale or return is one which becomes of increasing importance every day. Many manufacturers and dealers definitely state that they are willing to send their goods to a customer "on approval," and nearly all would do so if a customer specially asked for this consideration. Extra parts, accessories, gadgets, and often complete sets will be sent on trial; sometimes no specified period is mentioned for their return, and sometimes the customer is asked to send them back in four or six days or within some definite date. Must the purchaser (or intending purchaser) pay for these goods if during that period they are destroyed by accident, if, for example, a fire breaks out and the goods are burned, and who will have to suffer if they are stolen through no fault on the part of the intending buyer?

Paying the Price.

In the first place, where the article is sent on sale or return, and a definite period is stated, beyond which it cannot be retained by the prospective buyer, if in fact he does keep it for a longer time without any explanation of his conduct, he will be considered to have accepted the article, and cannot compel the seller to take it back—at any rate, on the grounds that he was holding it on a condition of sale or return—and if it is lost before he has been able to put it to any use, he will have to pay the price just the same.

Should no specified time be stated within which the article is to be returned, then, in the first place, the buyer will be deemed to have accepted the article after the expiration of a reasonable time from the date he received it. And what is a "reasonable time" is a question of fact, to be decided according to the circumstances in each case. And if, after the expiration of such "reasonable time," the buyer thinks he does not want the article sent, he cannot compel the seller to take it back, nor excuse himself from the obligation of paying for it if it is destroyed or lost.

In both cases, of course, the buyer takes on the risk and the liability to keep the goods as soon as he signifies his approval or acceptance of them to the seller, and once a contract has been accepted it cannot be revoked by either party.

Not only does a buyer accept goods sent on approval when he actually writes a letter to the seller stating that he wishes to keep the goods, or keeps them longer than the agreed period or for an unreasonable time, but acceptance is also deemed to have taken place when the prospective buyer does some act "adopting the transaction." What an act adopting the transaction is is again a question of fact, to be decided in each case, but a prospective buyer may usually "test" the article he is buying, and trying to discover its fitness for the purpose to which he wishes to put it, without saddling himself with the obligation of buying it, should it not prove suitable for that purpose. On the other hand, he may not generally use it on a certain occasion, and then, having got what he wanted from it, return the article to the seller as unsuitable.

The buyer is, of course, liable to the seller if he damages or loses the article sent on approval, through his own fault or omission, even though this occurs before the time for rejection is up, and before he has clinched the contract.

"Unordered" Goods.

The delivery of "unordered" goods is a subject which is much akin to that of the delivery of goods on approval, and one which is the cause of much inconvenience and annoyance to the receiver. If the article is one which can be sent by post, send it back unstamped, and probably the sender will not worry you again, and he has no legal remedy against you for doing this. If the article is too large for the post, send it back by carrier "carriage forward," and the carrier will not deliver till he gets paid, and the sender will usually pay. If you feel more than annoyed with one of these gentlemen, just send him an unstamped postcard, and ask him to collect his unwanted goods; he will in all probability send you a most polite letter and a postal order for their return, and something for the trouble of sending them. Most of these rogues have a fair idea of what the law on the subject is!

Broadcast Brevities

Savoy Hill Topicalities: By Our Special Correspondent.

Station 2BL.

A prominent Australian sporting authority is in England just now on leave from Sydney Grammar School, where he is sports manager. He is Mr. H. Marks, and he has an intimate knowledge of broadcasting "down under": for Mr. Marks is to Station 2BL what the ordinary sports reporter is to a newspaper.

oooo

How Broadcasting Helps the Press.

Mr. Marks carries round a microphone when he is at home and broadcasts descriptions of most of the sporting events. "I just watch a contest," he told me, "and when anything exciting or worth while takes place, I get through to the station director on the telephone and advise him. He tells me whether he can fit in a broadcast with the programme and for how long I may speak. Generally, the period of my broadcast is ten minutes; but this will be extended to half-an-hour if the occasion is sufficiently important; and then I am switched off for a time. We find that these descriptive broadcasts help the newspapers, as listeners rush out to get a complete report as soon as I have finished my show."

oooo

Seaside Programmes.

I do not think that a great deal of harm will be done by the organising of complete evening programmes from seaside resorts, similar to that recently put on by Brighton. Nor is the act of Sir Cooper Rawson, Brighton's M.P., in drawing attention to the attractions of the famous watering-place, likely to be widely construed as an unjustifiable use of the microphone for boosting one holiday resort at the expense of others.

oooo

No Favouritism.

If the authorities of any seaside town go to the B.B.C. and offer to provide an evening's entertainment, the company look at the thing first from the point of view of the entertainment value and next from the angle of helping forward the popularity of British holiday resorts. No arbitrary rule is drawn against particular resorts, and programmes from any of them are accepted entirely on their merits.

Advertising Clause Does Not Apply.

As regards the charge that Brighton was unduly advertised, the clause in the B.B.C. licence prohibiting advertisement does not seem to apply. It says that the company must have the consent of the Postmaster-General in writing before receiving money "or other valuable consideration" in respect of the transmission of messages; but matter provided gratuitously may be broadcast with or without an acknowledgment. No one would suppose that even the Postmaster-General could raise objection to one amusing statement broadcast the other night to the effect that there is more sea at Brighton than anywhere else.

A DIVING BROADCAST. Mr. Frank Shields, the veteran diver, who broadcast a talk from the bed of the Thames at Westminster last week. The microphone, stated to be the smallest ever used, was installed inside the diving helmet.

oooo

Gee-Gee to Broadcast.

Mr. George Grossmith, one of the stars of musical comedy and who has been doing useful work for the B.B.C. as programme adviser, is to appear before the microphone on July 19th, when he will read several humorous poems.

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Westminster Abbey.

The first broadcast of evensong from Westminster Abbey, which was fixed for July 22nd, has had unfortunately to be postponed. It is hoped that a commencing date will be arranged in the near future.

oooo

Sir Harry Lauder's Broadcasts.

During the five months' period covered by his series of broadcasts, Sir Harry Lauder did not fulfill many music-hall engagements; but now that he has completed his appearances before the microphone, for the time being at any rate, he is starting on a tour of the provinces. This clearly shows that his music-hall contracts have not been prejudiced by broadcasting.

oooo

Defying His Contract.

By the way, matters are coming to a head as between the broadcasting and variety stage interests. At the time of writing, one of the most prominent artists is negotiating an engagement with the B.B.C., in spite of the barring clause inserted in typewriting in his printed contract. The point at issue is only one of terms, and apparently the prohibitory clause is ignored.

oooo

A Contract Shortened.

At the same time I hear it announced that two well-known artists in syncopation have had a week knocked off their music-hall contract because they recently broadcast.

oooo

Which Pronunciation is Correct?

The cultured tones of the 2LO announcers, their use of the long "ah" in such words as "task," their omission of the "t" in "often" and the other evidences that their speech contains of favouring the Southern forms of pronunciation, are not altogether liked in the Midlands and the North. Questions frequently arise whether the announcer ought to use the technical pronunciation, the form to be found in the best dictionaries, or the form adopted locally.

A Committee to Discuss the Question.

In order to evolve a definite style in the spoken (broadcast) word, a Committee, which includes Mr. Robert Bridges, the Poet Laureate, and Sir Johnston Forbes Robertson, has been meeting at Savoy Hill since the beginning of this month, and lists of doubtful words have been considered by them. Their decisions will in due course be circulated to all stations of the B.B.C. and adopted by the announcers. In many cases the Committee's recommendations may raise arguable points; in the matter of the English language that is inevitable; but at any rate the uniformity to be adopted will prevent confusion.

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"The Passing of Talma."

It has been stated that "The Passing of Talma," a dramatic picture of the death of the great French actor who was the intimate of Danton, Desmoulins and other famous Revolutionary figures, was written by Mr. Henry Ainley. That is not the case; but Mr. Ainley will take the part of Talma when the play is broadcast on July 27. Others in the cast will be Howard Rose and Clare Harris.

oooo

A Jazz v. Classical Music Debate.

If the proposed wireless debate between Sir Landon Ronald, supported by the Wireless Orchestra, and Mr. Jack Hylton with his band, should take place on July 20 (although at present it is nothing more than a mere suggestion), it should give listeners a good deal for consideration. These two musicians, each of whom is prominent in his own sphere, might discuss the merits of jazz as against classical music and give illustrations in support of their arguments.

oooo

A Pious Hope.

But it is to be hoped that this debate would not resolve itself into merely blatant propaganda for modern syncopation, which the recent demonstration by the Savoy Bands struck one as being. How listeners must have sighed for some of the old-time waltzes and other tuneful rhythms instead of the few indifferent polkas and mazurkas which were presumably meant to be a guide to the dances of two or three decades ago.

oooo

Two New Indian Stations.

I met at Savoy Hill the other day an eminent Parsee financier who has been in this country for some time inquiring into the British system of broadcasting. He told me that two new stations are to be erected in the Dependency, one at Bombay and the other at Calcutta. They will be 12 k.W. stations, and the capital provided for their construction, amounting to 15 lakhs of rupees, will be held exclusively by Indians.

oooo

222 Languages.

The great difficulty that confronts the Indian broadcasting interests is that of dialect. In that country, more than anywhere else, there is the need of a common broadcasting language if the service is to become universal. It will be something of a problem to boil down 222 vernacular languages into one tongue, such as Esperanto or Ido, or even English.

oooo

Breakdown Figures.

Breakdowns—ominous word!—at the transmitting stations might be assumed, from a more or less superficial examination of one's memory, to have risen to rather awesome proportions, in view of the bad luck that has attended 2LO in recent times. But the figures for the whole of the B.B.C. stations during the first six months of this year do not make a bad showing when compared with the 1925 figures. The total percentage breakdowns per week were 2.23 in 1926 and 2.50 last year.

oooo

Higher Percentage at 2LO.

London's weekly percentage was unfortunately far higher this year than last, i.e., .44 as against .08. Bournemouth has helped to restore the balance by presenting a clean bill of health for the past six months, where as last year the percentage breakdowns per week at that station were .24. Manchester had the comparatively good record of .08 per week for 1926 as against .29 for 1925. Daventry's weekly percentage for last year was .56 and for the first six months of this year only .04. But even the most careful and systematic scrapping of obsolescent plant would not guarantee immunity from breakdowns, which are often due to causes over which the wireless engineer has no control.

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Shakespeare's Heroines.

The last of the Shakespeare Heroines Series (No. 12) will be broadcast on July 18, when Miss Gertrude Elliott (Lady Forbes Robertson) will appear before the microphone as Katharine of Aragon, from "Henry VIII."

oooo

Mr. Laurence Anderson.

Laurence Anderson and the "Roosters" will broadcast an entertainment entitled, "The Vicar at the Jumble Sale" on July 22. Mr. Laurence Anderson is well-known as a raconteur on the halls and over the microphone.

oooo

A Popular Play.

"Five Birds in a Cage," one of Miss Gertrude Jennings' popular and amusing one-act plays, will be presented by Mr. R. E. Jeffrey on July 23.

oooo

In a Prison.

A revue, "No Option," a light-hearted and amusing sketch written by Weston Drury, with popular numbers interpolated, will be broadcast on July 24. The scene is supposed to take place in a prison, and the cast will include Tommy Handley, Eddie Reed, Theo. Charlton, Robert Kepple, Ena Grossmith, and Miriam Ferris.

FUTURE FEATURES.

July 18th.

LONDON.—Shakespeare's Heroines: Katharine of Aragon—Gertrude Elliott. Light Orchestral Concert.
ABERDEEN.—Recital of Psalm Tunes—Precentors' Choir.
BIRMINGHAM. — Symphony Programme.
GLASGOW.—Band of 1st Bn. H.M. Cameronians relayed from Kelvingrove Park.
MANCHESTER.—Songs and Chamber Music.

July 19th.

LONDON. — Chamber Music and Variety.
BIRMINGHAM.—Musical Comedy.
BOURNEMOUTH. — Popular Light Music and Ballads.
BELFAST.—Two plays.
CARDIFF.—"The Merrymakers" in Melody, Mirth and Madness.
NEWCASTLE.—"The Novos" in a Sketch introducing Favourite Old Songs.

July 20th.

LONDON.—Popular Orchestral Concert.
CARDIFF.—"A Day's Coaching."
MANCHESTER. — Band Music and Quartet Songs.

July 21st.

LONDON.—"The Pier Revels of 1926," relayed from Pier Music Pavilion, Eastbourne.
ABERDEEN.—An Hour of Burns.
BIRMINGHAM.—Music and Comedy.
BELFAST.—Ballad Concert.
MANCHESTER. — Australian Bush Songs.
NEWCASTLE. — Vocal Duets and Solos.

July 22nd.

LONDON.—The Vicar at the Jumble Sale.
ABERDEEN.—Operatic programme.
CARDIFF.—Old and New Music.
GLASGOW.—Variety.
MANCHESTER.—Variety.

July 23rd.

LONDON.—"Five Birds in a Cage"—A Comedy.
ABERDEEN.—Mirth and Melody.
BIRMINGHAM.—Light Classics.
BOURNEMOUTH.—Operatic Night.
GLASGOW.—The City of Glasgow Police Military Band.
NEWCASTLE.—Songs and Entertainment.

July 24th.

LONDON.—"No Option"—a Revue.
BOURNEMOUTH. — A Merry-Go-Round.
BELFAST. — Popular Songs and Duets.
GLASGOW.—Mirth and Melody.
MANCHESTER. — Request Programme.

PIEZO-ELECTRIC WAVEMETERS.

A Development of the Visual Method of Giebe and Scheibe.

ON the basis of the work of Messrs. Giebe and Scheibe,[1] technical apparatus has now been constructed permitting the measurement in a simple manner of the frequencies of short-wave electric oscillations.

A small quartz crystal, about 5 mm. in length and 2 × 3 mm. in cross-section, is used in the manner shown in Fig. 2. The wire A, which supports the crystal, acts as one electrode, whilst the slender wire B, which is brought to within a short distance of the crystal, serves as a second electrode. The whole is inserted in a mixture of helium and neon, at low pressure, and Fig. 1 depicts such a quartz resonator complete.

If, now, the ends of the tube shown in Fig. 1 be connected with a coil, and the latter coupled with a transmitter, the quartz crystal begins to light up if the frequency of the transmitter coincides with the natural frequency of the crystal. The light of the gas discharge is clearly visible, since, according to the strength of the coupling, it permeates a greater or lesser volume of the glass bulb. The tuning is extraordinarily sharp, so that it is usually difficult to find the resonance position of the quartz crystal if the wavelength of the transmitter is not altered very slowly. With such a quartz crystal it is easily possible to determine wavelengths within the broadcasting range with a precision of 0.05 per cent.

Fig. 1.—Quartz resonator unit.

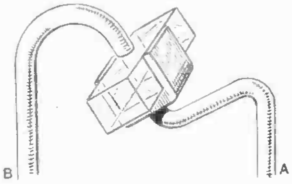

Fig. 2.—Method of mounting the quartz crystal. There is a small gap between the surface of the crystal and the electrode B.

The potential which is applied to the quartz for this purpose must be at least 30 volts. With a higher potential the luminous phenomenon is, of course, stronger, but the tuning becomes somewhat less sharp, and it may easily happen that the quartz becomes mechanically overloaded and that its wavelength suddenly alters considerably. For this reason precautions are taken so that an

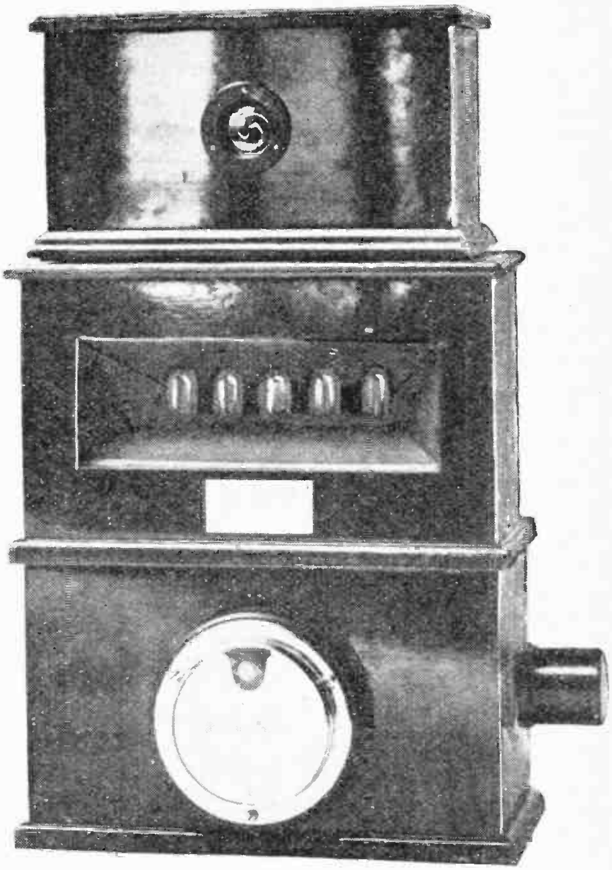

Fig. 3.—Complete frequency meter with five resonator units. The upper compartment contains the neon lamp for coarse tuning.

overload of the quartz crystal above 120 volts cannot take place in practice. This is effected by connecting a neon tube in parallel with the tube containing the piezo-electric quartz. By this method two important advantages are secured. In the first place, the quartz cannot be overloaded, as the neon lamp prevents the potential on the quartz from ever being higher than about 120 volts. On the other hand, the advantage is secured that the neon lamp can be used first of all to tune the transmitter coarsely to the desired wavelength. For this purpose the coupling coil, which is in parallel with the quartz tube, is provided with a fixed condenser, by which the coil is tuned approximately to the desired wavelength. The whole is coupled sufficiently tightly with the transmitter so that at resonance the neon lamp lights up. Then the coupling is made gradually looser and the transmitter is now tuned so finely that the quartz becomes luminous, whilst if the coupling is sufficiently loose the lighting of the neon lamp ceases entirely.

The whole device has been devised entirely so that the wavelengths of broadcast and other wireless transmitters may be kept as precisely as possible in accordance with the wavelengths allotted to them. For this reason the apparatus must be reliable, not only for tuning a trans-

[1] *The Wireless World*, Dec. 23rd, 1925.

Piezo-Electric Wavemeters.—
mitter to a definite wavelength, but it must also be possible to determine during working whether the wavelength has altered a little for any reason, and in which direction such an alteration has taken place. To do this, three, or, still better, five, quartz tubes of closely contiguous wavelength are coupled in parallel with the measuring circuit. Under normal conditions the middle tube should light up. If an alteration of the wavelength occurs, the middle tube is extinguished, and in its place one of the side tubes lights up, as long as the alteration of the wavelength is not too great. One can therefore recognise at once in which direction the wavelength must be adjusted. The whole apparatus, which is reminiscent of a frequency meter for low-frequency alternating current, is represented in Fig. 3. The middle box contains the five quartz tubes, whilst the uppermost box contains the neon lamp, which serves to protect the quartz tubes and to indicate approximate resonance. The five quartz tubes can be constructed so precisely that within the range of the 500-metre wavelength they are within 1 metre of each other. It is therefore possible by means of the new apparatus to keep the wavelength of a transmitter constant with a precision greatly exceeding that which is at present necessary. The frequency meter is manufactured by Messrs. Loewe-Radio, of Berlin. H. K.

TRANSMITTERS' NOTES AND QUERIES

Three-cornered Two-way Working.

An interesting interchange of messages between amateurs in three continents took place on Monday, June 28th. Mr. F. A. Mayer (G 2LZ), of Wickford, Essex, was in communication with Mr. H. H. Cooley (U 1AAO), Newton Centre, Mass., at about 5 a.m. G.M.T. when the latter suggested calling up Z 4AM, Mr. W. McGill, of Palmerston, New Zealand, with whom both G 2LZ and U 1AAO had previously been in communication. The experiment proved eminently successful. The American station called up the New Zealander, who at once got into touch with Mr. Mayer, and U 1AAO was able to listen to both stations. He then communicated with 2LZ and again with New Zealand, and it was mutually arranged that similar tests should be carried out next day.

We understand that they have been in similar three-way communication every day since, thus demonstrating that this transmission was not a "freak." The intercommunication was in Morse, but Mr. Mayer informs us that he is now attempting telephony.

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Three-letter Call-signs.

We understand that the three-letter call-signs (e.g., 2AHR) are allotted by the Postmaster-General to stations licensed for "Artificial Aerial" only. If the owner of one of these stations subsequently obtains a full transmitting licence he is given a new two-letter call-sign and informed at the time that full radiating facilities are granted to him and that he must not again use the three-letter call-signal.

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Misuse of Call-signs.

We receive frequent letters from correspondents complaining of the misuse of their call-signs by unauthorised transmitters. We have from time to time published notes on this subject, in the hope that they might induce the malefactors to stop their unsportsmanlike practices and "play the game," but this publicity appears to encourage others to follow their bad example, and, we believe, only hampers the R.S.G.B. and the G.P.O. in their efforts to trace these "pirates." We would therefore recommend all transmitters who have reason to believe that their call-signs are being used by unauthorised persons to communicate either with their local wireless society or the Secretary of the R.S.G.B., who will afford them every assistance in tracking down the culprit.

I 1RG. The experimental transmitting station of "Il Radiogiornale" in Milan, well known as one of the leading amateur stations in Italy.

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Working with Australia.

An Australian correspondent states that the best time for two-way working is between 6 p.m. and 9 p.m. G.M.T., or from 5.30 a.m. to 8 a.m. G.M.T. on 30 to 35 and 40 to 50 metre wavebands. Between 35 and 42 metres signals are likely to be lost among those from U.S.A. and local stations.

oooo

A Portable Station.

Mr. F. Livingston Hogg, 37, Bishops Road, Highgate, N.6, will be working a series of tests with his portable station, G 5VG, for a few days, commencing on July 24th. Transmission will be on 5, 8, and 44 to 46 metres, and detailed reports will be welcome. In these tests Mr. Hogg will have the assistance of G 2VW.

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New Call-signs and Stations Identified.

G 2AK (Ex 2AXO.) C. H. Young, Jnr., 52, Maidstone Rd., Handsworth, Birmingham, transmits on 45 and 150–200 metres.
G 2EDZ (Art. A.) D. Ll. Jones, 9, Clifton Terr., Llandyssul, Cardiganshire.
G 2BZC (Art. A.) M. W. Pilpel, 39, Tottenham Court Rd., W.1.
G 2RR M. Richardson, 39, Bell St., Wolverhampton, transmits on 150–200 metres.
G 6CP (Ex 2BIK, Rickmansworth.) C. L. Champion, Alvescot, Crestway, Roehampton, S.W.1, transmits on 8, 23, 45 and 90 metres.
G 6ON C. H Warrington, 47, Third Avenue, Queen's Park, W.10. Transmits on 150–200 metres.
G 6QT J. R. Brown, 93, Railway St., Hebburn-on-Tyne, transmits on 45 metres.
G 6TA C. D. Abbott, 120, Cavendish Road, Balham, S.W.12.
G 6XF (Ex 2BDF.) C. Powell, 33, Bridge St., Toll End, Tipton, transmits on 150–200 metres.
LA 1X (Ex LA 4X.) J. O. Berven, Uelandsgt. 14, Stavanger, Norway, transmits on 42–43 metres pure D.C. and on 33 metres grid Rect. A.C. usually in Morse, but occasionally by telephony.
Z 3AK (Ex 4AL.) A. H. M. Grubb, 205, Wai-iti Road, Timaru, New Zealand.

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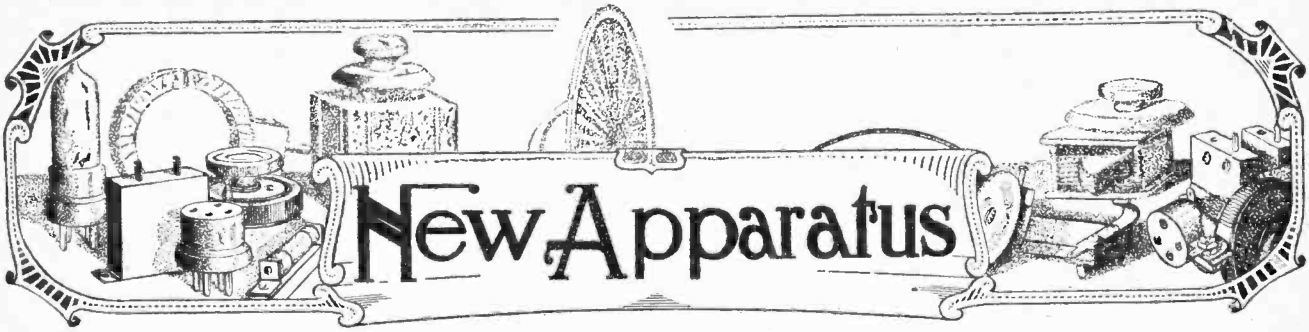
QRA'S Wanted.

G 2LW, G 2QX, G 5CZ, G 5LX, G 5RS, G 6IW, G 6NR, D 7XF, FBVY, L 1AG, NIHE, NIJD, NONAA, PE 6SK, U 4MV, U 8CWA, U 9HAN.



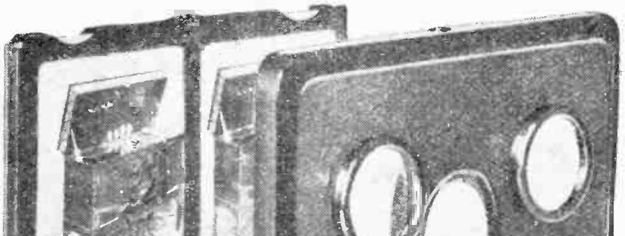
New Apparatus

A Review of the Latest Products of the Manufacturers.

NOVEL ADVERTISING.

The merit of a wireless receiver cannot be judged, as a rule, merely by the lay-out of the component parts, and the real value of a set is dependent essentially upon the detailed construction and finish. An illustration of a receiver such as generally appears in a manufacturer's list conveys very little knowledge as to the appearance of the actual set, and it is probably more important in the case of wireless sets than almost any other article, that the prospective purchaser should have a true idea of the make up and finish of the apparatus.

An interesting device is made use of by the Oxford Wireless Telephony Co., Ltd., 22-29, Queen Street, Oxford, to assist purchasers in obtaining a true idea of the appearance of the "Oxford" receiving sets. A metal-framed "Camerascope" is supplied, together with a stereoscopic set of photographs. When these are viewed through the magnifying lenses the instrument appears in remarkably good definition and stands out in bold relief, producing a very realistic effect. The minutest detail can be readily observed, even to such small parts as the heads of the screws used for holding the panel to the cabinet, while the attractive appearance given to the sets by the highly polished ebonite and cabinet work is at once appreciated, a feature that would be entirely lost by any of the ordinary methods of illustration.



Something new in wireless advertising. The use of a stereoscope for conveying in a realistic way the actual appearance of receiving equipments.

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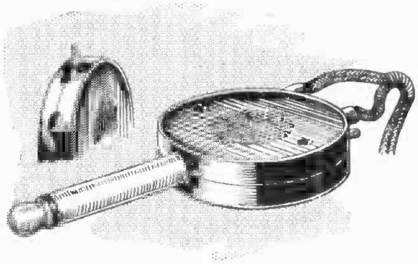
WESTON PLUG.

It is probably due to the inconvenience of attaching telephone leads to plug connectors that the plug and jack form of connection is not more generally adopted.



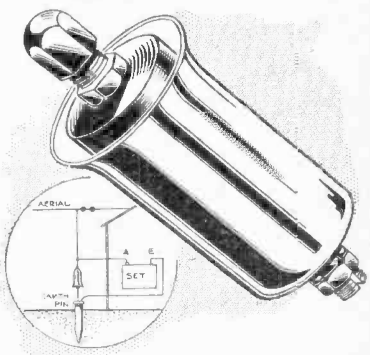
Telephone tags are securely held in the Weston plug without the need for dismantling the insulating piece. The tags are released by depressing a pair of spring catches.

The Weston Electric Instrument Co., Ltd., 15, Gt. Saffron Hill, London, E.C.1, however, manufacture a useful form of plug which is made to engage upon telephone tags merely by depressing a pair of clips. A very firm grip is obtained, ensuring good electrical contact. The plug itself is well machined, while the body part, which is circular, is of cleanly-moulded Bakelite. The particular merit of this plug is the ease with which the telephone tags are attached without the need for dismantling.

NEW FORM OF LIGHTNING ARRESTER.

Messrs. S. A. Lamplugh, Ltd., King's Road, Tyseley, Birmingham, have recently introduced a new form of lightning arrester of a type which is capable of replacing the more usual aerial earthing switch.

It consists of a nickel-plated bell of spun brass, which serves as a hood for protecting the ebonite interior from moisture and the action of the atmosphere. Inside is to be found a pair of sparking points, which form a short low resistance path to earth when the arrester is between the lead-in wire and the earth connection. At first sight one is inclined to regard this new lightning arrester as a rather superfluous device of little interest, and it is not until one takes the trouble to completely dismantle it that the amount of care taken in its design and manufacture is realised.



The Lamplugh lightning arrester is connected up out of doors, obviates the need for an aerial earthing switch and can be relied upon not to create a leakage path between aerial and earth.

In the centre is an ebonite core fitted with tapped holes, into which pointed brass pieces are inserted from each end and adjusted to provide a very short sparking distance. An inspection hole in the side provides for obtaining the suitable adjustment. Over this is slipped a turned ebonite piece completely obscuring the inspection hole fitting close enough to prevent the intrusion of dirt and at the same time considerably increasing the leakage path. The metal exterior fits over the ebonite pieces, rendering the arrester perfectly watertight.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

INSULATION EFFICIENCY.

Sir,—With reference to Mr. A. W. Wilson's remarks in your issue of June 2nd, suggesting a new type of insulator, we should like to say, for the benefit of all interested, that Patent No. 222,217 taken out by us in 1923 describes an insulator almost exactly to Mr. Wilson's sketch.

It consists of a rod of high insulation and tensile strength, with a suitable means of attaching the aerial wire to each end, surrounded in the middle by moulded insulation forming two cups, one facing each end of the rod.

In this way at least one portion of insulation material separates the two connections, and in any case the surface leakage path is exceedingly long.

We are hoping to have this insulator on the market very shortly.

A. HAYWOOD,
Purley, Surrey. *p.p.* Hayward Bros.

DO TRANSMITTING STATIONS SUFFER FROM FATIGUE?

Sir,—I have just read your editorial in *The Wireless World* of June 9th on the subject of Rugby being "undecipherable for 24 hours" in Australia, and it struck me that perhaps you might be interested in the following observations. These observations are purely personal, and not biassed in any way by commercial or other considerations.

Whatever may have been the signal intensity of Rugby in various parts of the world when the station was first opened for test, it seems to be an undoubted fact that signals have since fallen off considerably. I was not at sea when the first tests were made, but operators who were in different parts of the world at the time have since told me that everywhere Rugby's signals completely drowned out any local interference on that wave. The same men now tell me that they often have the greatest difficulty in receiving Rugby in certain positions, owing to the much weaker signal being swamped by local jamming.

During the initial tests, I am told that in New York harbour Rugby could be heard with the phones on the table (receiver l-v-l) in spite of local jamming from Long Island (Radio Central). My own experience since returning to sea this spring is that Rugby's signals on the same receiver remain at about R4 to R5 all the way across the Atlantic—no stronger. Frequently interference on the European side from Bordeaux (LY), and others, makes reception very difficult, and sometimes impossible. On the American side Radio Central causes interference of a similarly serious nature.

These difficulties were overcome to a certain extent by adding a second stage of tuned H.F. amplification, but in order to receive Rugby with ease and comfort I found it desirable to cut out the L.F. stage and switch in after the detector a 2-stage note filter, peaking at 1,000 cycles.

It may be that Rugby has reduced his power since the original tests. I believe they can use up to 1,200 kW., but a friend of mine who visited the station a few weeks ago told me that at the time he was there they were only using 540 kW. This may be the explanation, but it is a curious thing, which I have never seen remarked upon before, that nearly every newly-built station (spark or C.W., any wavelength) I have had the opportunity of studying during the last 12 years has fallen off in range within a month or two of opening. Whether they all reduce power after initial tests, or whether there is something else back of it I cannot say. It is an interesting point upon which other observers might be able to shed some light.

There are only two possible variables in a transmitting station which cannot be closely checked up. One is the surface condition of the aerial wire, and the other is the earth connection and the condition of the surrounding soil.

As regards the former, I recently installed a new cadmium bronze aerial here, and when it was new I got 6 amps. radiation on C.W. A month later, by which time the aerial had acquired a good surface coating of verdigris, the radiation fell to 5.5 amps. I have pursued that lost ½ amp. most ruthlessly, and I cannot retrieve it. Changing valves, overhauling aerial insulators, etc., etc., all made no difference. The plate feed to the oscillator remains the same as it was when the aerial was new. I can distinguish no diminution of range as a result of this lost ½ amp., but it is perhaps conceivable that if a similar effect occurred at a high power station, some difference might be noticeable.

As regards the earth connection, ordinary soil is not accustomed to having umpteen kilowatts of current pumped steadily into it. After a few weeks of such treatment, what sort of electrolytic actions take place, and in what way does that soil become decomposed or altered in character in the immediate vicinity of the earth plates? Has anybody ever investigated that point?

When Daventry was first opened signals came in strong and absolutely free from fading, in the extreme north of Scotland, for about a month. Then gradually signal strength dropped off slightly, and quite bad fading put in an appearance. This condition of signals has persisted ever since. We have heard a lot lately about the interference effects between surface waves and space waves causing fading, with sundry references to the Heaviside layer, but I have not seen anyone state yet that the Heaviside layer takes a month or so to get going on a new station! Without going into individual details, stations on which I have observed the above-described effects, and which occur to me at the moment, are:—The old non-synchronous rotary spark station at Miami, Florida (WST), opened 1915; the present Ushant transmitter; Chatham, Mass. (WIM. 600 metres); Devizes (old transmitter); and Burnham (new GKU transmitter).

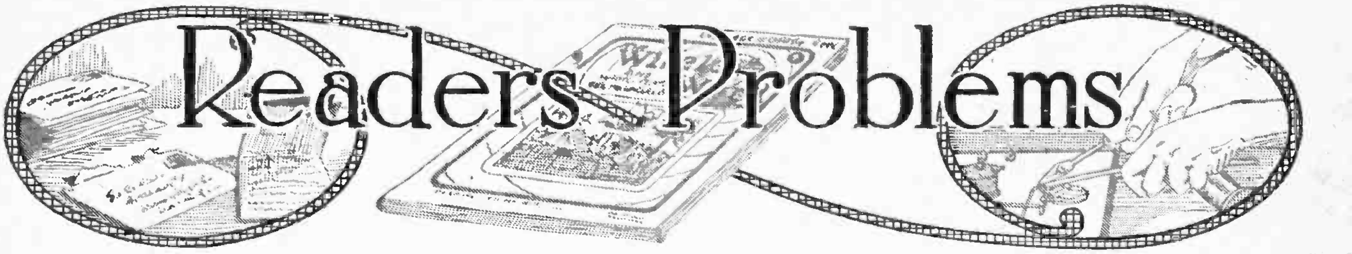
OBSERVER AT SEA.

WIRELESS FOG SIGNALS.

Unattended fog signals have been installed at Fort Matilda and Roseneath Beacon in the Firth of Clyde, which are started and stopped by means of a transmitting set installed at Gourock Pier, 1¼ miles from Roseneath Beacon. The essential features of the transmitter are a pendulum and mercury break, a spark coil, and quenched spark transmitter. In starting or stopping the gun the pendulum is allowed to swing freely, causing a small contact to dip into a mercury cup a predetermined number of times per minute.

The receiver comprises a two-valve unit for detecting and amplifying the incoming signals and a two-valve unit for operating a moving-coil relay which controls a local battery through balance wheels. The wireless apparatus was designed and supplied by the Marconi Company.

Readers' Problems



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Using a Separate Reaction Valve.

I have constantly seen it repeated in various publications that the greatest efficiency is obtained from a valve when it is called upon to perform only one function, and that in reflex receivers, wherein the valve is compelled to amplify at two frequencies simultaneously, a certain amount of efficiency has to be sacrificed. It occurs to me that in the ordinary regenerative receiver, the detector valve is performing the function of rectifier at the same time that it is feeding back part of its energy from plate to grid circuit to produce reaction effects. I was wondering whether it would be possible to obtain greater efficiency by dividing these two functions between two valves? G.R.I.

It is quite correct to state that when a valve is used to perform two functions simultaneously, a certain compromise is being effected between efficiency and filament current economy. Thus, in the case of the ordinary reflex circuit, it is well known that it is difficult to extract the last ounce of H.F. amplification out of the valve by the application of reaction, since before the full benefit of reaction is being obtained the receiver is apt to oscillate at low frequency, this phenomenon being indicated by a loud buzzing noise. It is, moreover, equally true to state that when a valve is being used for reaction purposes and also for rectification, it is in reality performing two functions simultaneously. It is quite easy to arrange a circuit in which a separate valve is used for providing reaction effects, but hitherto it has meant a prohibitive extravagance in filament current. Since there are now so many excellent and robust dull emitters on the market, it is no longer an extravagance to use an extra valve, and indeed the wattage of many of these valves is so low that an extra valve can be tolerated.

It is undoubted that by employing a circuit such as is illustrated in Fig. 1, a far smoother control over reaction is obtained than when the detector valve is called upon to shoulder this function in addition to its more legitimate one of rectification. In the circuit actually shown, a great opportunity is presented for employing one of the new valves with an amplification factor of thirty-five, such as the new Cosmos S.P.18/B (Blue Spot) valve, which consumes 0.09 amp. at 1.8 volts. The anode current is of course very small, but since the valve is not required to provide any reaction feed back, this is all to the good in considerably augmenting the life of our H.T. battery. This valve is specially suitable for anode rectification, which may be arranged for in accordance with the scheme outlined on page 390 of our March 10th issue. Of course, with this type of valve a much higher value of anode resistance would be required, and one of the new type of 1 megohm grid leaks could be used with advantage. This high resistance does not, however, mean an abnormally high value of H.T., as readers of the special article on page 395 of our issue of September 23rd, 1925, will be aware, and 100 volts is quite sufficient.

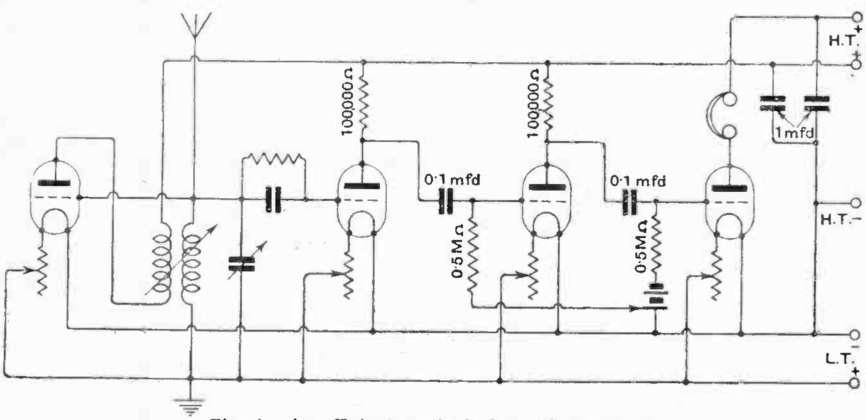


Fig. 1.—An efficient method of reaction control.

The system can equally well be employed with a transformer or a choke-coupled L.F. amplifier, or without any L.F. amplifier at all, the telephones being connected in the plate circuit of the valve in the ordinary manner. Similarly, of course, the system may be employed with an H.F. amplifier. It should be noted that the values of tuning and reaction coils are the same as normally.

This circuit should commend itself especially to the serious experimenter who is not averse to the use of an additional valve in the interests of extreme reaction efficiency.

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A Fuse Fallacy.

I have a four-valve receiver using two 0.06 ampere type valves for H.F. and detector, and an L.S.5 and an L.S.5A in the L.F. stages, using 300 volts H.T. and proper grid bias, the receiver being designed for outdoor demonstration purposes. In view of the expensive valves in use, I wish to incorporate some safety device in the circuit to protect the valve filaments in case the high and low tension wires inside the receiver accidentally came into contact. I have been told that if I remove the connection between H.T. — and L.T. — and replace it by a fuse designed to blow if the current exceeds 0.06 amp. I shall adequately safeguard all valve filaments. I wish to know, therefore, what gauge of fuse wire to use in order that it may blow at slightly over 0.06 amp. P. M. F.

It is, unfortunately, quite impossible to safeguard your valves in this way. If the fuse is made to blow at slightly over 0.06 amp, say at 0.07 amp., it will be found that the fuse will blow every time the receiver is switched on, because the combined normal plate current of the L.S.5 and L.S.5A, which of course will have to traverse this wire, is not very far short of 0.1 amp. when a plate potential of 300 volts is used with properly adjusted grid bias, as recommended by the makers. The plate current of the two 0.06 amp. valves must be added to this, although this will, of course, be small. It will be seen, therefore, that the normal plate current will suffice to blow the fuse. If the value of the fuse is raised so that it does not blow until a current of 0.1 amp. or a little over passes through it, it will be useless as a safeguard, since a current of 0.1 amp. would be more than sufficient to ruin the dull emitting properties of an 0.06 amp. valve. The plate current of the two power valves could, of course, be reduced by cutting down H.T. and G.B., but this would have the effect of cutting down the permissible grid swing on these two valves, and so greatly reduce the volume available for your outdoor demonstrations. It will be seen, therefore, that your project of using a fuse is impossible. A better method would be to use one of the many resistance units, such as the "Dubrescon," which are upon the market for this purpose. These instruments consist of a resistance of high enough value to prevent the damaging of even an 0.06 amp. valve in case of accidental contact between H.T. and L.T. leads inside the set, whilst at the same time they will easily accommodate the normal plate current of even the largest type of power valves. The resistance is shunted by a large capacity condenser for the purpose of by-passing all undulatory currents, and so no instability will be caused.

oooo

A Baffling Mystery.

I recently constructed a unit for taking H.T. from D.C. mains, my receiver being a detector and two L.F. valves, the final valve being an L.S.5. In each of the three H.T. + leads was connected a small 20 henry choke to eliminate mains hum. Unfortunately, however, the hum was still very prevalent. I was informed by a friend that he had succeeded in eliminating the hum by connecting two 20 henry chokes in series in each lead. I accordingly purchased three extra chokes of similar type, but found that hum was still bad. By careful eliminative tests I discovered that the whole of the trouble was due to the final stage of L.F. I obtained two more 20 henry chokes of the same type, and connected them in series with the other two already in the H.T. + lead of the final valve, but all to no purpose. Can you explain this extraordinary phenomenon? M. L. L.

Fortunately the cause of this phenomenon is not insoluble, and to understand matters it is first necessary to make it quite clear exactly how, by virtue of its inductance, a choke smooths out mains hum. The hum is caused, as you know, owing to the fact that the D.C. supply is not perfectly steady, the current rising and falling slightly in an irregular manner due to certain irregularities at the generating station. Now a steady current passing through the choke causes a steady unchanging magnetic field to associate itself with the choke. Now let us suppose that a ripple come along which tends to cause a slight momentary *increase* in the steady current. Immediately the current through the choke starts to rise, there is a back E.M.F. exerted by the choke due to its self-inductance which tends to retard this rise. Eventually of course, if the current kept on rising the electrical inertia of the choke would be overcome, but long before this happens the ripple passes and the current is no longer attempting to rise. Consequently, the actual momentary rise and fall of the current is small, much less than it would have been had there been no choke present. By increasing the inductance of the choke, or by inserting another choke in series, we can still further preserve the absolute steadiness of the current. If the ripple is such that it tends to momentarily *decrease* the steady value of the current, the effect is, of course, the same, the self-inductance of the choke tending to prevent any decrease of current.

It might be thought, therefore, that by connecting a large number of chokes in series, thus increasing the total self-inductance, we could "iron out" even the most terrible of ripples. Not so however, for we have another factor to contend with, namely, the saturation value of the choke.

Now you should know that the reason why a choke opposes any momentary increase or decrease of the current through it is because a rise or fall of current causes a corresponding increase or decrease in the density of the magnetic field associated with the choke, and this rise or fall of the magnetic field at once causes a back E.M.F. which is in each case in such a direction that it tends to oppose either the rise or the fall of the value of the current as the case may be. Now if the value of the steady current is large, the choke will probably be already magnetically saturated, which means that it is already as it were, carrying its full complement of magnetic lines of force, and therefore an increase in current cannot give rise to any further increase in the density of the magnetic field, although if it were only *just* saturated, a decrease in current will cause a decrease in the magnetic field. If however the steady current were so great that we were a long way beyond the saturation point, neither a small increase or a small decrease in the steady current would have much effect in changing the density of the magnetic field. The actual value of inductance necessary to smooth out the ripple of your mains, is not greater than 20 henries, because in the case of your first and second valves all is well. Now your first two valves are taking a comparatively small steady anode current, and your small 20 henry chokes are admirably suitable. Your final valve however, is an L.S.5 taking a very large anode current even if correctly biassed, and your chokes are probably hopelessly saturated, and no matter how many you connect in series, this will have no effect in reducing the saturation. It is necessary therefore, that you obtain a choke of 20 henries or thereabouts inductance of proper design, which will handle the comparatively large current of the L.S.5 valve, without becoming saturated. Now it might occur of course, that when testing your receiver on supply mains in another district where the commutator ripple is very much worse, that trouble in the matter of hum might occur in your first two valves, and in your final valve also once more. This would not indicate that the chokes associated with your first two valves had now become saturated, since of course your plate current passing though the chokes would be no greater than before. It would indicate however, the need for a higher inductance to combat the increased irregularity of the supply, and then your surplus small chokes would come in useful for connecting in series in the H.T.+ leads of your first two valves. It would not be permissible however to place one of these small 20 henry chokes in series with the existing large 20 henry choke in the plate circuit of the L.S.5 valve, and you would have to obtain an additional large 20 henry choke for this purpose.

It is clear, therefore, that if the smoothing choke in the plate current of any valve is just saturated, not very much smoothing effect will be obtained. Whilst if it is very much more than just saturated, the effect is almost the same as if no choke were there at all. The whole question of magnetic saturation has been already gone into very fully on page 704 of our May 26th issue, concerning a different matter, and for further information on this matter you should refer to this.

It will be seen, therefore, that in choosing smoothing chokes we must do two things. First we must ascertain the value of the steady current which they will be called upon to carry, or, in other words, bear in mind the normal plate current of the valves we propose using and choose a choke which is designed suitably to carry this current without magnetic saturation. Secondly, the actual required inductance necessary for adequate smoothing must be ascertained. This depends on the exact amount of irregularity present in the supply, and since this differs very greatly in different districts, it is well to ascertain this information from other wireless amateurs in the district and be guided by their experience.

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THE MELTING POT OF BROADCASTING.

IT would be unreasonable to suppose that the comparatively new service of broadcasting, which has created a new industry in this country, could have taken shape from the commencement in a stable form and with a policy which would have obviated the necessity for periodic changes.

From the point of view of the listener and user of wireless, as well as the requirements of the wireless industry, the ideal would have been achieved if it had been possible to know over a period of at least twelve months what the requirements in types of apparatus would be as decided by the technical policy of the broadcasting service; but, reviewing what has occurred since broadcasting started, one can legitimately exclaim "Pity the poor manufacturer."

Wastage Due to Changing Policy.

Regarded as an industry collectively, there has been an enormous wastage of effort and capital, a proportion of which is, of course, due to lack of foresight on the part of the business heads of wireless concerns and lack of skill in design, but it is also attributable in large measure to the uncertainty which has attended the technical conduct of broadcasting, due to various causes, almost since its inception.

Irresponsible Statements.

There have been too many afterthoughts and far too many irresponsible statements relative to changes in the distribution and organisation of broadcasting. Moreover, very inopportune moments seem to have been chosen for announcements regarding new schemes. We can quite understand that the B.B.C. is impatient to progress, but in an industry which depends solely upon the policy of those controlling broadcasting it is, in our opinion, grossly unfair to ignore them and neglect to appreciate the seasonable character of wireless and the fact that the manufacturer requires very long notice before he can make arrangements to meet a demand for a new type of apparatus. We recollect that the proposals for the building of Daventry were announced at a time when at least the majority of manufacturers had come to regard the shorter wavelength band as being the most stable thing about broadcasting. When Daventry came into existence the public believed that it would be useless for them to purchase sets which could not receive Daventry as well as the local station. This, in many cases, meant the complete scrapping of existing designs and must have cost the industry, as a whole, a very large sum.

The Effect of Daventry.

Now that the manufacturers have, for the most part, re-designed their types of apparatus so as to cater for the reception of Daventry, we are afraid the long-wave station has fallen very far short of expectations and the promises of the B.B.C. for a high-power alternative programme; so much so, that the attitude to-day is rather that Daventry is only useful for certain localities where there is no local broadcasting station of sufficient power to be satisfactorily received.

CONTENTS.

Having now arrived at this stage, we are advised that the B.B.C. is actively engaged in a scheme for the redistribution of stations with the object, we are told, of providing alternative programmes everywhere. This announcement is made within three months of the opening of what has come to be regarded as the "wireless season," and the holding of what promises to be by far the biggest British wireless exhibition yet held.

In the face of this uncertainty as to the policy of the future, coupled with delay and indecision in the matter of the formation of the new controlling body recommended by the Crawford Committee, we fail to see how manufacturers can be expected to produce new and up-to-date designs for the Autumn Exhibition, whilst the public are equally prejudiced against deciding on the choice of new models for the winter season, and, indeed, they even wonder if it is wise to make a purchase at all in view of the uncertainty of the future. A further disquieting influence, recently enacted behind the scenes, took the form of a proposed agitation to induce the Government to set aside the recommendations of the Crawford Committee, but this agitation has now happily been abandoned. We were emphatic in our protests against such a policy, primarily because we believed that it would only tend to unsettle the future without obtaining any advantage for the listener.

THE IDEAL PICNIC. In America the portable wireless receiver is regarded by many as a perfect concomitant to a day in the open air.

The Remedy.

In some quarters it has been suggested that the formation of a Government-appointed Commission to control broadcasting necessarily means a stodgy and unenterprising future for the service. We are by no means sure that a little less enterprise in some directions would not be an advantage to all concerned, provided that there is no curtailment of progress in the improvement of programmes and quality. Moreover, we believe that under Government control irresponsible statements purporting to emanate from the B.B.C., such as we see published almost daily in the Press, will be curtailed, and in future the expression, "We understand from a high official of the B.B.C." will, we hope, appear less frequently in print. The B.B.C., with the co-operation of the Post Office, is in a position to tell us precisely how we stand, and we believe that a technical policy once adopted should remain in force without modification for a definite period, and that no irresponsible statement should be made by any member of the B.B.C. during the period in which an approved scheme of distribution of stations, wavelengths, etc., is in force. When the end of that period arrives, any changes should only be made with ample notice to all concerned, and after consultation with every party interested. Imagine what would be the position if the Government from time to time issued regulations which rendered obsolete or unserviceable certain types of motor car engines or involved drastic changes in the design of any other commodity in general use. Yet the B.B.C. has an equivalent power in broadcasting, and even a chance word from "a high official of the Company" is enough to make the manufacturer hesitate to lay down the necessary plant and expend the capital required for the mass production of a really cheap set of any particular type.

The Need for Co-operation.

The time has come when everyone who is interested in the future prosperity of broadcasting, both from the point of view of the listener and the industry, should be prepared to follow a common agreed policy, and it should be remembered that almost any definite policy is better than an uncertain one. What is needed is confidence in the new Broadcasting Corporation under Royal Charter, and, having gained that, the co-operation of all parties in an endeavour to assist steady development.

It is, we consider, most regrettable that the Government has not yet seen fit to make any announcement regarding the selection of Commissioners, for, in our opinion, everything must depend upon that selection. Further, we consider it of extreme importance that certain interests should be represented on the controlling board, in particular those of the listener, the experimenter, and the manufacturer, yet it would appear that until the autumn we are to remain in uncertainty as to whether the Board will be so composed or confined entirely to "persons with no commitments," as recommended in the Crawford report.

Under present conditions, and until confidence and stability are restored, we cannot hope that prices will come down, nor that an improved industry and service can be established on an enduring basis.

MAPS AND WIRELESS WAVES.

Methods of Indicating the Track of Wireless Waves Over the Earth's Surface.

By R. KEEN, B.Eng., A.M.I.E.E.

If we were to be asked how the position of Vancouver lay with reference to London, we should reply that it was about due West, and might refer to the map of the world at the beginning of our atlas to confirm that this seems to be more or less the case. Now, the map of the world, which is, perhaps, the most familiar of any, is one called the "Mercator's Projection." Probably 95 out of every 100 people of average intelligence know this map by sight; about 10 per cent. realise that there is something radically wrong with the shape of some of the countries, and perhaps 1 per cent. or less will be able to say how it is made or what are its particular virtues and failings. It may be pointed out at once that one of its chief failings is that it is useless as a reference in the case just mentioned.

Directional Difficulties on Mercator's Chart.

Suppose that it be desired to set up, near London, wireless transmitters with strongly directional beams which are to work to Vancouver, which, according to the Mercator's Chart, is nearly due West of London, and to Accra on the Gold Coast, which will be found to be due South, and that the transmitting stations are accordingly arranged to direct the signals due West and due South respectively. If the power be sufficiently great and the apparatus all in working order, it will be found that the signals sent out to the South will be duly received at Accra, but Vancouver will wait in vain for any trace of the Westerly signals. On the other hand, these waves directed to the West will produce strong signals in a receiver in Jamaica or Panama, and Fig. 1 shows a Mercator's Chart with the actual track of the signals intended for Vancouver and Accra. For any investigation of long-distance wireless communications it is evident that this map is quite useless, but why is it that one direction is correct whilst the other is totally wrong, the wireless wave appearing to follow a curved path?

The trouble is that, since the earth is a sphere, it is impossible to represent it even approximately accurately on a sheet of paper. Any country, or small portion of a country, is actually a curved surface, and the problem of reproducing it as a map resolves itself into deciding in what particular way it shall be distorted in order to get it flat. The outer edge of the country may be stretched, or the middle of it may be compressed, but something of this kind must be done before the spherical surface can be drawn on a flat sheet of paper. The methods which are used are numerous and extremely complicated. About three dozen different kinds of map projections are in use, and a great many more have been made at various times by mathematicians who during the past 2,000 years have been interested in the subject. If it be difficult to represent a small section of the earth, how much more so the whole globe? Maps can, however, be drawn in which the curious anomaly shown in Fig. 1 does not occur, but they usually have some other disadvantage which prevents them from becoming popular for general use.

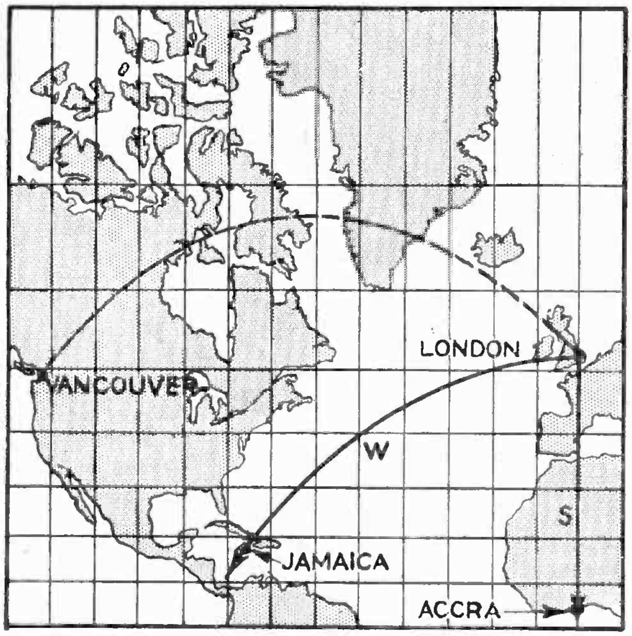


Fig. 1.—Great circle distances as they appear on Mercator's Chart

The Graduation of the Earth's Surface.

The only really accurate representation of the earth is the miniature globe, and, although fairly familiar, it is worth a little attention if we are to understand the reasons for the failure of most maps in the matter of long range bearings. For convenience in locating places a number of "meridians of longitude" are drawn on all maps, these being lines which half encircle the globe from pole to pole, and are evenly spaced around the Equator. Looking down on top of one of the poles these meridians are seen to be straight lines radiating from the pole, and, as there are 360 of them, they are spaced one degree apart. The principle of dividing up the surface of the earth by lines in this sort of way seems to have been started by Eratosthenes, who, about 250 B.C., made a very inaccurate map of Europe in which they were used. Of later years the study of the subject received a certain amount of attention in the reign of Charles II, who created the first Astronomer Royal, built Greenwich Observatory, and caused to be collected a great deal of astronomical data for navigational purposes. For this latter reason the standard meridian has been taken in this country (and in the majority of others in which British Admiralty charts have been used) as the one which passes through Greenwich.

Wireless Maps.—
The remaining Meridians are numbered off from 0 to 180 East and West. Now, in addition to these lines of longitude there is also the Equator, together with a number of other circles round the globe parallel to the Equator but getting gradually smaller and smaller until finally they become a point at the poles. These are the "parallels of latitude," and if we were to travel the full length of a meridian we should cross "parallels" at equal intervals between the North and South Poles, ninety to the North of the Equator and ninety to the South, making 180 parallels.

Great Circle Distances.

On a flat surface the distance between two points is the straight line joining them, and in the case of two towns situated a few miles apart we talk of the distance as being so many miles "as the crow flies," which is intended to imply a straight line. But wireless transmission and reception often oblige us to consider distances of many thousands of miles, and here the distance between places is always taken as the shortest distance measured along the earth's surface. Since the earth is approximately a sphere, it is not difficult to see that the line representing the shortest distance will probably be an arc of a circle, and in Fig. 2 is shown a piece of black thread stretched between London and Vancouver on the globe, and which automatically takes up the shortest path. Now the very important point about this circle, of which the thread forms a part, is that if it be continued it will always be found to pass round the globe at its maximum diameter—like the Equator—and never attempts to "cut off corners" like the smaller circles forming the parallels of latitude. For this reason it is known as a *great circle*, and the part of it between the two places is called the *great circle distance* between them. Only one of the parallels is a great circle, and this is the Equator itself, although, of course, all the meridians are semi-great circles. By means of a small globe it is very easy to convince oneself that the other parallels are not great circles. Choosing two places which are on the same parallel, if we attempt to stretch a piece of thread along the parallel between them, it will immediately slip and take up the great circle path as the shortest route. Applying this to the case of London and Vancouver, if we take careful note of the exact route followed by the great circle on the globe and then plot it off on the Mercator's Chart, it is found to take up the position shown dotted in Fig. 1. Clearly this map is badly distorted so far as directions East and West are concerned, but note that Accra, being due South of London, is on the same meridian, so that, since meridians are straight lines on this map, great circles North and South are also straight lines and directions are correctly rendered.

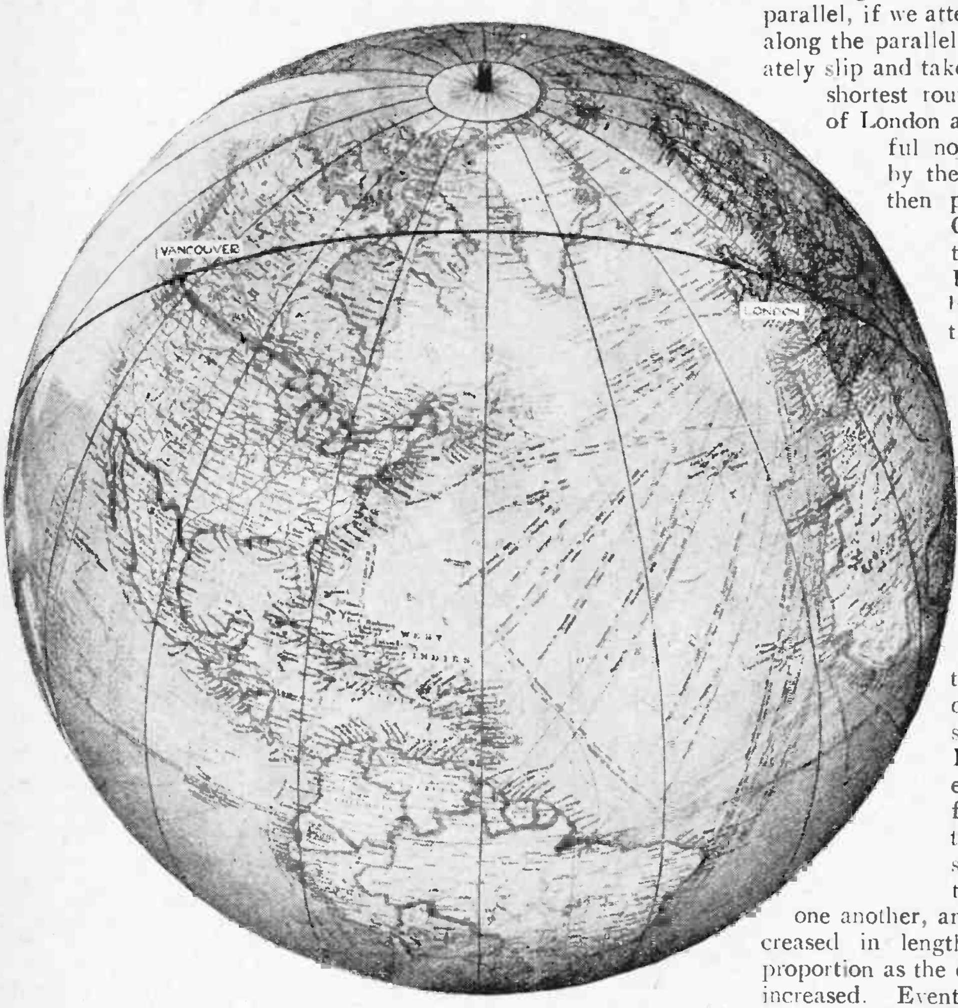


Fig. 2.—The great circle passing through London and Vancouver.

Distortion of Coastline on Mercator's Chart.

Fig. 3 shows a small part of the globe on which the great circle drawn due West from London is seen to pass through the West Indies. Suppose that in an effort to make this curved surface into a flat map we stretch the top corners in the directions shown by the arrows until all the meridians are parallel to one another, and also until they have been increased in length in approximately the same proportion as the distance between them has been increased. Eventually the sheet will become flat and may be made to coincide exactly with the Mercator's Chart in Fig. 1. The North of Greenland has now become a very large expanse of land, Iceland and Canada are appreciably bigger than they should be, and the great circle tracks across the Atlantic ocean have become badly distorted in the process. If the Mercator's Chart is so badly distorted, why use it

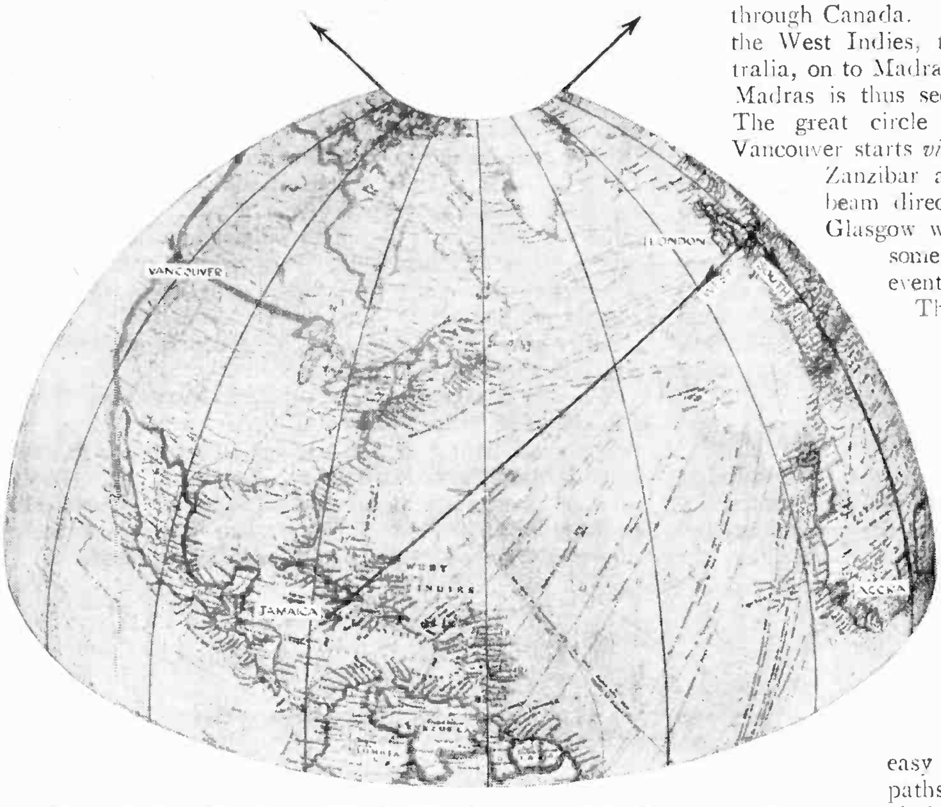


Fig. 3.—Section of the globe showing that the West Indies are due West of London on a great circle.

so much? The reason is that it has unfortunately become very popular as a method of showing the world, with the exception of the polar regions, in a single sheet, and it is peculiarly well adapted to the navigation of ships, being almost universally used for that purpose. At the present time the globe is being used to an increasing extent in schools, but to those who have not used one recently and who are familiar with the appearance of the Mercator's Chart, a number of rather astonishing facts come to light when we start to plot great circle tracks.

To do this, the simplest way will be to stretch a piece of thread round the globe and then plot on the map shown in Fig. 4 the places through which it passes. First of all consider the great circle which passes through London in an easterly and westerly direction, and which was originally intended to pass through Canada. It is seen to curve down through the West Indies, through Perth in Western Australia, on to Madras and back to the starting point. Madras is thus seen to be due East of London! The great circle which actually passes through Vancouver starts *via* Liverpool and returns through Zanzibar and Sardinia, whilst a wireless beam directed roughly in the direction of Glasgow would, if it went straight on for some 7,000 miles round the globe, eventually reach Honolulu.

This great circle from London to Honolulu passes through Greenland and skirts Alaska, and is the track along which wireless signals would normally travel between the two places. If, however, the signals from London were directed in exactly the opposite way, they would still reach Honolulu, for they would be travelling along the remaining portion of the arc of the same great circle, although the distance in this case would be some 18,000 instead of 7,000 miles. It is very important to realise and not very easy to understand that these two paths, namely, the *short* and the *long* great circle routes, are the only two tracks along which wireless signals can travel between two points. Starting from London in any other direction, signals will simply go round the earth along some

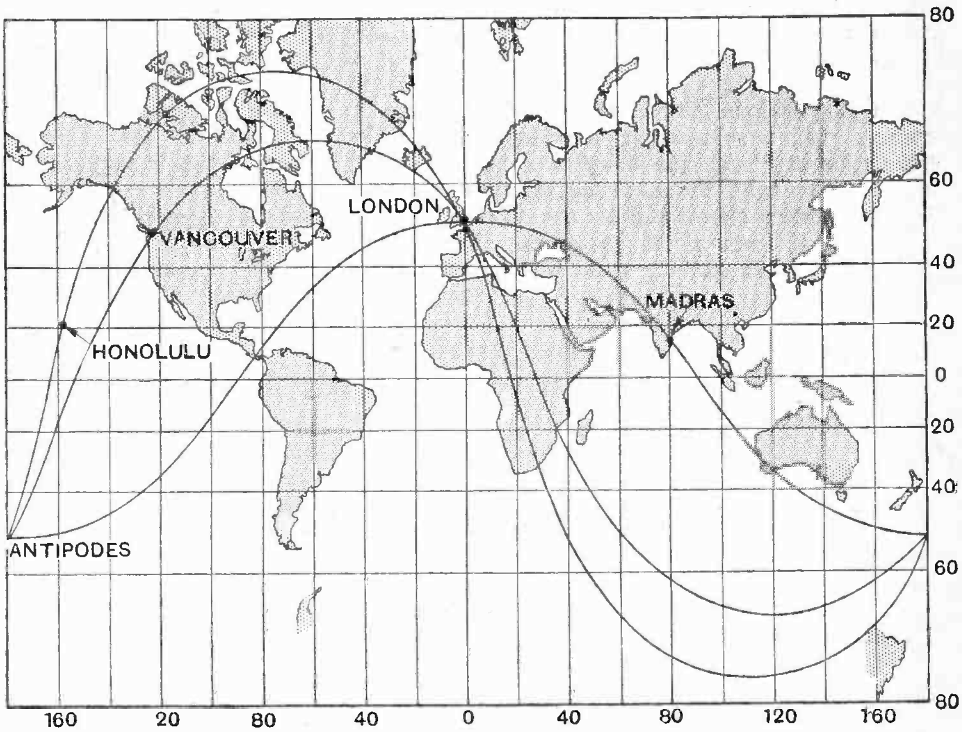


Fig. 4.—Track of wireless waves emanating from London as indicated by Mercator's Chart

Wireless Maps.—
other great circle which does not include Honolulu. Of course, in the special case when the place at which the signals are being received is exactly at the other extremity of the earth, that is to say, at what is called the *antipodes*, all great circle paths will take signals there, signals will be arriving from practically all directions at the same time, and a number of extraordinary wireless phenomena would be observed at the receiving station. Actually this has never been reported as having happened, but cases are recorded of signals from a station almost at the other side of the world arriving with equal strengths by both long and short paths at the same time and interfering with one another so badly as to make reception difficult on a non-directional aerial.

Light and Dark Paths.

It might reasonably be supposed that the wireless signals would always be received with the greatest intensity along the shortest path from the transmitter, but this does not always happen. Generally speaking, the longer wavelengths of the order of thousands of metres can be received over far greater distances during the dark hours than when it is daylight, whilst, at the other extreme, wavelengths of a few metres are in some instances found to attain their maximum range over the lighted part of the earth. The writer witnessed an example of this recently when signals which were being received by the short path from a station some 8,000 miles away suddenly began to fade, and within half an hour were totally inaudible. The receiver, which was a directional one, was turned to the opposite bearing, and signals *via* the 17,000-mile route were found to be steadily strengthening and soon reached a value almost equal to those by the previous short route.

When it is taken into account that day and night and the changing seasons are continually varying the distribution of light and darkness over the earth, it is easy to understand how situations occasionally arise, not only of some uncertainty as to what intensity the signals will be from an unfamiliar distant station, but also as to the *direction from which the signals may be expected.*

COMMERCIAL SHORT-WAVE TRANSMISSIONS.

Results of Tests between Nauen and Buenos Aires.

The accompanying curves illustrate graphically the results of tests which were carried out some months ago by the Telefunken Company with the object of exploring the commercial possibilities of short waves. Many amateurs will no doubt remember these tests, as the signals received in this country were of exceptional strength.

Figs. 1 to 3 give an idea of the results of tests with short waves which have been carried out between the Telefunken station at Nauen and the various stations of the world. Fig. 1 shows the receiving strength of communications between Nauen and Buenos Aires when using wavelengths of 26 metres and 30 metres. Reception is practically impossible on both these wavelengths during daylight. As soon, however, as about half the route is in darkness, reception commences and remains almost uniformly good throughout the night. As Fig. 1 shows, the utility of the 26-metre wave is very much greater than that of the 30-metre wave, since the duration of reception is considerably longer.

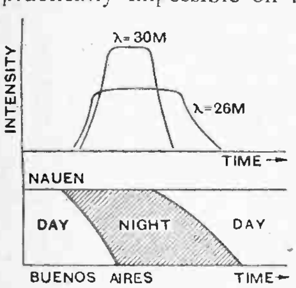


Fig. 1.

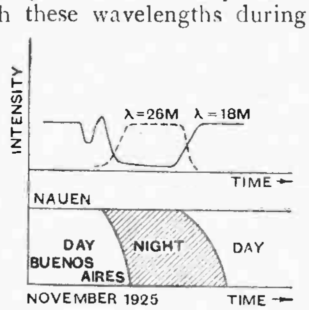


Fig. 2.

Fig. 2 shows the results of working on a 26-metre and an 18-metre wave on a day in November, 1925. As will be seen, the strength of signals with the 26-metre wave are practically the same as is shown in Fig. 1, whilst the 18-metre wave, on the contrary, could only be received very weakly during the night, but was very good in broad daylight. Unfortunately, however, this favourable result is not the rule, and the reception of the 18-metre wave depends very largely upon the atmospheric conditions prevailing at the time. On many days the 18-metre wave can be received well at night, but during the day-time cannot be received at all or only with varying intensity. Fig. 3, therefore, shows the approximate strength of reception on the 18-metre wave at the end of October, 1925. As will be seen, the short-wave communication over long distances is often dependent to a greater or less extent upon chance or the weather. For a reliable commercial traffic, therefore, the construction of short-wave transmitters of greater power will be indispensable.

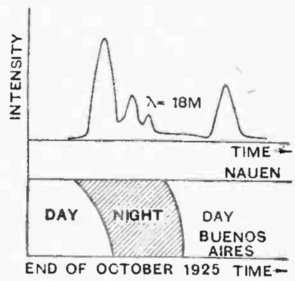
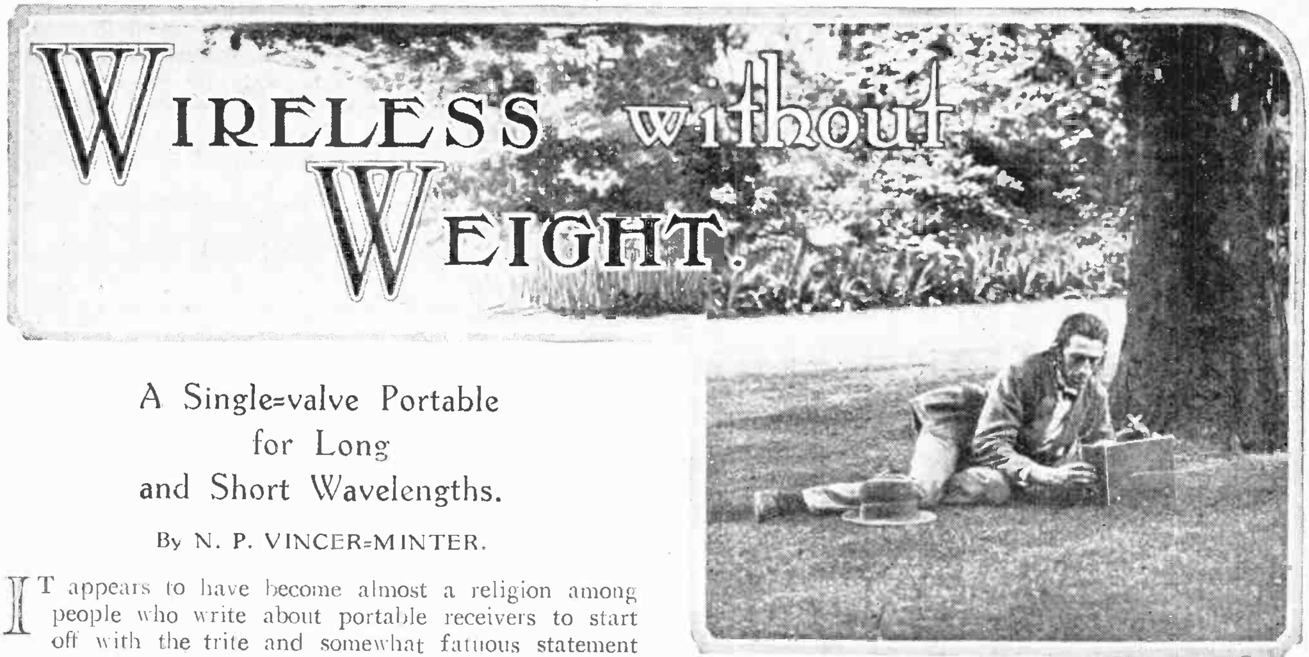


Fig. 3.

Since these experiments were conducted the Nauen station has succeeded in communicating with Tokio on 40 metres. Data similar to the above on transmissions to Japan should prove interesting.

H. K.

WIRELESS without WEIGHT.



A Single-valve Portable for Long and Short Wavelengths.

By N. P. VINCER-MINTER.

IT appears to have become almost a religion among people who write about portable receivers to start off with the trite and somewhat fatuous statement that the first essential of a portable receiver is that it must be portable. The truth of this remark is at once apparent (painfully so, in fact) to anybody who has attempted to lift the average "portable" receiver, whether home or commercially made. Having duly delivered themselves of this lofty sophism, these excellent gentlemen promptly proceed to forget all about it, and to unfold before the wondering gaze of the reader a gargantuan instrument designed apparently for the "strong silent man with a jaw of chilled steel" so beloved of women novelists. In fact, so crowded have the waiting rooms of Harley Street heart specialists become since the advent of the "Picnic four" and the "Perspiration five" that the writer determined to see if something could not be done about it, and the present instrument is the outcome of his efforts in the interests of suffering humanity.

Who Wants a Portable ?

Now it became speedily evident to the writer upon reviewing the situation that portable receivers could be divided into two distinct classes. First, there is the portable receiver which is constructed by simply taking the ordinary receiving equipment, complete with frame aerial, loud-speaker, a 15 lb. accumulator, and a 20 lb. H.T. battery, and cramming it all into the largest suit-case obtainable. The utility of an instrument such as this, is undeniable, for it does mean that the whole equipment can be lifted bodily and transported quickly to any room in the house or into the garden as desired. When it is remembered that in order to transport an ordinary wireless set from one room to another necessitates carefully disconnecting batteries, loud-speaker, etc., transporting all these instruments separately to the garden or elsewhere, and then laboriously connecting them all up again, and rigging up a temporary aerial, it will at once be seen that an "all in" receiver, which can be picked up and transported without any connecting or disconnecting of accessories, would be a great boon to the average man. Obviously, there would be no sense in cheeseparing in the matter of weight or dimensions in such a portable. The average portable set appears to fall naturally (presumably by its own weight) into this class. The other class of portable receiver which is meant to be actually taken some distance from the house and must therefore be light at all costs, appears to have been given the cold shoulder by manufacturers and amateurs alike, and it is this deficiency that the writer has attempted to remedy.

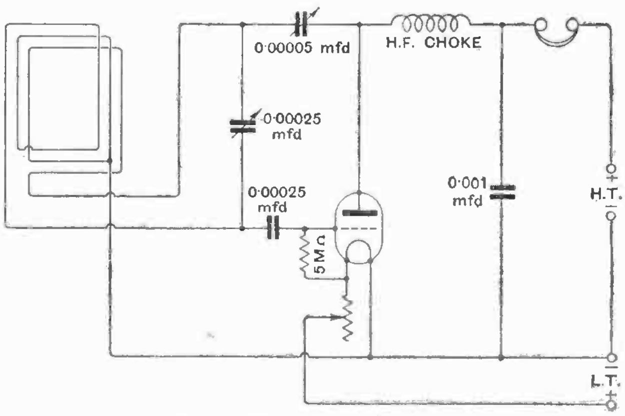


Fig. 1.—The fundamental circuit.

Let us first see what is the object of transporting a receiver out of the house. What occasions are there when we are away from home, that the reception of broadcasting becomes sufficiently desirable to warrant us incurring the trouble and expense of building one? The usual excuse offered by the builder of the average portable receiver, for the perpetration of his particular atrocity, is that it is useful for picnics. Now picnics are usually quite unpleasant enough in themselves without carrying forty odd pounds of additional weight across ploughed fields and stiles, for

Wireless Without Weight.—
it must be remembered that telephones are of little use at a picnic, and a loud-speaker receiver must be provided. This entails a 120-volt H.T. battery, and a fairly heavy accumulator, apart from the loud-speaker

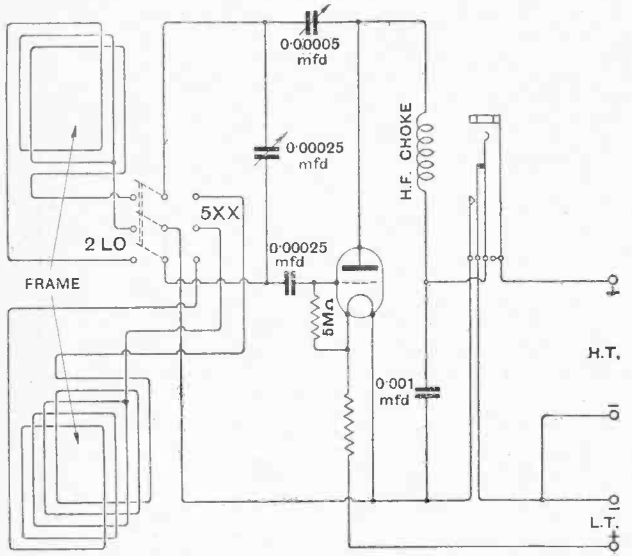


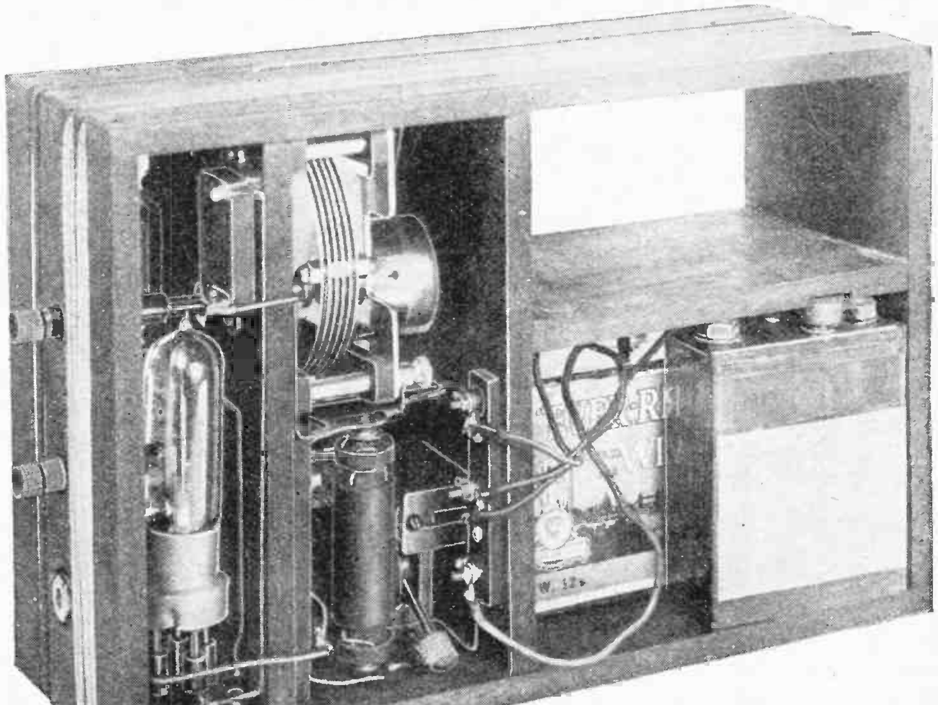
Fig. 2.—The actual theoretical diagram used.

and other paraphernalia. For those people, therefore, who like grasshoppers in their tea and wasps in the jam, and at the same time feel that they must have sustenance for the soul in the form of the children's hour as well as for the body in the form of the aforementioned grasshoppers and wasps, a class 1 portable is necessary.

When considered seriously, it becomes evident that the only people to whom a compact and light portable receiver is really a necessity are commercial travellers and such-like people who are compelled to spend a large proportion of their evenings in hotels and railway waiting rooms, whilst to those people who are only occasionally compelled to spend a few hours in such a depressing environment, a really compact instrument would be a great boon in whiling away the time in a pleasant manner. By a very long stretch of imagination one could also imagine a man travelling homewards in the evening on the top of a 'bus desiring not to miss the recitation of the first general news bulletin. It must not be forgotten, also, that in the time of any national trouble, such as the recent strike, when news bulletins are broadcast throughout the day, the possession of a small portable receiver which could be instantly put into operation anywhere—in the office, in a restaurant, or even in the public street—would be a valuable acquisition. Howbeit, the commercial traveller is, in the writer's opinion, typical of the class of people to whom a portable receiver is an absolute necessity.

What Circuit Shall We Use ?

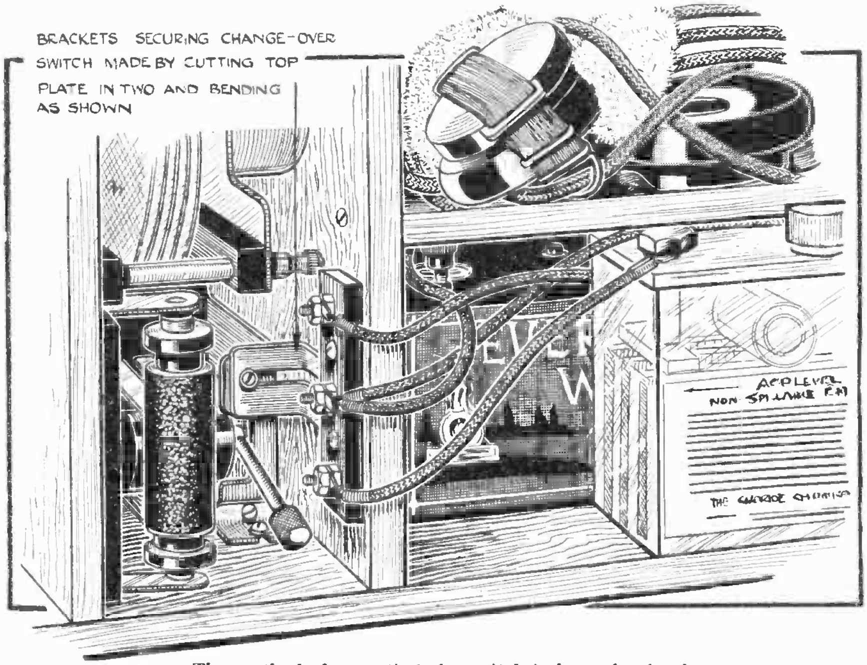
Now compactness and lightness are obviously essential in such circumstances, as the writer has mentioned above, and, therefore, the loud-speaker must go by the board, and, indeed, quite apart from the weight of its attendant apparatus, a loud-speaker is not desirable in the circumstances. The abandonment of the loud-speaker at once effects a large saving in space, weight, and expense, owing to the absence of power valves, with their attendant large H.T. batteries and accumulator. Is H.F. amplification necessary? No, not if a really smooth system of reaction be incorporated and reception is limited to twenty miles or so from the local station, or double that distance from the high-powered station. This reduces us to a single valve regenerative receiver, and at once means that our L.T. supply can consist of the smallest possible 2-volt accumulator, of the unspillable type, and a very small 30-volt H.T. battery. In order that the receiver be really self-contained, a built-in frame aerial is essential, but provided that a greater range than that given is not desired, it will be found that 12in. by 8in. is big enough for this. Now, having decided to employ a single valve regenerative circuit, the particular



An interior view showing the valve in position.

Wireless Without Weight.—

form which this circuit shall take must be decided. Smooth control of reaction is essential, and so the swinging coil method of reaction is out of the question. It



The method of mounting the switch is here clearly shown.

very fortunately happens that the very circuit which in practice gives the smoothest control of all is the simplest to set up and the one requiring the least amount of components. In fact, the only components required, apart from the frame aerial, are a variable tuning condenser, a small neutrodyne-type condenser, and the usual grid leak and condenser, no coils whatever being used in the receiver. This will be evident on referring to the circuit diagram in Fig. 1. It will be seen that the neutrodyne condenser is used to produce reaction effects. The action of the circuit is somewhat similar to that of the Reinartz circuit, which the writer himself has dealt with at some length in this journal.[1] Actually, the writer is of opinion that this circuit is even better from the point of view of smooth reaction control than the Reinartz, good as that is, and, moreover, the adjustment of the degree of reaction has little or no effect in tuning. The circuit can, of course, be used on an ordinary aerial and earth system, and is adaptable to all wavelengths by the use of centre tapped plug-in coils which are now obtainable. Since, however, a complete article has already been devoted to the Hartley circuit in this journal,[2] the writer will not dwell further upon it, except to say that it is extremely sensitive and stable.

How to Escape Ribaldry.

There is one other point in connection with the design of a portable receiver which should be emphasised, and that is the nature of the carrying case. The average portable which, when closed up, looks like a portable, consisting, as it often does, of a wooden case with a handle stuck on to it, and bristling with knobs, is apt, when carried in the public street, to excite the curiosity and ribaldry of small boys, whose repeated requests to "give us a tune, mister," frequently become somewhat embarrassing. The portable ought, therefore, to look as much as possible like some ordinary, every-day object which it is customary to carry; in other words, it ought to be contained in an attaché case. Many portables are

[1] *The Wireless World*, April 28th, 1926, page 608, and June 16th, 1926, page 799.

[2] *The Wireless World*, January 27th, 1926, page 117.

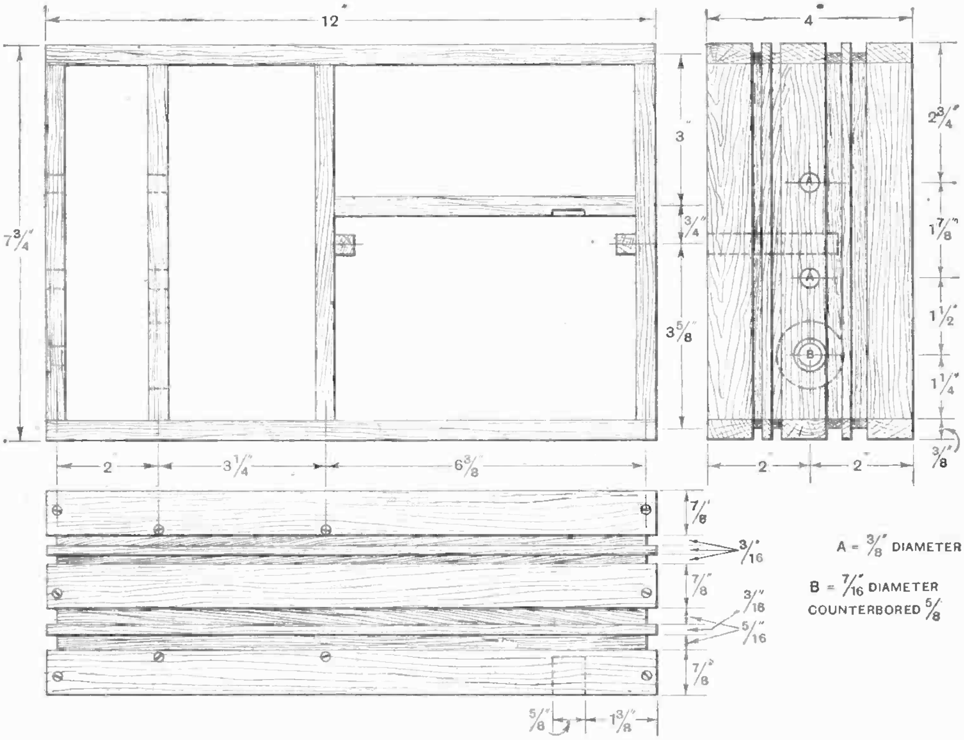


Fig. 3.—Constructional details of the wooden framework.

Wireless Without Weight.—

so designed, but nearly all of them possess the disadvantage that in order to operate them the case has to be opened up in order to get at the tuning controls, and if desiring to use the instrument in the lounge of a hotel, or in any public or semi-public place, one does not wish to gather a crowd; in fact, one desires to use the receiver in the least conspicuous manner possible. The receiver should, therefore, be "operatable" with the case closed up. This is impossible if an H.F. stage is used, since the frame will interact with the H.F. transformer and cause perpetual oscillation. In the receiver under discussion, however, it is easily possible to operate the receiver without opening the case, but this does not entail a row of conspicuous knobs on the outside of the attache case, as will be seen from the photographs, the two "knobs" controlling tuning and reaction respectively, consisting of neutrodyne condenser handles, just projecting through the end of the case, whilst underneath is an inconspicuous telephone jack. Inserting the phones into the telephone jack switches on the batteries, and the receiver can actually be tuned and reception carried on whilst carrying the attache case in the hand in the usual manner, there being not the slightest trace of hand-capacity effect owing to the special construction adopted, which will be discussed later. A special pair of R.A.F. phones, with a fur and elastic headband, is used, so that the user may actually receive the programme with his hat on in the normal manner, thus rendering him as inconspicuous as possible. Ordinary telephone receivers may be used if desired, and if folded up compactly will fit into the compartment provided for them, but by using these special "portable" phones they can be thrust instantaneously in their compartment after reception without the irksome task of folding them up. Now for some constructional details.

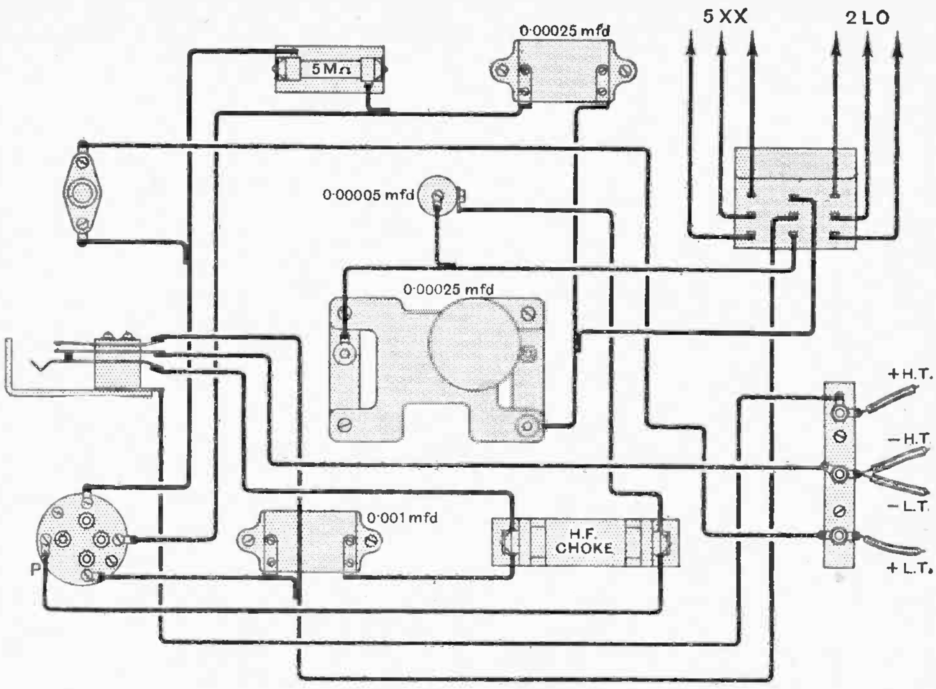
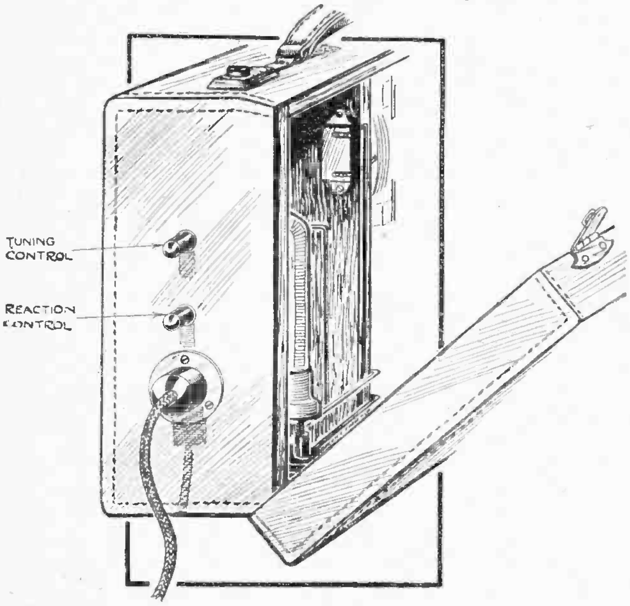


Fig. 4.—The practical wiring diagram.



This illustration indicates the position of the tuning controls and telephone plug.

And Now to Work.

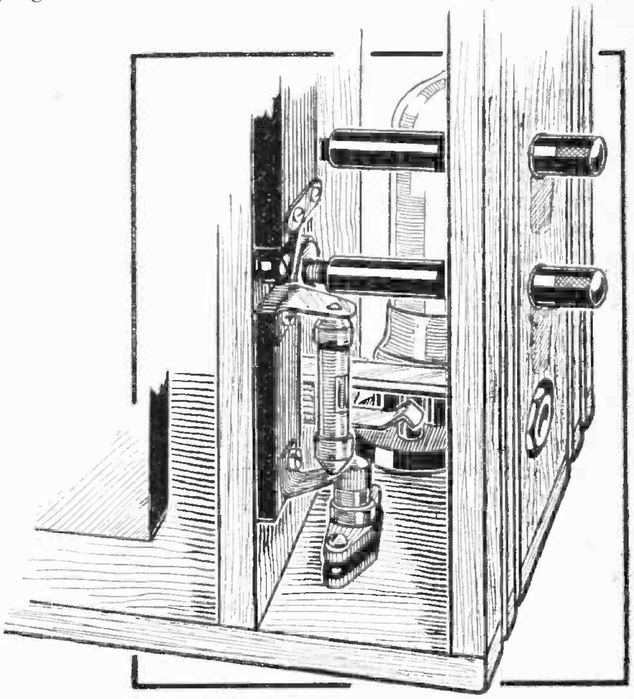
It is first necessary to obtain an attache case (not a suit case) with internal dimensions of 12in. × $7\frac{3}{4}$in. × 4in. The wooden framework should then be constructed from the particulars given in Figs. 3 and 4. Some difficulty may be experienced in cutting the four grooves necessary for the two frame aerials, which, in the writer's case, were done with a rabeting plane, and it would probably be better to arrange for the whole of the wooden framework to be constructed by the local joiner. The grooves are cut to a depth of $\frac{3}{16}$ of an inch; that is half the thickness of the wood. There is no absolute necessity to divide each of the frame aerials into two portions, but it is advised because it is so much easier to make connection to the centre tap of the frame, which will naturally occur at the junction between these two sections. Furthermore, since it is important to tap the electrical centre of the frame as accurately as possible, it is more likely that, by adopting this method of winding, the electrical centre of the frame will coincide with its geometrical centre. A three-pole change-over switch is provided for shifting the plate-grid-filament connections of the valve from the short-wave to the long-wave frame. This switch is fixed by sawing in half the fixing

Wireless Without Weight.—

plate of the "Utility" switch employed, and bending to the position shown in the sketch on page 79. The tuning condenser used is a 0.00025 Ormond square law fitted with their slow-motion friction drive. A 0.0005 condenser is unnecessary, and only provides additional weight. An extension handle is cut from a piece of $\frac{1}{4}$in. diameter ebonite tubing to the same size as the handle of the Gambrell "Neutrovernia," and is fixed by a grub screw to the centre spindle of the condenser, thus providing a very fine vernier control of tuning. The Gambrell "Neutrovernia," fitted underneath, gives a smooth control over reaction.

The Reward of Effort.

It will be noticed that the lay-out is rather unusual, no panel being employed. This is in order that the control handles may project through the side of the case in the most convenient and least conspicuous position. Furthermore, we are able to place the two condensers in a position well back from the side of the case, where no hand capacity effects will be experienced. Indeed, in spite of the fact that the hand comes in close proximity to the frame aerials, not a trace of this baneful effect has been experienced, and the receiver is delightfully easy to tune. It should be pointed out that the two tuning handles must be removed when inserting or withdrawing the framework from the case. A 30-volt "Eveready" H.T. battery is used, this being ample, provided the correct valve is used. The 2-volt accumulator weighs $1\frac{1}{2}$ lb., and has dimensions of $3\frac{1}{4}$in. × $1\frac{7}{16}$in. × $4\frac{1}{8}$in., and is a type made for a portable hand lamp. Using one of the new 0.1 amp. 2-volt valves, it gives seventy hours' service on one charge, which is, of course, ample. The short wavelength frame consists of 12 turns of No. 26 D.C.C. wire wound into each groove, thus giving 24 turns in all, a centre tapping being taken at the point where the wire crosses over from one section to the other. The long wave frame is similarly constructed, but contains 42 turns in each section. Two small holes are cut into the side of the case for the control handles, and a large hole surmounted by the outer rim of a nickel-plated valve window is used for the insertion of the phone plug. Using two-volt valves, a shorting plug is inserted in the fixed resister holder, this device being only incorporated for the benefit of those readers desiring to use a "Wecovalve" or a Cosmos D.E.11, which operate on 1 volt. It will be noticed that a 5-megohm grid leak is used instead of the conventional 2-megohm. By adopting this expedient, it will be found that the signal strength and range of the receiver is greatly enhanced, whilst the quality is not appreciably impaired.



The method of mounting the grid leak and fixed resistor holder is quite straightforward.

With regard to the question of valves, the writer has experimented at great length with these, and whilst practically all 2-volt valves of medium or low impedance give satisfaction, by far the best results were obtained with the new Cossor "Point-one" detector type valve, which is of medium impedance. Excellent results were obtained from this valve from the point of view of sensitivity, and also it was found that, owing to the special method of mounting the filament, the valve proved to be singularly free from microphonic noises. A high-impedance valve should under no circumstances be used, or difficulty will be experienced in obtaining the full benefit of reaction.

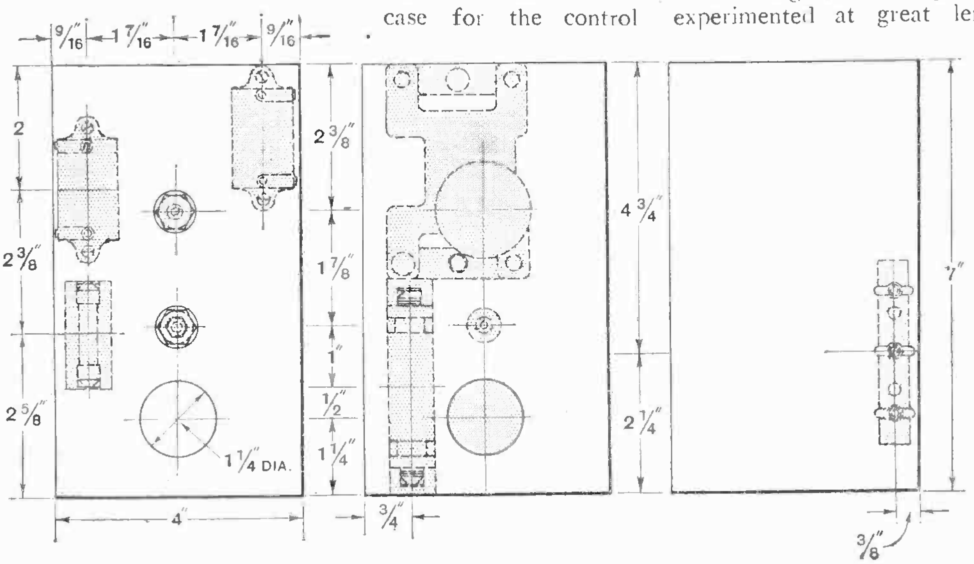
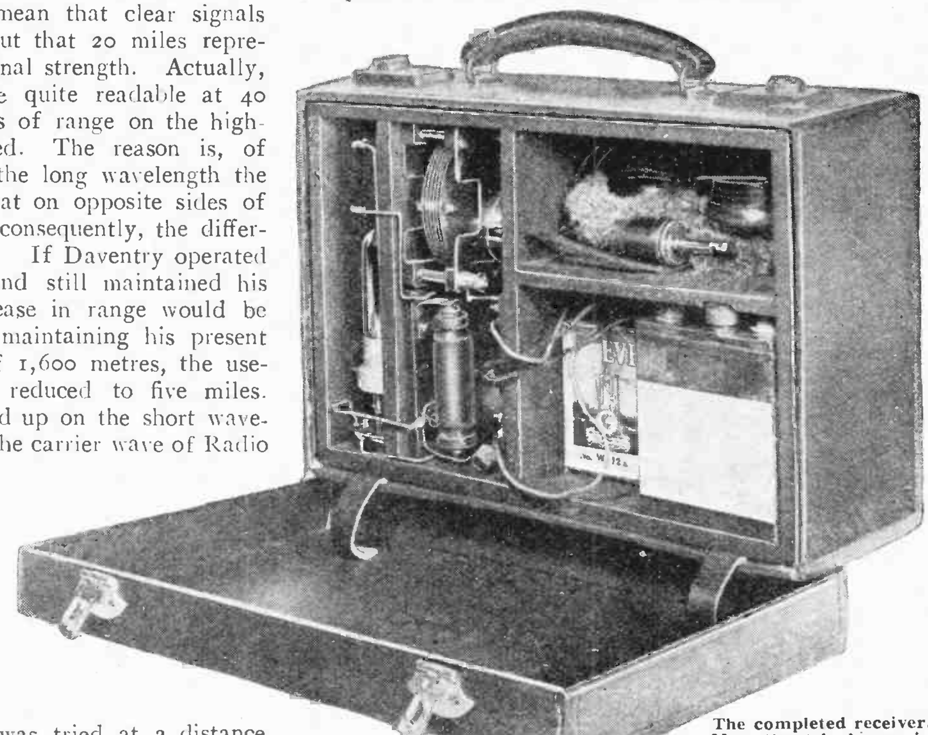


Fig. 5.—Details of the instrument lay-out.

Wireless Without Weight.—

This receiver has been subjected to very extensive tests on both short and long wavelengths, and, as a result of this, the writer is able to state definitely that the useful range of the receiver as it stands is about 20 miles for the local station and double that distance for the high-power station. This does not mean that clear signals are unobtainable at 25 miles, but that 20 miles represents the limit of comfortable signal strength. Actually, it was found that signals were quite readable at 40 miles from 2LO. The shortness of range on the high-power station may be questioned. The reason is, of course, due to the fact that on the long wavelength the phase difference is not very great on opposite sides of this small diameter frame, and, consequently, the difference of potential set up is small. If Daventry operated on the 400-metre wavelength and still maintained his same power, a very great increase in range would be apparent. Similarly, if 2LO, maintaining his present power, adopted a wavelength of 1,600 metres, the useful range would probably be reduced to five miles. Several carrier waves were picked up on the short wavelengths, and on the upper range the carrier wave of Radio Paris could be picked up, but no useful results obtained. By winding a single turn of wire roughly round the end of the attache case and connecting the ends to a normal aerial and earth, a number of stations were received at pleasant strength, and the local station signals heard at a strength too loud for comfort. Later the instrument was tried at a distance of 50 miles from 2LO, by carrying a wire round one side of the room, looping it once round the outside of the case, and taking it down to the other side of the room to form a rough counterpoise, and excellent signals were obtained. In both cases, of course, the rough external winding forms an aperiodic aerial coupling.

If anyone is staying in a hotel, therefore, which is within 20 miles of the local or 40 miles of the high-powered station, he may count on receiving pleasant signals from the unaided receiver. At greater distances entertainment can be obtained in the privacy of one's own room by taking a wire across the room, looping it round the case two or three times in the case of a normal station, and ten or twelve times in the case of Daventry, and then either taking it across the room again or attaching it to a radiator. Probably two or three turns of wire round the case and then attached to a normal aerial and earth will be the easiest method of testing this receiver when first constructed, unless the constructor is in close proximity to a station. After thus obtaining the "feel" of the receiver, it will be much easier to operate it on its frame in the usual manner.



The completed receiver. Note the telephones in the compartment above the batteries.

For those persons who live within 20 miles of a local station and more than 40 from Daventry, or within 40 miles of Daventry and at a greater distance than 20 miles from any other station, it is hardly worth while incorporating the two frame aerials, and it is recommended that only one frame be constructed and the change-over switch omitted, in which case the circuit diagram in Fig. 1 should be followed.

In conclusion, the writer hopes that this little instrument, which weighs less than ten pounds, including valve, batteries, and telephones, and is, therefore, really portable, will be found to fill a long-felt need amongst those members of the community to whom a portable receiver is a necessity rather than a luxury.

LIST OF COMPONENTS.

- *1 Attaché case, 12in. × 7¾in. × 4in. (Gray's Inn Trunk Stores, Ltd., 9, Gray's Inn Road, W.C.1).*
- *1 0·00025 mfd. square law variable condenser with friction drive (Ormond).*
- *1 0·00005 mfd. variable condenser (Gambrell "Neutrovernia").*
- *1 Three pole two way switch (Utility).*
- *1 0·00025 mfd. fixed condenser (Dubilier).*
- *1 0·001 mfd. fixed condenser (Dubilier).*
- *1 5 megohm, grid leak with clips (Dubilier).*
- *1 H.F. choke (Cosmos).*
- *1 Single circuit filament control jack (Edison Bell).*
- *1 Telephone plug (Edison Bell).*
- *1 Valve holder (Bowyer-Lowe).*
- *1 2 volt accumulator, type M.P.2 (Exide).*
- *1 30 volt H.T. battery (Everready).*
- *1 Pair R.A.F. type 4000 ohm telephones (Leslie Dixon, Ltd., 218, Upper Thames Street, E.C.4).*
- *1 2 volt 0·1 amp. medium impedance valve (Cossor).*
- *1 Pair wander plugs.*
- *Quantity of No. 26 D.C.C. wire.*
- *Length of red and black flex.*

Total cost, *including* valve, batteries and telephones - - - £5 0s. 0d.

TRACKING A CONCEALED TRANSMITTER

Sheffield Society's Exciting Field Day.

DIRECTION finding experiments in the open air generally prove fascinating, particularly when they can be carried out over a wide tract of variegated country. And when, moreover, the participators assume the roles of hunter and hunted, the excitement of the chase will make a summer afternoon seem all too short.

A field day of this description was held on a recent Sunday by the Sheffield and District Wireless Society, the venue of the tests being the hills and dales in the Peak district of Derbyshire.

A secret transmitter was set in operation at an unknown point within a defined radius, and the members of the Society were divided into three groups, each equipped with a frame aerial receiver. The three groups thus competed against each other in efforts to be the first to discover the concealed station.

The transmitter was in the charge of Mr. H. Lloyd and two other members, who were sworn to secrecy regarding the position which was to be taken up. C.W. transmission was used throughout the test, the anode supply being obtained from an Evershed generator driven from one of the wheels of Mr. Lloyd's car. The party left Sheffield stealthily some time prior to the opening of the "hunt."

Sealed Instructions.

The three receiving stations, working independently, were each equipped with a 2 ft. square frame aerial, two valve receiver (o-v-l), compass and map. Each receiving station was given sealed instructions before leaving Sheffield to proceed to certain points marked on the map as follows:

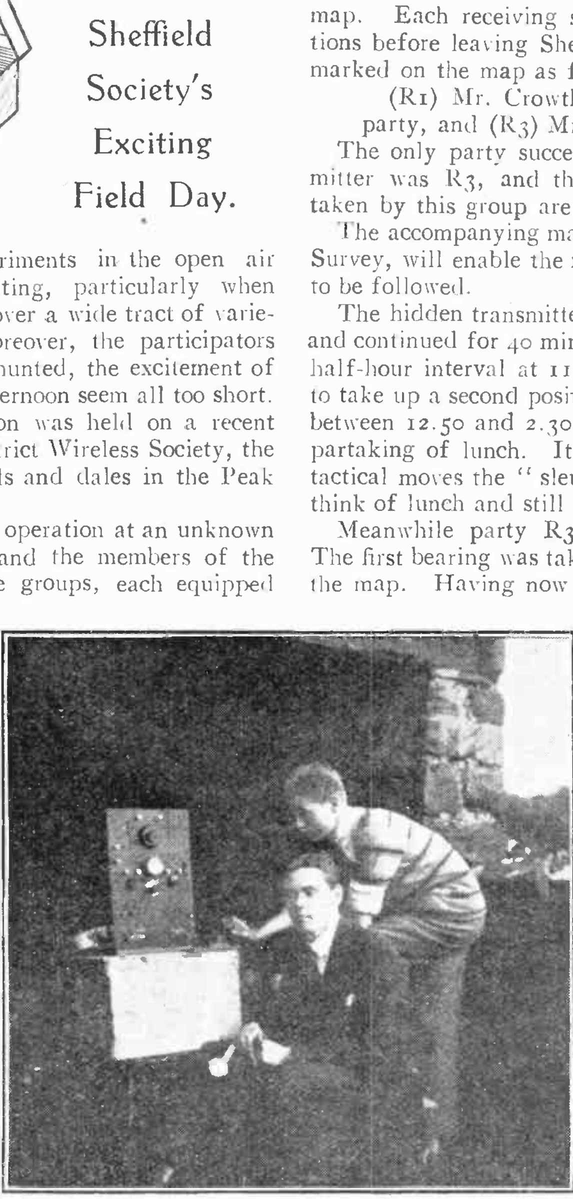
(R1) Mr. Crowther's party, (R2) Mr. Jakeman's party, and (R3) Mr. Raynor's party.

The only party successful in tracking down the transmitter was R3, and the movements made and bearings taken by this group are of considerable interest.

The accompanying map, reproduced from the Ordnance Survey, will enable the movements of the successful party to be followed.

The hidden transmitter first began operating at 11 a.m. and continued for 40 minute periods until 3.10 p.m. with a half-hour interval at 11.40 to enable the searching party to take up a second position. Yet another move was made between 12.50 and 2.30 p.m., when the transmitters were partaking of lunch. It will be seen that owing to these tactical moves the "sleuths" had little time in which to think of lunch and still less in which to digest it.

Meanwhile party R3 was getting well on the track. The first bearing was taken at Moscar Lodge, as shown on the map. Having now some idea of the right direction, R3 proceeded four miles to Shatton, when a further bearing helped to restrict the area in which the transmitter might be located. It was obvious that the transmitter lay in the neighbourhood of Ringinglow and accordingly the party set out on the six-mile journey to that place. The third and fourth bearings, taken at Ringinglow and Bassett respectively, show how the hare was run to earth. The transmitting station was situated in a barn as shown at the point T, about 100 yds from the actual intersection of the 1st, 3rd and 4th bearings.



THE SECRET STATION. Mr. H. Lloyd's portable transmitter concealed in a barn at Brown Edge Farm, near Bassett. Three parties were engaged in the search, but only one was successful.

When the discovery was made no one was more surprised than Mr. Raynor and his search party. In carrying out their successful search, party R3 had taken 4 hours and 10 minutes.

At 4 p.m. all parties made their way to "Woodville,"

Tracking a Concealed Transmitter.—Hope, the residence of Mr. R. Jakeman, where tea was served on the lawn.

This fascinating and successful field day constituted the Society's last meeting until the opening of the winter session.

For the purpose of a field day, a D.F. hunt can hardly be equalled for the excitement which it can create, and for the practical experience gained by all who take part. While impossible to conduct within, or very near, a large town, D.F. experiments can always be effected a few miles out in the country. The example set by the Sheffield Society might well be copied by other societies anxious to hold a field day which will prove a real "draw."

ON THE SCENT. A search party taking bearings on C.W. signals from the concealed station. The experiments obviously appealed to the bovine intelligence.

There can be little doubt that, so far as most clubs are concerned, direction finding is a closed book, probably because the winter months are generally devoted to theoretical discussions and opportunity for directional tests are comparatively few. In the summer, however, a field day devoted to D.F. will reveal a hundred and one lines of research and will open up fresh avenues for discussion during the winter. Information will be gleaned regarding screening effects exerted by hills, trees, buildings and, in certain cases, by geological formations.

Practical experience with D.F. will also assist in the preparation of polar charts and prove a useful basis for experiments in determining the positions of unknown transmitters.

THE FIELD OF OPERATIONS. The dotted lines indicate the bearings taken by the successful party, R3, starting from Moscar Lodge, four miles to the north-west.

AMATEUR COMPETITION AND EXHIBITION.

A COMPETITION has been organised by the Selfridge Radio Society, to take place on September 2nd, followed by an exhibition of all sets entered in Messrs. Selfridge's Palm Court, by the courtesy of the Directors. There are seven sections open for competitors, therefore giving everybody a wide choice of entries.

The competition is open only to bona fide amateurs who are members of the Radio Society of Great Britain and/or its affiliated societies, or members of the Wireless League and its branches.

The prizes are as follows :—First prize, £15 ; second prize, £7 10s. ; and third prize, £5 ; also 100 consolation prizes of 30s. each, presented by the Mullard Valve Co. Radio components, etc., can be chosen at the option of the prize-winners from the manufactures of Messrs. Alfred Graham (Amplions), the Mullard Valve Co. and The Radio Communication Co. (components). All the entries will be eligible for the gold medal offered by Sir Arthur Stanley for the best radio invention of the year. Professor A. M. Low has offered a special prize for the best set constructed by a lady competitor.

The full details can be obtained from the honorary secretary of local branches.

HINTS and TIPS for NEW READERS

A Section Devoted to the Practical Assistance of the Beginner.

AN IMPROVISED "VERNIER" CONDENSER CONTROL.

Condensers of the older pattern, without provision for fine control, may be used in simple sets designed mainly for local reception, but are hardly suitable for modern, sharply tuned receivers with highly efficient coils and transformers, as it is most difficult to make sufficiently accurate adjustments without the aid of special devices.

It is often possible to fit a "slow-motion" dial to an existing condenser, and this is almost certainly the best way of overcoming the difficulty, but is not always practicable, particularly when the spindle is of an unusual size. The next best alternative is to connect a separate "vernier" condenser in parallel with each of the main tuning condensers; many of the former now on the market occupy a very small amount of panel space, and room can generally be found for them.

When it is not desired to go to the trouble of installing either of the above-mentioned devices, it may be mentioned that the use of an ordinary pencil, fitted with a soft rubber eraser tip, enables one to obtain an extremely fine control over the movement of the condenser for a few degrees of its rotation. The rubber tip should be firmly pressed against the panel in such a way that its side also bears against the periphery of the dial, when it will be found that, by turning the pencil slightly, a considerably reduced movement will be imparted to the rotor of the condenser. This arrangement is admittedly only a makeshift, but is surprisingly effective, and has the advantage that the pencil acts as a form of "anti-capacity" handle.

SELECTIVE CRYSTAL RECEIVERS.

The average crystal receiver is not remarkable for its selectivity, and, indeed, this quality is, as a general rule, not particularly necessary, except to the small minority of listeners living in close proximity to a spark station. The position is, however, now somewhat changed, in view of the fact that the transmission of alternative programmes by neighbouring stations is being considered, and has, in fact, been tried experimentally.

If suitable precautions are taken in order to reduce crystal damping, it is possible, and, indeed, fairly easy, to design a crystal receiver possessing a high degree of selectivity. A certain amount of signal strength must generally be sacrificed, but this will not be excessive unless circumstances make it necessary to take extreme measures.

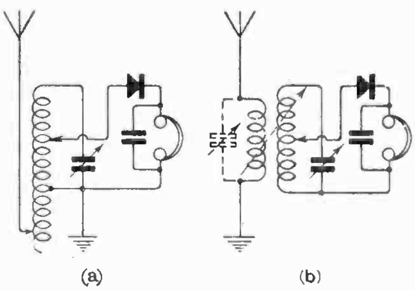


Fig. 1.—Crystal circuits for maximum selectivity.

The circuit shown in Fig. 1 (a) is the simplest arrangement likely to give the amount of selectivity which is necessary if the broadcasting of different programmes on the general lines of the original experiments becomes an accomplished fact. Referring to the circuit diagram, it will be seen that the aerial circuit is not separately tuned, and the coupling between it and the tuned secondary coil is increased or decreased by moving the aerial tapping in such a way that a greater or lesser number of turns are included in the aerial-earth circuit.

The coil may be wound as a simple single-layer solenoid with a total of 80 turns of No. 22 D.C.C. wire on a 3in. former, with a tapping at the 15th turn from the lower end for connection to earth. This aerial section should be tapped at every second or third turn. A number of tappings should be made experimentally on the upper portion of the coil; when a low-resistance galena crystal is used, it may well be found that the best results from the point of view of selectivity with adequate signal strength will be obtained when the crystal is joined to a point only some ten or fifteen turns above the earth connection.

It is suggested, when the receiver is first set up, that the crystal tapping should be connected to, roughly, the centre point of the tuned section of the coil, and the aerial to its lower extremity. When a station is once tuned in selectivity may be progressively increased by moving both aerial and crystal tappings towards the earth connection. The reduction of crystal damping, obtained by the first adjustment, will be found to have a very marked effect in improving the sharpness of tuning.

Another effective circuit arrangement, shown in Fig. 1 (b), is of the more conventional type, with a tuned aerial circuit and variable coupling between primary and secondary coils. It is, generally speaking, capable of giving somewhat better results than the simpler receiver described above, at the expense, however, of an extra tuning adjustment.

TESTING A NEUTRODYNE.

A convenient method of testing a two-stage neutralised H.F. amplifier-detector was suggested in the "Dissected Diagrams" accompanying this section of *The Wireless World* for May 26th, 1926. Briefly, it was shown that the effectiveness of the transformers and of the apparatus associated with them could be tested by removing temporarily, in the order named, the second and first H.F. amplifying valves, and connecting the aerial lead to the anode sockets of the respective valves.

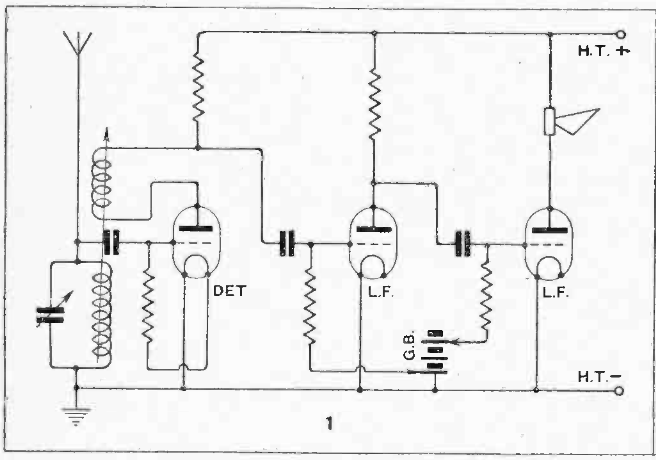
In this particular case a transformer-coupled receiver was under consideration, and the primary winding was made to act as an aerial coil. The method is, however, applicable to a receiver operating on the "tuned anode" principle, but it should be borne in mind that some precaution must be taken to prevent excessive damping by the aerial, or a totally inaccurate idea of the condition of the set will be obtained, and, moreover, the extra capacity introduced (that of the aerial itself) will further complicate matters.

In practice, the trouble is most easily overcome by inserting a variable condenser of, say, 0.0003 mfd., set near its minimum capacity, between the aerial lead-in and the anode socket of the valve holder.

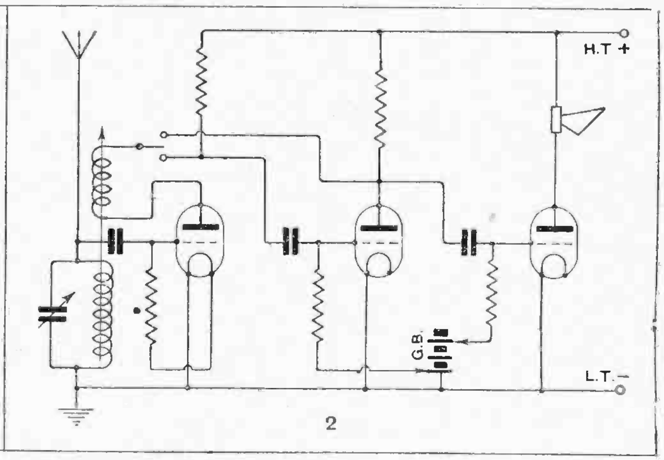
DISSECTED DIAGRAMS.

No. 37.—Switching a Resistance-capacity Amplifier.

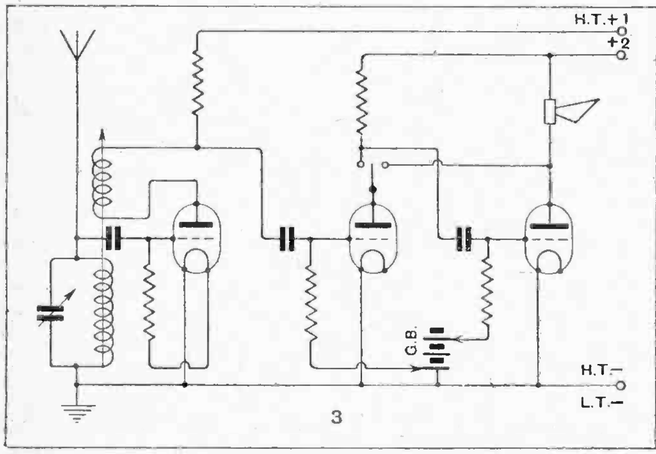
Various practical switching arrangements, whereby different numbers of valves may be used at will, are shown below; the methods indicated are obviously equally applicable when three L.F. stages are used. Circuits Nos. 3 and 4 are particularly useful when headphones are used as an alternative to the loud-speaker.



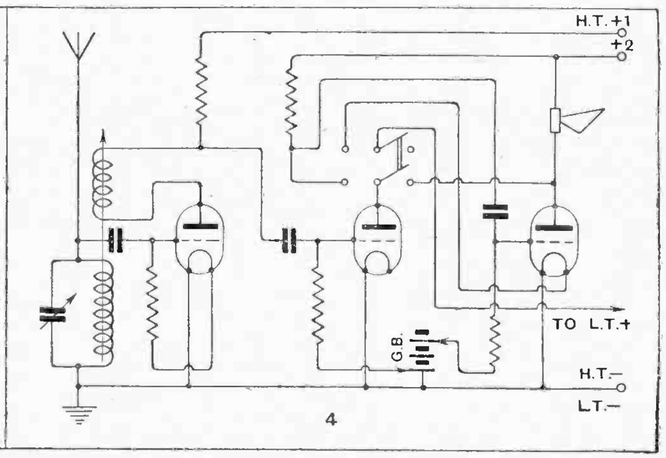
The basic circuit diagram, without switching. In order to simply matters, filament circuits are omitted. Note that a common H.T. voltage is used for all valves. (This may be quite permissible, even as regards the detector.)



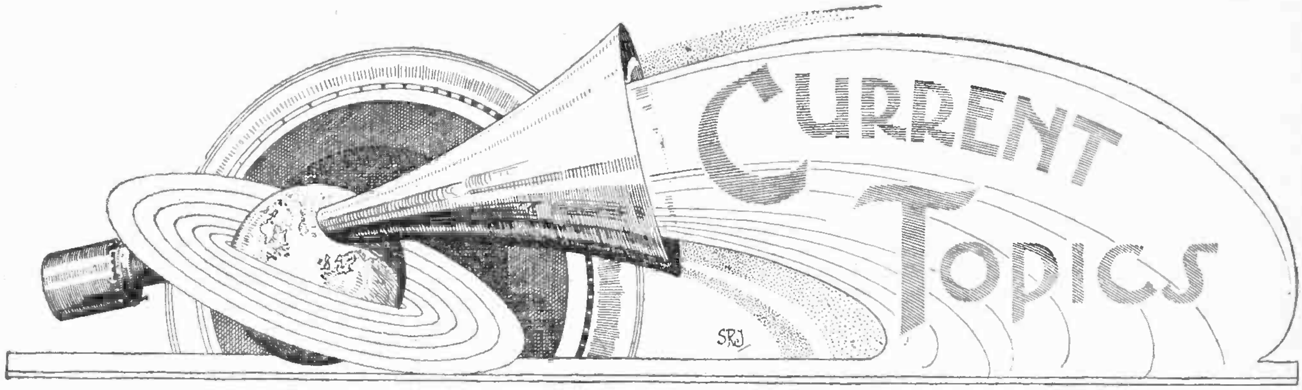
The first L.F. valve may be eliminated by connecting a single-pole change-over switch as shown above. This leaves the loud-speaker in the anode circuit of the last valve, which is presumably of the power type.



A suitable arrangement, under certain conditions, particularly when a separate H.T. feed is supplied for the detector valve. The loud-speaker (or telephones) are transferred to the anode circuit of the first L.F. valve, the second being eliminated.



The same as No. 3, but with automatic control of the filament of the last valve, by means of an extra pole on the switch. The same arrangement may easily be applied to the No. 2 circuit, using the extra blade for breaking the filament circuit of the first L.F. valve.



News of the Week in Brief Review.

BEAM STATION.

The new wireless beam station at Tetney, near Grimsby, destined for communication with Australia, is nearing completion.

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BROADCASTING IN IRELAND.

The scheme proposed for the development of broadcasting is the erection of a high-power station at Athlone to serve the Midland area of the Irish Free State, with lower-powered stations at Dublin, Cork, Galway and Bundoran. The present Dublin station would, of course, be maintained for the Eastern area, and the station at Cork will serve the South.

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HOSPITAL RECEIVERS.

The local branch of the Wireless League has presented the Victoria Hospital at Kingston with a fine four-valve receiver, costing about £80, which has been collected for their "Wireless for Local Hospitals" fund. They hope to have four other hospitals similarly equipped in the near future.

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SHORT WAVELENGTH TESTS.

The American Naval Research Laboratory has recently conducted tests to determine the most economical and reliable channels of wireless communication. Regular messages have been exchanged on about 13 metres between the naval station at Bellevue, Anacostia, D.C., and Mare Island, California, a distance of about 3,000 miles. This is considered a very satisfactory demonstration of the carrying power of short waves over a long distance in daylight, even with a low-power transmitter.

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PIRACY IN THE I.F.S.

The Minister for Posts and Telegraphs in the Irish Free State estimates that twenty-five thousand persons in the Free State own wireless receivers, but of these only 5,000 had taken out licences since the beginning of the financial year. As it is proposed to erect four new broadcasting stations at a capital cost of £80,000 and an estimated annual cost of between £60,000 and £70,000, taxpayers are hoping that the Irish authorities will be successful in convincing these "pirates" of the error of their ways.

THE UNTIRING AMATEUR.

Every day and all day in every country of the world, says *Western Wireless*, the amateurs are plodding along, helping to keep short-wave radio in its place as one of the foremost advances of modern science. Long live the amateur!

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PROPOSED WIRELESS EXHIBITION IN DUBLIN.

The Wireless Society of Ireland is considering the organisation of another Exhibition in Dublin during the coming autumn, but in view of the duty imposed on wireless goods in the Irish Free State, the Society wishes to ascertain the feelings of those whose interests are affected before taking any action in the matter. The hon. treasurer will, therefore, be glad to have the opinion of manufacturers and others as to whether (1) an exhibition should be held in Dublin in the autumn; (2) under the management of the Wireless Society of Ireland; and (3) if they would become exhibitors.

SPEEDING DOWN THE MUSIC.

Women, all the world over, often fail to grasp the difference between a wireless receiver and a gramophone. The editor of a South African contemporary recounts how a lady who found it difficult to keep pace with the tunes broadcast by the dance bands, enquired in desperation "Will you please tell me how I can slow down the music for dancing? I have tried turning all the knobs, but it is no use."

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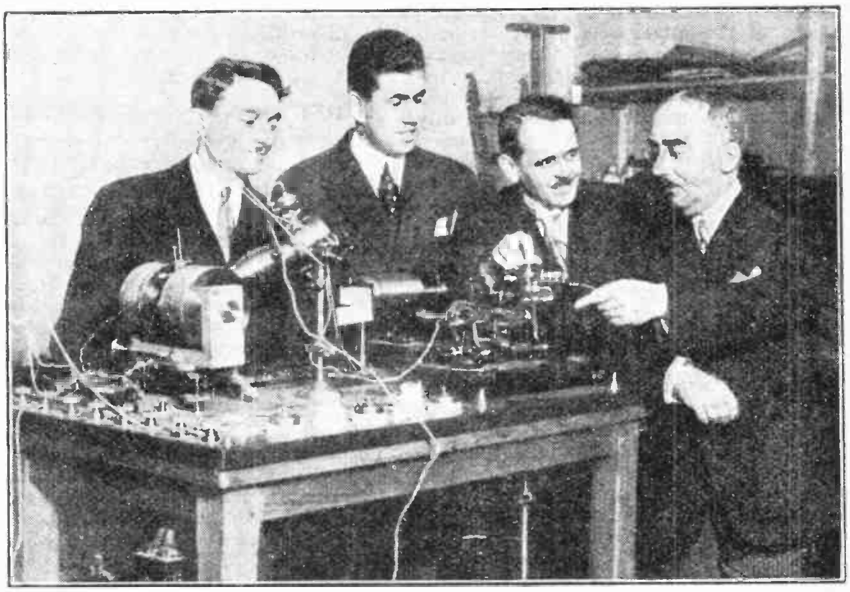
WIRELESS TELEPHONE SETS ON WHALERS.

A fleet of eight whaling vessels is to be fitted with wireless telephone sets. Experience has proved that this type of installation is better suited to the requirements of such vessels than sets requiring an operator skilled in reading Morse. They will undoubtedly be of great service in the navigation of the fleet and in getting into telephonic communication with the shore staff.



WIRELESS PICTURE TRANSMISSION. M. Edouard Belin (right), the distinguished French inventor, photographed at the Vienna broadcasting station. He is seen describing his telephoto apparatus to Professor Richtera, a station director. The Vienna station will shortly supply its listeners with a picture service.

ESPERANTO AND TECHNICAL LITERATURE.

At the first International Congress of the Technical Press, held in Paris last October, a resolution was passed suggesting that Esperanto should be used for summarising the articles appearing in the columns of various papers. The "Electrician," in commenting on this suggestion, points out that an author not only writes in a language, but thinks in it, and it is a matter of considerable difficulty to translate his meaning into a language which is not a vehicle of thought.

This argument is undoubtedly true from a literary standpoint, but, at the same time, a universal though artificial language may be very useful in outlining the skeleton of a scientific article for the benefit of widely distributed foreign readers.

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A.C. MAINS UNIT.

In the theoretical circuit diagram given on page 7 of the issue of July 7th, the leads passing from the centre tapping points on the H.T. supply transformer are reversed. These should be changed over, making the lead from the filament tapping point connect through the choke to the H.T. positive terminal. The practical wiring diagram is, however, correct.

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THE LOEWE RESISTANCE.

Apropos of the article on High Ohmic Resistances by Dr. Kroncke, in our issue of June 30th, we are able to state that The Edison Swan Electric Co., Ltd., of 123-5, Queen Victoria Street, E.C.4, possess the sole manufacturing rights in this country of the Loewe resistance.

The outstanding characteristics of the Ediswan vacuum grid leak are that the resistance remains constant whatever the applied voltage; the resistor, being in vacuum, is unaffected by varying conditions of the atmosphere, thus ensuring the absence of crackle. They possess practically no self-capacity—a very important factor, often overlooked—for grid currents are minute, and consequently losses should be reduced to a minimum. The resistance element of the Ediswan grid leak, not being of granular type, does not "pack up." The end caps, which make perfect contact with the resistor, cannot slide or become loose, since they are cemented on to the glass tube.

They are manufactured in the following sizes :—.5, 1, 2, 3, 4 and 5 megohms, and are retailed at 2s. 6d. each.

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VOLTA CENTENARY.

The centenary of the death of Alessandra Volta, which occurred on March 5, 1827, will be celebrated next year at Como by an International Exhibition and Congress relating to telegraphy, telephony and radio, which will be held between May and October. The radio section will include records, documents, apparatus and statistical and educational matters. Public bodies and firms who wish to participate should communicate with the Ministry of Communications, Viale de Re 131, Rome.

A BROADCAST AUCTION.

One of the latest New York crazes is said to be listening by radio to auction sales. At a recent sale of a collection of works of art the bidding was held up for the space of an hour to enable listeners to make better offers by telephone. At the expiration of the time the listeners' bids were read out and regular bidding resumed.

We understand that this particular sale was in the cause of charity, and it is unlikely that dealers either in America or England will encourage the growth of this innovation.

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PRESIDENTIAL ADDRESS BROADCAST.

The President of Haiti has recently broadcast two addresses, one in English for the benefit of listeners in the United States, the other in French to his people in Haiti. President Borno is greatly impressed with the possibilities of wireless as a peace-preserving agency.

EVERYMAN'S 4-VALVE RECEIVER.

A receiver of special interest to every reader will be described by Mr. W. James in our next issue. The receiver is one of extreme simplicity, and although economical to build, its efficiency places it in a class by itself.

WIRELESS IN MOUNTAIN HUTS.

The Radio Club de France has decided to equip refuge huts in the Pyrenees and other mountain ranges with wireless transmitters and receivers. The difficulty of equipping these huts with land-line proved almost insuperable so, for the past three years, experiments have been carried out with wireless to enable mountaineers in difficulties to communicate with the world below.

WIRELESS AT WESTMINSTER.

(By Our Special Parliamentary Correspondent.)

THE FUTURE OF BROADCASTING.

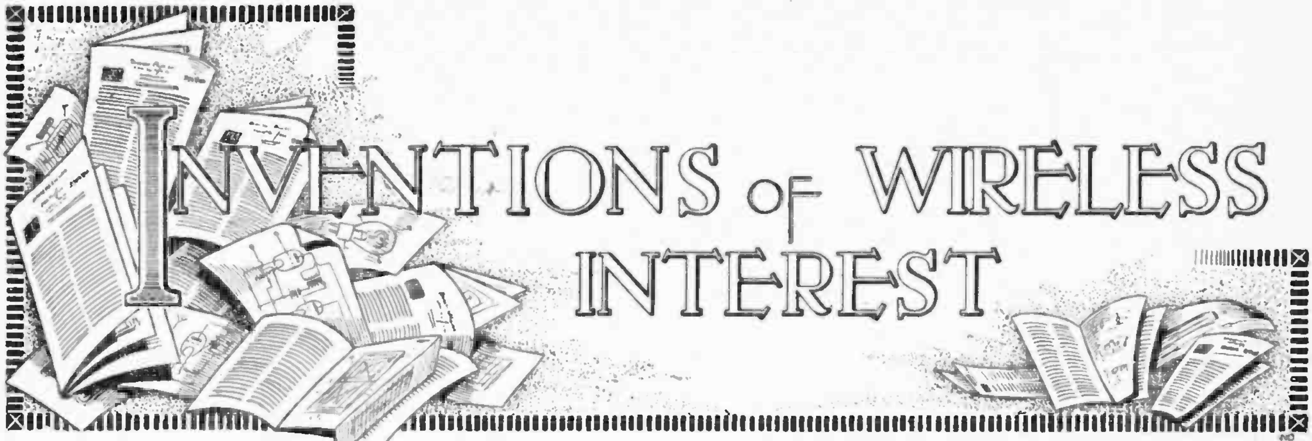
Details with regard to the future of broadcasting were given by the Postmaster-General during discussion on the Post Office Estimates in the House of Commons on Wednesday last. The Government, as already announced, propose to accept the recommendations of the Crawford Committee, and the new body which is to control broadcasting is to be set up in the autumn by Royal Charter and is to be known as the British Broadcasting Corporation. The House will have an opportunity of discussing the matter again in the autumn. At the outset, Sir Wm. Mitchell-Thomson said that the number of wireless licences actually in force was 2,076,000, as compared with 1,387,000 a year ago. There was an idea that the rate of progress in the issue of wireless licences had fallen off, but the number of licences issued last June was higher as compared with June 1925. He hoped that no one would imagine that the Post Office would relax its efforts to prosecute any people who failed in their duty as citizens and as honest people to take out wireless licences. It was the cheapest form of entertainment ever offered.

With regard to the future of broadcasting, proceeded Sir William, the Government had accepted in general the recommendations made by the Committee under the Chairmanship of Lord Crawford, which were, briefly, that the broadcasting service should be taken over by a public corporation, acting as trustee for the national interest; that the corporation should be licensed by the Postmaster-General for a period of not less than ten years; that the undertaking of the British Broadcasting Company should be taken over as a going concern; and that the receiving licence should be retained at 10s. There would be no interruption whatever in the continuity of the service. The intention was that on December 31 the service at present conducted by the British Broadcasting Company should pass over as a going concern—plant, assets and a large part of the staff—to the control of the new authority.

As to the constitution of the authority, the Government felt that to set up a body by statute would prejudice its position from the start, by introducing into the minds of the public the idea that in some way or other it was the creature of Parliament, and connected with political activity. If broadcasting was to live in this country he was perfectly certain that its vitality would be increased directly as they succeeded in divorcing it from political activity. They also found inseparable objections to setting up a new body under the Companies Acts, and they therefore proposed to move the Crown to be pleased to grant a Royal Charter for an incorporated body to hold a licence from the Postmaster-General and to conduct this service. The actual regulation of the functions of the new body would have to be made by the House of Commons, either by legislation in the autumn or by way of supplementary estimates. Whichever way was chosen there would be further opportunity for discussion of details, and before that discussion the draft of the petition and any relative papers would be issued. The new body would be called the British Broadcasting Corporation rather to emphasise the fact that it existed by Royal Charter. He had the financial arrangements in hand, under which he hoped it would be possible for the new body to start with a clean sheet, free from all liabilities.

SMALL ADVERTISEMENTS.

In view of earlier closing for press, necessitated by the August Bank Holiday, Monday, August 2nd, Miscellaneous Advertisements intended for insertion in *The Wireless World* of August 4th should reach Dorset House, Tudor Street, London, E.C.4, not later than first post on Wednesday, July 28th, or Branch Offices on Tuesday morning, July 27th.

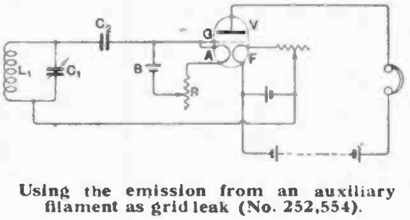


The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

An Electronic Grid Leak.
(No. 252,554).

Application date June 19th, 1925.

What is virtually an electronic grid leak is described by the Dubilier Condenser Co. (1925), Ltd., and J. V. Capicotto in the above British patent. The accompanying illustration shows a valve V provided with the usual grid G and filament F. Connected to the input of the valve, that is, between the grid and filament, is an ordinary tuned circuit L_1 C_1, connection being made through the grid condenser C_2. A valve connected in this manner would soon cease to function, because the grid would assume a negative charge which would cut off the anode current. It is necessary, therefore, to leak the negative charge away from the grid, and for this purpose an ordinary grid leak is normally employed. According to this invention, however, the grid is electrically connected to another filament A sealed into the valve, this filament being heated by a small battery B and the current controlled by a resistance R. As soon as the filament is heated electronic emission will occur, establishing a path directly between the path of



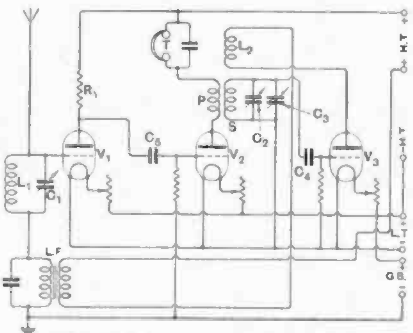
Using the emission from an auxiliary filament as grid leak (No. 252,554).

the main filament F, thereby enabling the negative charge which accumulates on the grid to leak away. This leakage will be dependent upon the amount of emission from the auxiliary filament, which can be controlled by the variable resistance R, the arrangement thereby substituting the normal grid leak, and being, of course, more stable in operation than the usual variable high resistance.

A Reflex Circuit.
(No. 251,374).

Application dates February 11th, 1925, *and March 28th* 1925.

C. A. Cleghorn describes in the above British patent a reflex circuit which will no doubt be of interest to experimenters. The novelty of the invention lies in the



Resistance-coupled reflex circuit (No. 251,374).

use of a resistance as a coupling device for the first high-frequency stage, this valve also acting as a low-frequency amplifier. Thus the accompanying illustration shows the arrangement of the device. An ordinary aerial tuning circuit L_1 C_1 is shown connected in the grid circuit of the first valve, the anode circuit of which contains a resistance R_1, which is coupled by a condenser to the grid of the second amplifier. The anode circuit of this valve contains the primary P of a high-frequency transformer, the secondary S of which is tuned by a variable condenser C_2 to the incoming wavelength. This is coupled in the normal manner to the second valve V_3 through a coupling condenser C_4, reaction being obtained in the anode circuit of the valve V_3 by means of an inductance L_2 and the secondary of the coupling transformer. The anode circuit of the detector valve also includes the primary winding of a low-frequency transformer LF, the secondary of which is included in the grid circuit of the first valve. The low-frequency potentials are thus reamplified by the first valve, and are passed on through the coupling condenser C_5 to the second valve which also contains the telephones T.

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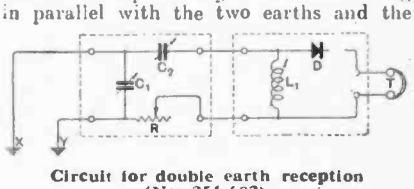
Double Earth Reception.
(No. 251,693).

Application date February 6th, 1925.

Many aerial systems have been devised from time to time, and an interesting system employing two earth connections is described in the above British patent by G. A. Morris and B. C. Stevenson. The accompanying illustration shows the arrangement of the reception system, which consists essentially of two independent earths X and Y, such, for example, as one made to a water pipe and the other to a buried plate. These are associated with an ordinary receiver, which is shown as a variable induction L, and a crystal detector D connected to a pair of telephones T in the normal manner. Connection from the earths is not made direct to the set, but through an arrangement of variable condensers and a resistance. Thus, there are two variable condensers C_1 and C_2, the former being in parallel with the two earths and the



Circuit for double earth reception (No. 251,693).

latter in series with one earth, while the variable resistance R is in series with the other earth. The remote side of the variable condenser C_2 and the variable resistance R are connected to the ordinary aerial and earth terminals of the receiving set. The series condenser C_2 may be between 0.00001 and 0.0003 mfd., while the shunt condenser may be of the order of 0.001 mfd., and the variable resistance may be about 20 ohms. In another modification of the invention high-frequency chokes are shown connected across the two variable condensers C_1 and C_2.

THE FOUR-ELECTRODE VALVE.

Are we Taking Full Advantage of its Many Useful Properties?

By A. P. CASTELLAIN, B.Sc., D.I.C., A.C.G.I.

THE four-electrode valve has not gained the popularity it should have, in view of its theoretical possibilities, and the writer is attempting, in this article, to show why this has been so, and to see if it is worth while for the manufacturers to consider spending time and money on producing special types of these valves—as they have done for the usual three-electrode type. The conclusion arrived at is that there is a very big future indeed for these valves, *if they are properly designed for the work they have to do*—in fact, the writer is of opinion that they will become even more popular than the present type.

It is perhaps not very well known that there are three main ways in which a four-electrode valve may be used. These are enumerated below.

Four-electrode Valve Circuits.

(*a*) The valve may be used as two ordinary three-electrode amplifiers, or for dual amplification, one grid dealing with high-frequency currents and the other with the low, as indicated in the diagram of Fig. 1.

(*b*) The valve may be used for amplification and rectification at the same time—here the inner grid deals with H.F. amplification, the outer grid becomes the " plate," and may also deal with low-frequency amplification, while the plate is used as a control electrode for rectification, as shown schematically in Fig. 2.

(*c*) The inner grid may be kept at a permanent positive potential in order to reduce the effect of the " space charge," and so permit of much reduced values of H.T. being used. This is shown in diagram Fig. 3.

It should be a fair assumption to make that a valve specially designed for method (*a*) will not necessarily be the best, or even a suitable design for methods (*b*) or (*c*), and as a matter of fact this is so, and one of the reasons why the four-electrode has not come into its own, is that existing designs on the market are very much of a compromise, and so do not give results with any

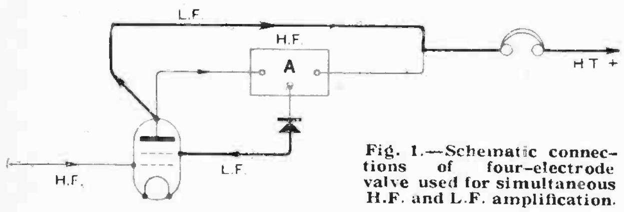


Fig. 1.—Schematic connections of four-electrode valve used for simultaneous H.F. and L.F. amplification.

one method that might be expected of them from the theoretical point of view.

Taking first method (*c*), the use of the inner grid to reduce H.T. value required, as being of the most general interest, from the point of view of use in existing sets; let us just see what are the general principles on which the valve must be designed.

First of all, it is necessary to understand how the inner grid can affect the H.T. voltage required.

In the ordinary three-electrode valve, with the grid in metallic connection with one side of the filament (through the external grid circuit, of course) there is a cloud of electrons surrounding the filament when the latter is normally heated. With the valve in normal use only a comparatively small number of electrons from this cloud pass through the grid to the plate to form the plate current, and the presence of this cloud of electrons tends to limit the number of electrons evaporating from the filament, since electrons are negatively charged bodies and therefore repel one another, although, as electrons are removed from the cloud to the plate, they are replaced by others from the filament.

Thus, the larger the cloud the greater its effect on suppressing more electrons from the filament. Now the size of this cloud depends on the potential of the other electrodes with respect to the filament, *i.e.*, on the force

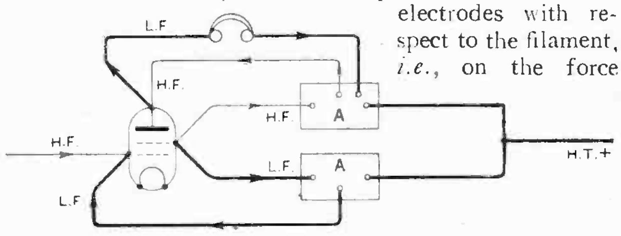


Fig. 2.—Circuit for simultaneous H.F. amplification, rectification and L.F. amplification.

tending to drag electrons away from the cloud. Obviously, since the grid is much nearer the cloud than the plate, a given potential change on the former will have a much larger effect than the same potential change on the latter, giving rise to the well-known amplifying properties of the valve; but, by making due allowance for this, it is convenient sometimes to regard the effect of these two electrodes as being due to one mythical electrode having a potential called the *lumped* potential (*i.e.*, plate potential + amplification factor × grid potential).

The Lumped Characteristic.

Fig. 4 shows the relation between this lumped potential and the plate current.

It will be seen that the minimum value for the lumped potential is the value shown at (*a*) in Fig. 4, when the valve is used as an amplifier, since below this value the plate current is not proportional to the lumped potential —and hence, since the plate potential is kept fixed, not proportional to the grid potential, therefore distortion will be produced.

If this potential is of sufficient value the cloud will cease to exist, since all the electrons will be rushing over to the plate as fast as they evaporate from the filament, and the valve is then said to be saturated, or giving its saturation current.

With the valve in use as an amplifier—especially in the case of a low-frequency amplifier—the grid must

The Four-Electrode Valve.—

always be negative in order that no distortion may be produced by grid current flowing. Hence, since the lumped potential referred to above must be positive and of reasonable size, it follows that the plate potential must have a very large positive value in order to make up for the necessary negative grid potential, simply in order to cut down the space charge cloud to a size where it ceases to affect the linear relation between grid voltage and plate current.

If the space charge could be reduced by other means, then quite small plate voltages would be all that is necessary, since we would at least save the value represented by (*a*) in Fig. 4, which may be 30 or 40 volts.

If we put another electrode between the grid and the filament, and make it of grid formation so that electrons may travel through it, then such an electrode if kept at a positive potential, will obviously reduce the space charge by providing a local "pull" on the electrons forming the cloud.

So much for the action of the inner grid on the space charge and H.T. value required. The next point to consider is what other effects the introduction of the second grid will have, especially on the amplification characteristics of the valve.

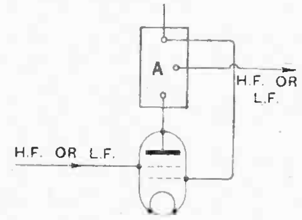


Fig. 3.—Connections for reducing space charge and H.T. voltage.

It has already been shown that the amplification of the three-electrode valve, as usually used, depends on the grid being nearer to the filament than the plate—*i.e.*, depends on the ratio of plate-to-filament to grid-to-filament distances, but it also depends on the "closeness" of the grid—*i.e.*, on the ratio of space to metal in the grid itself—thus a "close" grid means a high amplification factor and an open grid a low one.

Spacing of Electrodes.

If we introduce a second "plate" (although of grid formation) as we are doing, between grid and filament, we must put it as far from the grid as possible, and therefore very close to the filament. For convenience, the H.T. supply to the plate will probably be used for the inner grid, so that the latter may be very "open" indeed, since it is to be very near the filament.

If the second grid is placed near the ordinary grid, then the amplification factor of the valve will obviously be reduced, since the effect is the same as bringing the plate nearer to the grid in an ordinary valve.

Filament Emission.

Another point that requires consideration is the filament emission—especially in the case of low-frequency amplifiers. It is well known that a valve for loud-speaker work—commonly called a power valve, should have a large filament emission of the order of 25 milliamps. or so saturation value, yet the writer is not aware of any four-electrode valve on the market which fulfils this very necessary condition. It is, of course, possible to approximate to the required conditions by connecting two or more valves in parallel, but this is a compromise, and an expensive compromise, too, which rather defeats what should be one of their chief advantages—namely, lower installation and running costs.

A moment's consideration will show how the provision of a totally inadequate filament (as in present-day designs) adversely affects the use and popularity of these valves, since, to run a loud-speaker properly, power L.F valves *must* be used, and since there are no power four-electrodes yet on the market the ordinary three-electrode type will have to be installed, with its attendant high-tension battery having the comparatively high voltage of 100-120.

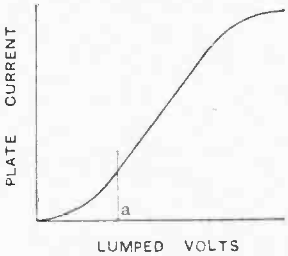


Fig. 4.—"Lumped" valve characteristic.

Since this value of H.T. has to be supplied anyway, there is no advantage whatever in using four-electrodes for H.F. and detector stages in the set instead of the ordinary type—in fact, there is a positive disadvantage in the H.F. case, as existing four-electrodes have a much lower amplification factor than H.F. type three-electrodes.

Also, valves used for dual amplification—as in methods (*a*) and (*b*) previously discussed—should have big filament emissions, as they are dealing with L.F. amplification—so that, until this condition is complied with, four-electrode valves are not likely to be popular or to replace the more usual type.

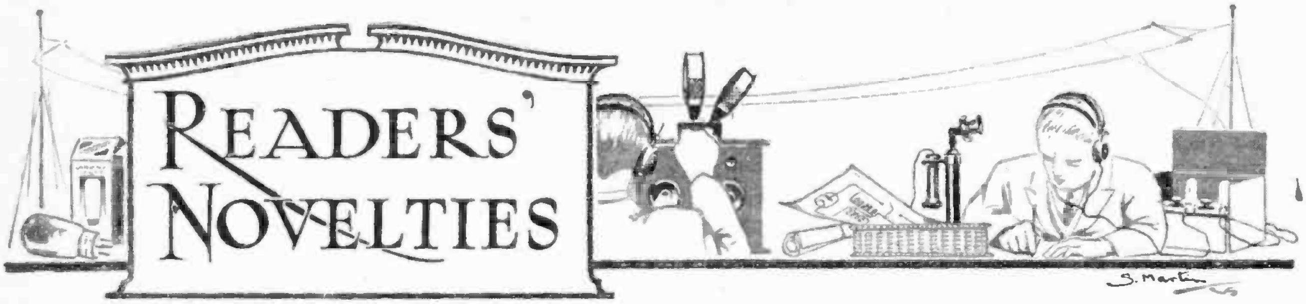
However, when this is done, and when they are otherwise correctly designed for the job they have to do, then they will come into their own, and also the real light-weight portable *loud-speaker* set will be a thing of fact and not as it is now—the product of an optimist!

EUROPE'S WAVELENGTH PROBLEMS.

THE Committee of the International Wireless Union, which represents the principal European wireless organisations, met on July 5th and 6th in Paris. Approval was given the points put forward in the report of M. Raymond Braillard, President of the Technical Commission, regarding the plan for redistribution of wavelengths among the European broadcasting stations working between 200 and 600 metres. This plan for re-allocation of wavelengths was given official sanction last March at Geneva, and it may be brought into force in the latter half of September. When applied, it should considerably reduce interference by neighbouring stations.

Advice will be available to listeners regarding any slight modification to their sets which may be found necessary in order to adapt them to the new wavelengths of those stations to which they are in the habit of listening.

The application of the Geneva plans will be a very important step forward in the development of broadcasting. Further plans with respect to stations working on wavelengths of more than 600 metres are in preparation.



A Section Devoted to New Ideas and Practical Devices.

CONDENSER CONNECTIONS.

There is often difficulty in making connection to home-made condensers built up with sheets of mica and tin foil. If an attempt is made to use ordinary solder for the joint, it will be found that the tin foil will melt away before a satisfactory connection can be made. The difficulty is easily overcome by using Wood's metal as a solder, though care must be taken that the iron is not overheated by force of habit to the temperature required for ordinary tinman's solder.

Although electrically perfect, the joint is not mechanically very sound, therefore it is advisable to anchor the connecting wires just before they reach the condenser, and to complete the connection with a short length of home-made flex, consisting of four or five strands of No. 38 S.W.G. wire. —M. I. E.

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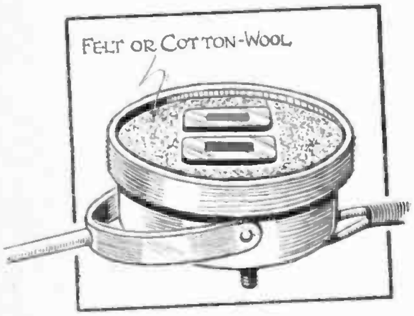
HEADPHONE IMPROVEMENT.

The quality of speech and music from many types of head telephones is hollow and metallic, due to acoustic resonance in the cavity behind the diaphragm. This can be overcome to a large extent by filling the spaces surrounding the permanent magnets and speech coils with cotton wool. In some cases it may be advantageous to allow the sound-absorbing material to come into actual contact with the underside of the diaphragm, in which case a ring of felt should be fitted, as shown in the sketch, to equalise the pressure on the underside of the diaphragm. Experiments with loud-speakers on the same lines would be well worth trying.—C. J. D.



Preventing resonance in head telephones.

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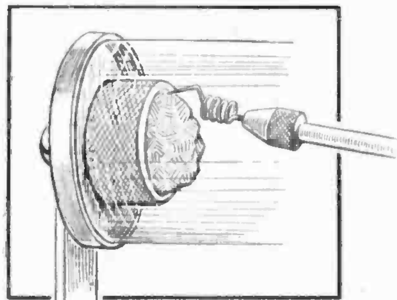
CRYSTAL CONTACT.

It is the experience of every crystal user that some of the best contact points are to be found on the sloping sides at the outer edge of the crystal.



Improved crystal contact.

It is, however, difficult to explore this region with the ordinary cat-whisker, which has been shaped to make contact with the face of the crystal. By bending the point slightly downwards and using an up-and-down movement of the adjusting knob instead of sliding it in a horizontal direction, an exceptionally critical variation of contact pressure can be obtained. This brings about a marked improvement in reception when applied to the many good rectifying points to be found at the edge. —G. A. H.

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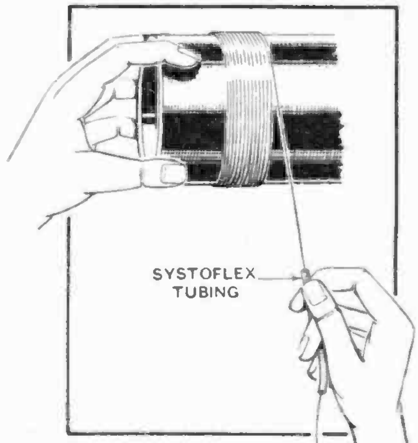
COIL WINDING.

In winding solenoid and other coils a certain amount of friction is necessary in order to keep the wire taut. This is generally supplied by letting the wire slip through the fingers, which after a time causes discomfort. A small piece of cloth may be used to protect the fingers, but a piece of Systoflex, about 4in. in length, threaded over the wire is much better. By interlacing the tubing between the fingers any desired degree of friction may be obtained, and it will be found that the insulating covering of the wire does not suffer in any way, since the area of friction contact is large. The method is particularly useful when using a mechanical winder.—W. F. C.



Method of keeping wire taut for coil winding

VALVES FOR IDEAS.

Readers are invited to submit brief details, with rough sketches, where necessary, of devices of experimental interest for inclusion in this section. A dull emitter receiving valve will be despatched to every reader whose idea is accepted for publication.

Letters should be addressed to the Editor, "Wireless World and Radio Review," Dorset House, Tudor St., London, E.C.4, and marked "Ideas."

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S

21.—Willoughby Smith Links the Fastnet Rocks with Mainland.

EARLY in 1892 the Trinity Brethren placed the Needles Lighthouse at the disposal of the Telegraph Construction and Maintenance Co. in order that they might have an opportunity of testing a method of wireless communication, invented by Willoughby Smith, whose researches in the subject date back to 1883.

Willoughby Smith was born at Great Yarmouth on April 16th, 1828, died at Eastbourne on July 17th, 1891, and was buried at Highgate Cemetery. At 20 years of age he commenced his life-long interest in telegraphic signalling and cable laying. He first joined (in 1848) the Gutta Percha Co., of London, and soon after commenced experimenting in insulating iron and copper wires with gutta percha for telegraphic purposes. In 1849 his company undertook to supply 30 miles of insulated wire to be laid from Dover to Calais, and during the following year Willoughby Smith manufactured and laid this cable. He was subsequently engaged almost continuously in cable work, assisted Sir Charles Wheatstone with his experiments, and—in 1854—laid the first Mediterranean cables, between Spezzia and Corsica and Corsica and Sardinia, and later between Sardinia and Cona, in Algeria. On his return he was appointed Manager of the Gutta Percha works, which (in 1864) were formed into what is now the Telegraph Construction and Maintenance Co., Ltd.

Willoughby Smith.

In 1865 Smith was on the *Great Eastern* assisting in laying the cable from Ireland to Newfoundland, and he was again on board during the following year, when the second cable was successfully laid.

Signalling to Trains.

It would seem that it was one of his assistants who was the first to discover the peculiar properties of selenium, in or before 1878. Willoughby Smith did not, however, realise at that time the wonderful possibilities that this discovery held; indeed, it was not until comparatively recently that these properties have been fully developed.

Willoughby Smith's first contribution to wireless appears to have been made in 1883, when he read a paper before the Institution of Electrical Engineers on wireless communication with trains. (This paper was dealt with in our last instalment, and we mentioned that the suggestions it contained were put into practice by T. A Edison.) He suggested fixing one or more coils of wire between the rails at any convenient distance from the signalling station and sending intermittent currents through them. Another coil was to be fixed underneath the engine, or under the guard's van, and telephones connected in the circuit. Then, as the train passed over the fixed spirals, a signal would be picked up and reproduced in the telephones. Phelps took the matter a step further, and, as we have already seen, in 1885 Edison and Gilliland developed and perfected it into a practical system.

Conduction Experiments.

The result of these suggestions for communicating with trains seems to have caused Willoughby Smith to think that communication by induction was not practicable, and he appears to have then turned his attention to the alternative method of conduction by earth and water. In *The Electrician* (November 2nd, 1888) he explained his method by which he had been able to signal to lighthouses and ships within a certain distance of the shore.

From his shore station he laid two insulated copper wires 115 fathoms in length. "The ends of the wires, scraped clean, were twisted round anchors, their position being marked by buoys, about 100 fathoms apart, and in about 6 fathoms of water. Midway between the two a boat was anchored with a copper plate hanging fore and aft about 10 fathoms apart, and consequently about 45 fathoms from either end of the anchored shore wires. This boat represented the sea station, and, owing to the state of the sea, a very wet and lively one it proved; therefore, taking this fact into consideration, together with the crude nature of the experiment, it was remarkable with what distinctness and ease messages were passed. The last message sent from shore was: 'Thanks; that will do; pick up anchors and return.' To this the reply came from the boat: 'Understand,' and they then proceeded to carry out instructions. The boat employed was a wooden one, but it would have been much better for my purpose had it

Pioneers of Wireless.—
been of metal, for then I should have used it instead of one of the collecting plates, as the larger the surface of these plates the better the results obtained."

With Willoughby Smith's system signals were transmitted with "distinctiveness and ease," and accordingly a patent (No. 8159) was taken out on June 7th, 1887. The system was tried in May, 1892, between Alum Bay, in the Isle of Wight, and the Needles Lighthouse, and communication established first with the telephone as a receiver and later with a vibrator and Morse key. A mirror speaking-galvanometer was found more satisfactory, however, and a call apparatus was devised and installed successfully. The current from two or three Leclanché cells was found ample to maintain communication through the gap of water 60 yards in length.

On the recommendation of the Royal Commission, Willoughby Smith's method was subsequently installed at the Fastnet Rocks, off the south-west coast of Ireland. This is one of the most inaccessible beacons on our coasts, and so situated that it had been found impossible to maintain a cable, which was repeatedly broken by the waves.

The Fastnet Rock is 80ft. in height and 360ft. in length, with a maximum width of 150ft. By Willoughby Smith's system it was placed in electrical communication with the town of Crookhaven, eight miles distant.

The shore end of the main cable was landed at a small bay called Galley Cove, about one mile to the west of the Crookhaven Post Office, to which it was connected by means of a subterranean cable.

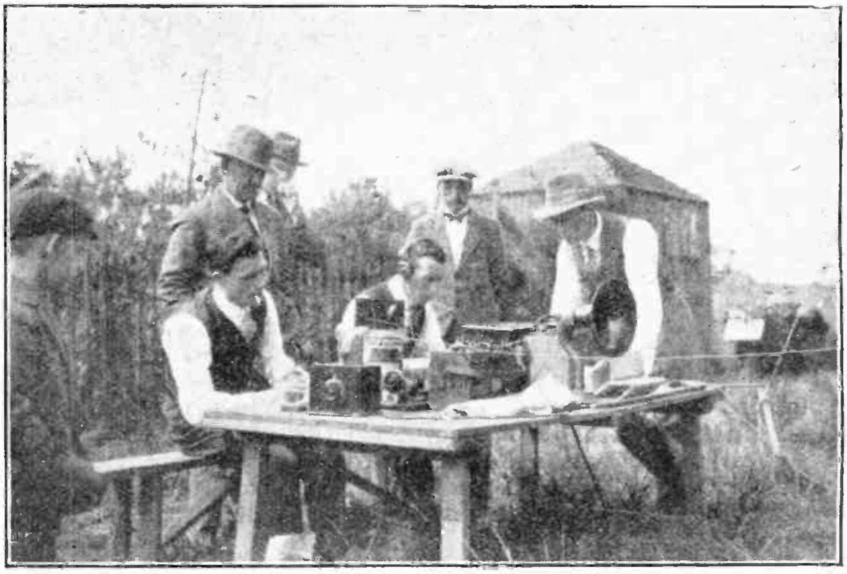
The "call" apparatus which at the time of its installation was described as being both "novel and substantial" is interesting. It automatically adapted itself "to any variation in the earth or polarisation current, and consisted essentially of two coils moving in a magnetic field. These coils are mounted one at each end of a balanced arm suspended at its centre and free to rotate horizontally within fixed limits. The normal position of the arm is midway between two fixed limiting stops. Any current circulating in the coils causes the whole suspended system to rotate until the arm is brought into contact with one or other of the stops—the direction of rotation depending upon the direction of the current. A local circuit is thus closed, which releases a clock-work train connected to a torsion head carrying the suspending wire, and thus a counter-balancing twist or torsion is put into the wire, and this torsion slowly increases until the arm leaves the stop and again assumes its free position. If, however, the current is reversed within a period of, say, five or ten seconds, then the clock-work closes a second circuit and the electric bell is operated. By this arrangement, whilst the relay automatically adjusts itself for all variations of current, the call-bell will only respond to definite reversals of small period and not to the more sluggish movements of earth-currents. It is evident that one or more bells can be placed in any part of the building. The receiving galvanometer and the 'call' relay have worked very satisfactorily, and any man of average intelligence can readily be taught in two or three weeks to work the whole system."

NEXT INSTALMENT.
The Early Experiments of Preece.

SHORT-WAVE TESTS WITH A PORTABLE.

TO maintain the enthusiasm of members during the summer season the Southend and District Radio Society is holding monthly meetings (Sundays, 10.30 a.m. to 12.30 p.m.) at Rochford. Last month's meeting took the form of a series of two-way communication tests between the Society's portable transmitter 5QK, situated in a meadow, and stations owned by Mr. A. C. Webb (6WQ) and Mr. C. J. Deal (6QO). Signals were successfully exchanged on a wavelength of 180 metres. The receiver and transmitter used on this occasion were constructed by Mr. Burrows (the Society's chairman) with the assistance of Mr. Revell, both of whom contributed much to the success obtained.

Intending members (who are welcome to any of the Society's meetings) are asked to communicate with the hon. sec., Mr. Fred Waller, Eastwood House, Rochford, Essex.



A MOBILE TRANSMITTER. The portable station 5QK, owned by the Southend and District Radio Society. Outdoor experiments in short-wave communication with other amateur stations were recently carried out successfully.

QUARTZ TECHNIQUE.

Calibrating a Quartz Wavelength Standard.

By A. HINDERLICH, M.A.

A QUARTZ standard of frequency gives results of such superlative accuracy, at such a modest cost, that at least one of these should form part of the equipment of every experimenter. This article describes how one may be set up and calibrated.

The apparatus required is :—

(a) Any receiver that has been roughly calibrated over some portion of its range.

(b) A simple absorption wavemeter, borrowed, if necessary, for the occasion.

(c) A quartz crystal. These are now available from several commercial sources. When ordering, the purpose for which it is required should be stated (to avoid getting one with extra weaker fundamentals), also the approximate wavelength. For short-wave purposes, 360 to 400 metres fundamental is convenient. If the quartz has been cut by the experimenter the wavelength will be either 105 or 155 metres per millimetre thickness ± 5 per cent.

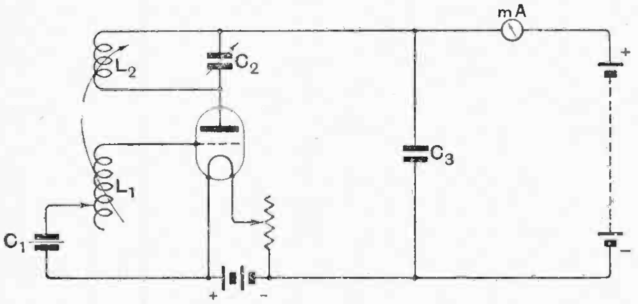


Fig. 1.—Crystal-controlled oscilator.

(d) Two surface-plates. The bottom one may be anything over one inch square, but the top one may with advantage be rather smaller. The finish obtained by using carborundum powder (obtainable as fine valve-grinding powder at any garage) on to plate glass (an old photographic negative plate will do) is sufficiently accurate.

(e) The apparatus shown in Fig. 1. Here C_1 is the mounted crystal, L_1 a tapped coil of about 15 turns closely coupled to the anode coil (with a good crystal it is dangerous to use L_1, so this should be short-circuited when first trying an unknown crystal). L_2 C_2 must cover the crystal fundamental. C_3 is a fixed by-pass condenser. mA is any milliammeter that will give a readable deflection in conjunction with any valve that will oscillate with about 60 volts H.T. It need not be accurate, and may even be dispensed with later on.

Fig. 2 shows the sort of thing that happens when L_1C_1 tune to about 28 metres, the crystal fundamental is on 45, and the condenser C_2 is varied. At A, the L_1C_1 combination is controlling, but at B it is the crystal alone. The sudden cessation of oscillations for a slight increase of anode capacity is characteristic of the crystal.

To show the method of calibration, we have chosen a slightly exaggerated example, merely to avoid confusing the diagram. We assume the crystal fundamental to be

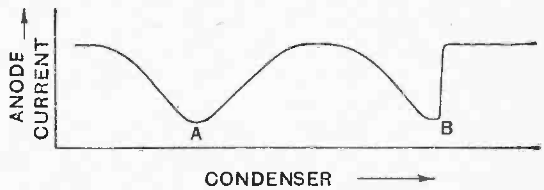


Fig. 2.—Change of anode circuit in the circuit of Fig. 1 near a crystal resonance point.

about 230, and that having picked up WGY's easily-recognised crystal-controlled transmission on 32.79 metres, we know the exact receiving condenser and wavemeter settings for this wavelength. The crystal oscillator is started, and C_2 is varied until the sudden reduction of anode current shows that the crystal is oscillating. In this case, the 6th, 7th and 8th harmonics are picked up and recorded in Table 1, columns 1 and 2. By reference to curve (a) in Fig. 3, which represents the previous rough calibration, we fill in the approximate wavelengths in column 3, and hence the real value of the fundamental in column 4. At the first trial these figures will rarely be identical, so we assume a more likely value, divide by the corresponding harmonic, and get column 5, which, when plotted out, gives curve (b). This looks very nice, but unfortunately does not pass through our calibration point, so we try again until it does, giving curve (c), plotted off column 6.

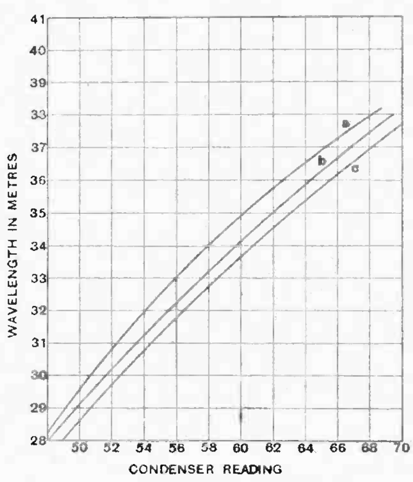


Fig. 3.—Curves plotted from Table I.

We are now in a position to calibrate the wavemeter off the receiver.

Having now got both the receiver and wavemeter accurate over a certain range, it is easy to extend in both directions. The great thing to remember is to keep one of them constant whenever changing coils on the other. If this precaution is neglected, one may find that one has started, say, from the 15th harmonic under the impression that it was the 16th. Results from both instruments should be plotted as they are obtained upon

Quartz Technique.—

squared paper. It is sometimes possible to get confused between, say, the 4th and $\frac{9}{2}$ harmonics, an error which will be shown up when the curves are found to be irregular.

For a permanent standard, where cost matters, the variable condenser C_2 may now be replaced by a fixed one of appropriate value, and the milliammeter may be removed, thus reducing the cost of bought components to about 15s. without the slightest sacrifice of accuracy. The crystal itself will have cost from 17s. 6d. to 50s., according to the original specification.

The accuracy attainable is governed by three factors. Firstly, that of the original wavelength standard chosen; secondly, that of the closeness to which the dials may be read; and thirdly, by a small temperature correction. To make a measurement, the reading of the desired station is taken, then those of the crystal harmonics on either side, and if the calibration curve is reasonably straight, a simple interpolation gives the required result, otherwise the curve must be redrawn should the receiver have changed in the meantime. An ordinary wavemeter may develop an error of 1 per cent. in a very short while, and in any case has a limited range, whereas the crystal standard is permanent, and may be calibrated to 1 part in 1,000 under laboratory conditions, and relied upon ever after.

TABLE I.

1	2	3	4	5	6
Condenser Reading.	Harmonic.	Approx. Wavelength.	Approx. Fundamental.	Revised Wavelength.	Accurate Wavelength.
68.4	6th	38.1	228.6	37.8	37.33
58.0	WGY	32.79	—	32.79	32.79
56.3	7th	33.3	232.1	32.4	32.00
48.6	8th	28.7	229.6	28.4	28.00
—	Crystal	230.0	230.0	227.0	224.0

TRANSMITTERS' NOTES AND QUERIES.

New Zealand Amateurs.

Through the courtesy of Mr. A. W. Watt (A 2WW), editor of "Radio in Australia and N.Z.," we are now able to supplement and correct the lists of New Zealand amateurs which were published in the "Wireless Annual for Amateurs and Experimenters, 1926."

Call-signs marked * indicate changes or corrections in addresses previously published. Other call-signs are additional to previous lists :—

***1 AC** L. S. Spackman, 2, Elizabeth St., Ponsonby, Auckland.
***1 AH** Hartle & Grey, 7, Alten St., Auckland.
***1 AI** C. S. Goodwill, 96, Great South Rd., Auckland.
***1 AN** H. P. M. Arthur, 266, Jervoise Rd., Herne Bay, Auckland.
***1 AR** F. B. Hobbs, 44, Te Aroha St., Claudelands.
***1 AU** R. E. L. Aubin, 224, Manukau Rd., Auckland.
1 FA G. R. West, White Island, Auckland.
1 FD F. R. Booth, 28, Rosstrevor St., Hamilton, Auckland.
1 FE L. F. Wood, Waihau, Auckland.
1 FG J. Lonsdale, "Heathdale," Marohemo, Auckland.
***1 FQ** T. R. Clarkson, Madeira Lane, Auckland.
***2 AJ** T. H. Bransgrove, Juliet St., Stratford.
***2 AN** M. L. Weston, 47, Barraud St., Dannevirk, Wellington.
***2 AO** G. A. J. Brunette, Club Hotel, Opunake, Wellington.
***2 AW** C. R. Clarke, 133, Thorndon Quay, Wellington
2 BB C. Ward, 63, Norway St., Kelburn, Wellington.
2 BK L. Hansen, 77, Linton St., Palmerston North.
2 BX R. G. Black, 22, Stafford St., Wellington.
***2 BY** N. C. Sheppard, New Plymouth.
***2 GH** D. M. Tombs, 22, Burnell Ave., Wellington.
2 YM Gisborne Radio Co., Rutena Rd., Gisborne, Wellington.
3 AD A. C. L. Fooks, Cr. Park and Peter Sts., Ashburton.
***3 AE** J. F. Donald, c/o. J. Purser, Leeston, Canterbury.
3 AI Rangiora High School, Rangiora, Canterbury.
3 AJ R. G. F. Blake, Rangiora, Canterbury.
3 AK A. H. McL. Grubb, 205, Wai-iti Rd., Timaru, Canterbury.
***3 AM** L. A. Halcrow, 441, Madras St., Christchurch, Canterbury.
3 CG H. P. V. Brown, 49, Gracefield St., St. Albins, Canterbury.
***4 AB** Otago Radio Assn., Princes St., Dunedin.
***4 AC** R. E. Robinson, 3, Chetham Ave., Dunedin.
***4 AK** F. P. Earland, 33, Waverley St., Dunedin.
***4 AM** W. McG. Crockett, Tiverton St., Palmerston.
***4 AO** H. H. Shrimpton, 17, Coney Hill Rd., Saint Clair, Dunedin.
4 AQ N. Arundel, 26, Moray Place, Dunedin, Otago.
4 AZ T. K. S. Sidey, Caversham, Dunedin.

Experimental Stations.
***2 XB** Physics Dept., Victoria University College, Wellington.

General Notes.

Mr. E. Megaw (GI 6MU) is at present on board s.s. "Lord Antrim" bound for Montreal, and is returning some time in August. He has his transmitter and receiver on board and will be pleased to work with British stations between 22.00 and 24.00 G.M.T. on 45 metres; the call-sign used is GX 6MU.

We understand that on July 7th he was about 350 miles west of Ireland and had arranged a nightly series of tests with Mr. F. R. Neill (GI 5NJ), at Whitehead, Co. Antrim.

An Australian Receiving Station.

The illustration on this page shows the receiving station at Malvern, Victoria, owned by Mr. James Harding. The receiver shown on the left, in a cabinet, is for ordinary broadcast reception, while the small set is for short-wave reception, and is tunable between 20 and 100 metres. It comprises a Schnell tuner with two stages of audio-frequency amplification, with which Mr. Harding has received stations in all districts of U.S.A. as well as in Europe.

Change of Address.

G 2BKD.—C. Ayres, Trevone Cottage, Yarmouth Road, Oulton Broad, Lowestoft.

QRA's Wanted.

G 2BUW, G 5BC, G 6GI, B 2XX, EAC 3, LA 1SE, P 30R, SUC 2.

ENERGY IN AUSTRALIA. The QSL cards screening the wallpaper at this station, which is owned by Mr. J. Harding, of Malvern, Victoria, Australia, tell their own story.

THE GOOD OLD DAYS.

Some Radio Recollections of the Pre-Broadcasting Period.

RADIO broadcasting has so quickly become a national institution that it is difficult to realise how few years have passed since the days when the possessor of a wireless set was regarded as some sort of scientific enthusiast—not to say genius. Sitting in the comfort of your armchair beside a fire, your newspaper on your knee, your loud-speaker in a corner, one could hardly wonder if you asked, "What was there to listen to then?" Indeed, what was there? A "mush" of spark, arc, C.W.—Morse, all Morse!

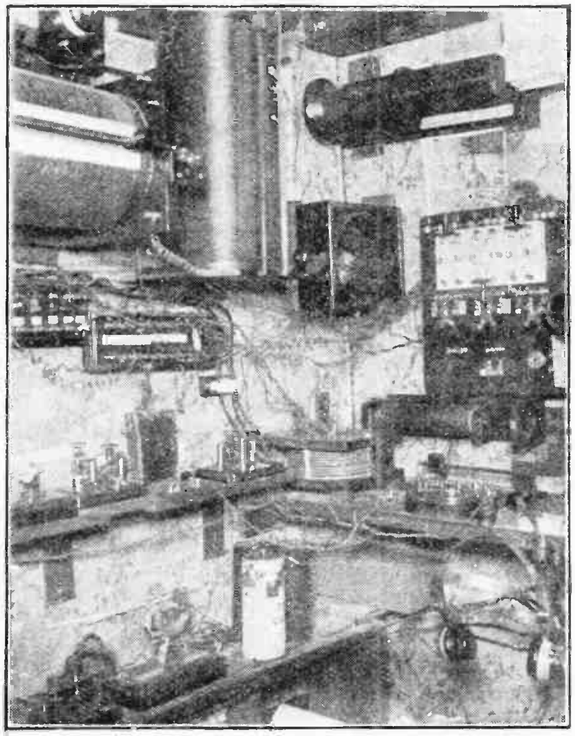
How many shops there were in the country dealing in radio apparatus I will not attempt to hazard a guess, but they were very few. I lived in the Midlands at the time, and I sent to London or Manchester for everything I wanted; my own electrical dealer didn't even stock double cotton-covered wire! Valves were scarce; the R type were mostly of French manufacture and were excellent value for 12s. 6d.; they were bright emitters, of course. I have still one survivor in regular use.

The trouble with valves was that as so few establishments sold them it was usually necessary to obtain them through the post, and they did not invariably arrive with their filaments intact. Hence, since dealers sent at buyer's risk, the cost was not infrequently increased, and one fell back in despair on the crystal.

Home-made Components.

Ordinary component parts were usually taken from ex-Government sets. Practically everything was second-hand, and catalogues stated what was new, the reverse of more recent procedure. Some very good stuff was obtainable if you knew where to look for it, but, generally, you made everything possible yourself. There wasn't much variety; for instance, there were only two or three makes of telephones, but what you got was good, unless, supposing it was second-hand, it had seen too much war service. This you had to guard against, though 'phones were usually reconditioned by their manufacturers.

The erection of an aerial set the district guessing; who would have thought that in such a short time it would be possible to see a whole row of houses each with its dropping pole supporting 100ft. of wire? You were regarded as something of a marvel; some scientific dabbler who would ultimately explode himself and probably wreck the locality. And then you would ask in one of your doubters and let him listen, awestruck, to Cleethorpes' grate or Nauen or the Eiffel Tower. What remarkable distances! And he would go home still doubtful.



IN THE GOOD OLD DAYS. A corner in the wireless room at CXX (Mr. F. C. Stimpson of Leyton) *circa* 1913. Note the large inductance for tuning to the Clifden Station, the large variable condenser, the tubular condenser on the wall and the several crystal detectors. The spark transmitter consisted of an electrolytic interruptor, step-up transformer, rotary and quenched gaps with strip wound inductances tuning to 150 metres

There was only one receiving licence at that time, just as, after a complexity of categories, there is only one now. It was obtainable direct from the G.P.O., and the Postmaster-General required two written references and a definite assurance that you were of British nationality. You received periodic visits from one of his representatives who inspected your set in order to see that you were not using more than 100ft. of aerial wire, or more than one valve if you had expressly stated that you were only going to use one valve. These visits were sometimes rather humorous, for the representative often came from the local post office, and knew next to nothing of wireless. Then, out of the sheer love of having it to boast of to your friends, you refrained from showing him the frame aerial or the extra bit of wire tucked away behind the house, or the additional Bosch valve you had picked up more on account of its merits as a sourvenir.

Portable Sets.

You were not supposed in those days to move your set temporarily from one house to another without a permit. There was a form of Pedlar's Licence obtainable if you wished to take your set round to your friend's or away with you on your holidays, but I never met anybody who had applied for one, it being considered much more the thing to carry your "junk" about in a suitcase, yourself assuming an air of mysterious importance. No doubt they were used by itinerant lecturers, to one of whom I remember listening once when I was in the North. A modest fellow, this, who told us, on showing a slide of Carnarvon's valve panel, that he had there received a shock sufficient to hurl him sixty yards! It may have been feet; but I'm glad he got over it, anyway.

We used to listen to

The Good Old Days.—

Cleethorpes at 6 p.m. There was nothing important about Cleethorpes, really, but its reception was not considered a bad day's work. Then there was Horsea's Press news a little later. This, of course, was thoroughly interesting, but it necessitated a considerable time spent in laboriously deciphering Morse before it could be read in its entirety and fully appreciated. The famous Poldhu, the station from which Marconi transmitted his first transatlantic message, was another favourite; and there was Moscow with Bolshevist propaganda. It was amusing trying to solve code telegrams and intercepting private messages, but under the terms of our permits we were not permitted to divulge anything we heard. Hardly anybody bothers with that nowadays, but I expect the rule holds good, as, indeed, it should until some absolutely secret method of wireless communication has been evolved. We used to time our watches by Eiffel Tower's signal at 11 a.m. at that time, or by Nauen at noon.

After that came the first glimmer of telephony, although we had heard *of* it, of course. Now we got scraps here and there: Koenigswusterhausen, the Hague—the epoch-making Dutch concerts—aviation stations and aeroplanes, and later Writtle.

We are told that we are rapidly approaching an era of international broadcasting, but I think some of the glamour of the old days has gone, because then it was entirely "wireless," and there were no land-lines interconnecting stations.

W. H. C.

London, N.10.

Great Britain:—2AK, 2AL, 2BAV, 2BAZ, 2BMA, 2BQ, 2BRD, 2DR, 2FZ, 2GN, 2HQ, 2IA, 2II, 2JC, 2KI, 2KJ, 2KK, 2LF, 2MA, 2NX, 2QF, 2QM, 2QV, 2RB, 2UA, 2VO, 2WW, 2YO, 2YU, 5BR, 5CX, 5IH, 5KO, 5LB, 5MU, 5NX, 5NY, 5OC, 5RH, 5RS, 5SI, 5SR, 5TU, 5TZ, 5UQ, 5US, 5UW, 5YG, 6AH, 6AM, 6AR, 6BN, 6BR, 6CJ, 6CL, 6FA, 6FT, 6GF, 6GG, 6HF, 6HT, 6IA, 6JH, 6LD, 6MI, 6NO, 6OG, 6OX, 6PU, 6RY, 6SZ, 6TD, 6TW, 6VT, 6WG, 6YN, 6YT, 6YU, 6YZ, 6ZA, 6ZD, 6ZJ. Northern Ireland:—2IT, 2WK, 5GH, 5NJ, 6QD, 6SQ, 6TB, 6YW. Irish Free State:—1IB, 1IX, 1IZ, 3XX, 3YM, 3YY, 3ZZ. Holland:—OAW, OBX, OFP, OGG, OHB, OKH, OKS, OPM, 2PZ. Belgium:—A4, A44, A8, B1, B11, BI8, B44, C22, E4, G33, I44, K2, K3, K44, M1, M2, M8, O2, P2, P7, Q22, R6, R9, S1, S2, S4, S5, S6, U33, V33, Y5. Z1. Z6, Z7, Z8, Z9. France:—8AB, 8AG, 8BA, 8BP, 8BU, 8BW, 8CA, 8CC, 8CH, 8CL, 8CO, 8CP, 8CT, 8DHH, 8DI, 8DJ, 8DK, 8DP, 8DGS, 8EI, 8EU, 8EZ, 8EN, 8FR, 8GX, 8HU, 8IG, 8IX, 8JB, 8JF, 8JRT, 8JYZ, 8KB, 8LPP, 8MR, 8NA, 8NO, 8NOZ, 8OQP, 8PAM, 8PEP, 8PGL, 8PM, 8PY, 8QC, 8RVR, 8RZ, 8SSY, 8TOM, 8UOU, 8UT, 8VO, 8WEL, 8ZB, 8ZEB,. Germany:—4AS, 4WM, J1, K4, KI8, P6, W1, W3, Y4, Y8. Luxembourg:—1AA, 1AG, 1AZ, 1ES, 1JW. Spain:—EAR2, EAR3, EAR7, EAR9, EAR10, EAR18, EAR20, EAR23, EAR24. Italy:—1AS, 1AX, 1BB, 1BD, 1CH, 1CO, 1ER, 1FP, 1GW, 1MA, 1NO, 1RG, 1RT, 1SS, 1SRA, 1FW, Switzerland:—9AD, 9BF, 9CA, 9GP, 9XA, 9XN. Poland:—TPAI, TPAJ, TPAV, TPAX, TPAY. Norway:—1A, 1B, 4N, 4X. Denmark:—7BJ, 7BX, 7BZ, 7EW, 7JM, 7JS, 7MT, 7ZM. Sweden:—SMRG, SMSP, SMSR, SMTG, SMTN, SMUF, SMUH, SMUI, SMUP, SMUV, SMVC, SMVG, SMVH, SMVX, SMWE, SMWF, SMWG, SMWS, SMXA, SMXC, SMXU, SMXV, SMXZ, SMZX, SMZZ. U.S.A.:—1AA, 1ARE, 1AVL, 1AW, 1BF, 1BZP, 1CAL, 1CH, 1CI, 1CKP, 1CME, 1CMF, 1CMX, 1KB, 1PL, 1SW, 1XM, 1XW, 2ABK, 2AEV, 2AGK, 2AGP, 2BDG, 2BDV, 2BGM, 2BRB, 2BUY, 2BW, 2CVJ, 2CWR, 2CYX, 2JN, 2KG, 2LE, 2XAC, 3BHV, 3BWT, 3JW, 3LE, 3LW, 4CH, 4SA, 4VS, 4XE, 5MI, 5SR, 5XAY, 6NX, 7DF, 7DX, 7ZU, 8AKS, 8ALY, 8ATX, 8BCO, 8EQ, 8GX, 8GZ, 8PL, 8XE, 8ZE, 9ABP, 9BC, 9BRT, 9CYU, 9EAN, 9EAR, 9EAZ, 9QQ. KEL, WIZ, NAD, NUMM, NOT. Canada:—1AA, 1AR, 1BQ, 1DD, 1DF, 2AX, 2BG, 2BN, 2BY, 3BQ, 3HZ, 4DQ, 4GT, 5BA, 8AR. Brazil:—1AA, 1AB, 1AK, 1AL, 1AP, 1AT, 1AU, 1AW, 2AA, 2AB, 4SS, 5AA, 5AB, 5AG, 5AT, 6QA. Chile:—2RM, 2LD, 3IJ, 4RM, CLAA, 9TC. Argentine:—A8, BD2, CB8, DB2, FC6, FG6, HA2, HB1. Miscellaneous:—YHBK, HZA, ANDIR, PI3AA, J1AA, A3BK, A3KB, Z4AC, KEGK, OA6N, O2SR, YS7XX, CSOK3, S2ND, S2NS, S2NN, RNRL, PE6YX, FI8QQ, SS8LBT, E1BH, G2WE, G2EL, G2EF, G6EZ, 6EP, U4IRT, U4VT, OAA, FJJ.

(0-v-0, 0-v-1) 8 to 50 metres.

J. Hum.

Bridlington.

(May 1st to June 26th.)

France:—8VY, 8GI, FW, 8PEP, 7VX, 8SAX, 8IX, FL. 8CL, 8VO, 8DP, 8MB, OCTU, OCNG, OCNP, 8XX, 8FP, 8PM, 8CL, 8UT, 8SSW, 8DGS, 8LZ, 8KOA, 8GSM, 8RK, 8UDI, 8OQP, 8RZ, 8XX, 8AR, 8XPX, OCMV, 9BE, 8KP, 8EZ, 8PAM, 8NOX, 8JYZ, 8PRY, 8YY, 8XLH, 8JN, 8WW, 8RBP, 8BA, 8CN, 8PHI, 8GAZ, 8FRX, 8JB, 8RIT, 8BN, 8JRT, 4RL. Belgium:—D8, K6, B1, G33, B7, K3, B8, O8, M8, M2, A1, 4YZ, 4QQ, S4, K8, K44, KW3, A8, A4, H6, W7, T8, 9WJ, E4, 1W, S5, K2, Y8, W5, 4AA, V33. Holland:—OWC, PCTT, OCO, PCK4, PCLL, OBX, 12BB, PCRR, PCPP, OHBN, OKS, PCMM, TPX, 2PZ, OBH, OFP, PB3. Sweden:—SMUA, SMYG, SMWS, SMUV, SMVG, SMXV, SMVL, SMVX, SMSY, SMXG, SMTX, SMTN, SMWR, SMVH, SMYU, SMVJ, SMTN, SMSR. Finland:—S2CO, SGC, SAB, S2NL, S2NM, STB. Germany:—Y5, W3, 4GA, KPL, P6, Q5, P4, W9. Denmark:—9GZ, 9YU, 9WJ, 7BZ, 9SA, 7ZM, 7BZ, 7ZM. Spain:—EAR23, EAR20, E4AS, EAR9. Brazil:—1AK, 1AE, 1AW, 1AO, 1AR, 1BI, 1IA, 2AB, 1IC, 5AB, 1AF, SNI, 1BB, 1AX, 1AQ, 5UB, 1AD, 1AN, 6QB, 3AA, 2AF. United States:—5ZAZ, 5AWS, NIDK, 2XG, 1AVL, 1ALL, 1MV, 2AL, 2ASQ, 1ZK, 1ML, 1BUO, 2APV, 1AAG, 2CVJ, 1UW, 2AHM, KEGK, 1KK, 2UO, 2TT, WIZ, WVR, NKF, WQK. Switzerland:—9XA. Chile:—2LD. Yugo-Slavia:—7XX. Portugal and Maderia:—1AE, 3GB, 1AW. Porto-Rico:—4RX. Italy:—SRA, 1GW, 1NO, 1BK, 1CH, 1JBD. Norway:—1AE, 1AG. Austria:—WA. Australia:—2LM. New Zealand:—2AC, 4AM, 2AE, 3AG, 4AA. Russia:—RCRL, RCB8. Miscellaneous:—P 7VX, GFR, B 2SW, YR, DE3. SBF2, BZ SNI, HRP, GBM, SUC2, BT8, BE4, G 3WK, NOT, KP4A, NTPX, DM, PKX, 9YU, GWAO, NPB3, LPZ, LCO, PTQ, TBMN23, GW 3ZZ.

(0-v-1) On 30 to 50 metres.

T. Woodcock
(G 600).

FUNDAMENTAL RECEIVING PATENTS.

The Principal Inventions for which Royalties are Claimed.

By W. H. PAULETT.

ALL owners of wireless receiving sets employing valves know that royalties are paid when they purchase their sets, but I wonder how many know to what the patented inventions included therein relate. I may state at once that the royalties are payable in respect of certain fundamental or master circuit patents, and do not specifically concern the components themselves.

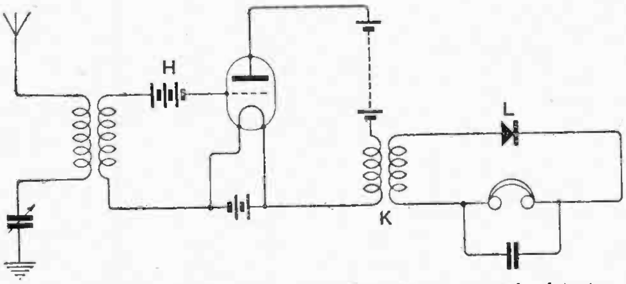


Fig. 1.—Single stage H.F. amplifier with crystal detector (British Patent No. 8,821; 1913).

There are at the present time patents in force for each of the following valve circuits :—

(*a*) High-frequency amplification, followed by a detector.

(*b*) Reaction.

(*c*) Grid-leak rectification.

There are, of course, very many other valve-circuit patents, but I do not think one will be able to reach out very far with a receiving set without using one or all of the three functions mentioned above.

The first British Patent relating to high-frequency amplification followed by a detector is No. 8,821 of 1913, communicated by the Gesellschaft für Drahtlose Telegraphie m.b.H. The actual circuits of this patent

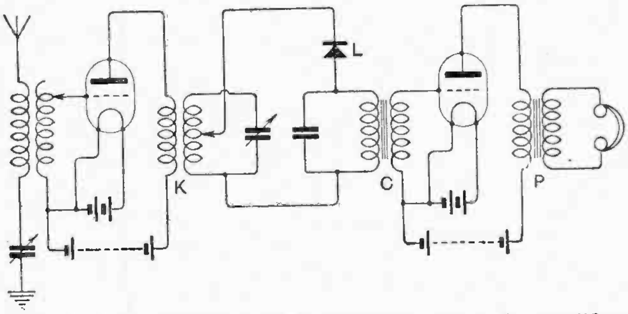


Fig. 2.—H.F. amplifier, crystal detector and L.F. amplifier (British Patent No. 8,821; 1913).

specification are shown in Figs. 1, 2, and 3. It may be taken therefore that high-frequency amplification was first known in this country in 1913. I say this country because I believe that the arrangement shown in Fig. 1 of the drawings was invented by the German engineer von Bronk in 1911, and that the circuits shown in Figs. 2 and 3 are the joint invention of the German engineers Schoemilch and von Bronk in 1913. These prior inventions, however, have no effect upon the British patent, and are only mentioned as of historical interest.

Fig. 1 shows a high-frequency valve followed by a crystal detector; Fig. 2 shows a high-frequency valve followed by a crystal detector and by a low-frequency amplifier; and Fig. 3 shows a single valve adapted to function as a high-frequency amplifier and as a low-frequency amplifier at the same time, a crystal being used as

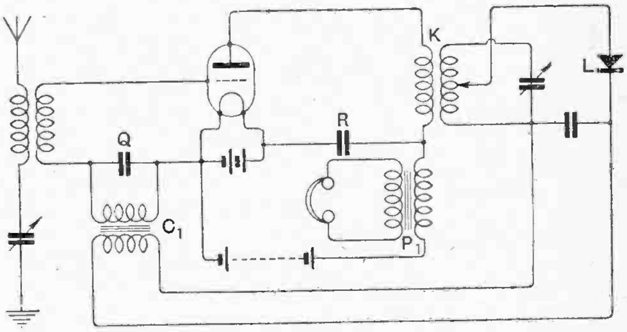


Fig. 3.—Single valve and crystal reflex receiver (British Patent No. 8,821; 1913).

a detector. This, of course, is the now well-known reflex or dual circuit.

In the light of present-day knowledge there is nothing unusual in the circuit arrangement of Fig. 1, although it is interesting to note the presence and position of the grid bias battery H in the grid circuit of the high-frequency valve and also the position of the H.T. battery.

Tuned Intervalve Couplings.

Fig. 2 is more interesting, since it shows a high-frequency transformer K with an untuned primary and a tuned secondary. The crystal L, moreover, is shown as adapted to be tapped across only a portion of the secondary. The transformer C is a low-frequency coupling and P a telephone transformer. Compare the position of the H.T. battery with the arrangement shown in Fig. 1.

Fig. 3 is still more interesting because it shows how to arrange a valve to amplify at both high and low

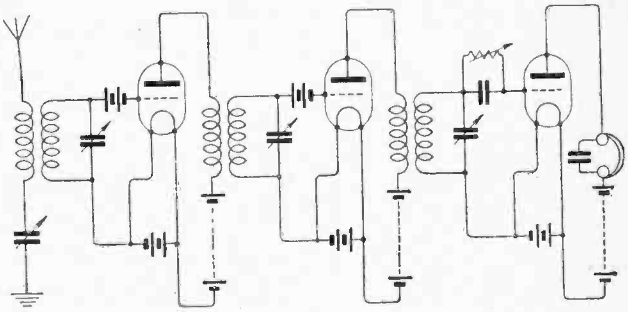


Fig. 4.—Multi-stage H.F. amplifier (British Patent No. 147,147; 1913).

Fundamental Receiving Patents.—

frequencies simultaneously. Points of interest not to be overlooked are the H.F. by-pass condenser Q across the secondary of the L.F. transformer C, and the position of the by-pass condenser R between the low-potential end of the primary of the high-frequency transformer P, and the filament. The position of the feed-back L.F. transformer C is interesting since its secondary is connected in the filament side of the grid circuit. Moreover, a high-frequency transformer K, having a tuned secondary and the crystal tapped across only a portion of the secondary, is used to couple the crystal L to the plate circuit.

The first multi-stage high-frequency amplifier was also invented in 1913, this time, however, by the American engineer E. F. W. Alexanderson. The British Patent is No. 147,147, and was filed in the name of the British Thomson-Houston Company, Ltd. This patent shows the tuned transformer method, and also the tuned anode method. Figs. 2 and 4 of this patent are reproduced with modern conventions in Figs. 4 and 5.

Fig. 4 will be seen to comprise two stages of high-frequency amplification followed by a valve detector, the high-frequency stages being transformer coupled, and the grid or secondary circuits tuned.

Fig. 5 comprises two stages of tuned anode high-frequency amplification followed by a valve detector. Both

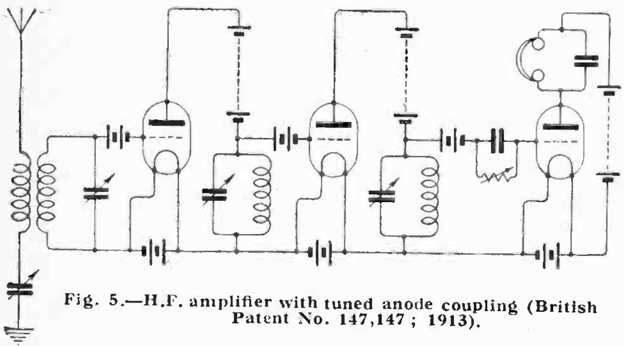


Fig. 5.—H.F. amplifier with tuned anode coupling (British Patent No. 147,147; 1913).

these figures show the grid-leak method of rectification, but this particular invention was not devised by Alexanderson, and is not claimed by itself in this patent.

The next step in the development of valve receiving circuits was the invention of reaction for the production of continuous oscillations by the reaction of a three-electrode valve upon itself. The patent situation on this invention in some countries is very involved, but in this country there are five important patents relating to reaction. The numbers, dates, and inventors are as follows:—13,636/13, June 12th, 1913, C. S. Franklin (Marconi Co.); 147,042, October 29th, 1913, E. H. Armstrong; 28,413/13, December 9th, 1913, H. J. Round (Marconi Co.); 24,231/14, December 18th, 1913, E. H. Armstrong; 252/14, January 5th, 1914, Von Arco and Meissner (Marconi Co.).

In the United States the Commissioner of Patents awarded Armstrong the priority, the date of the invention being January 31st, 1913. This decision was, however, subsequently reversed in the Court of Appeals, and the priority of August 6th, 1912, awarded to De Forest. It is pointed out here that these priority dates are based on documentary evidence and not on actual filing dates in the United States Patent Office.

In Germany, however, Dr. Alexander Meissner applied for a patent on April 10th, 1913, for the invention shown in Fig. 6, while in Austria Von Strauss applied for a

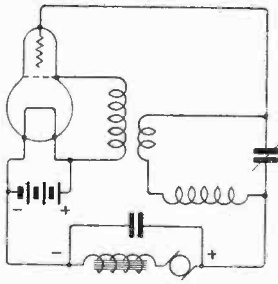


Fig. 6.—The oscillating valve circuit described by Dr. Meissner in his German Patent, dated 10th April, 1913.

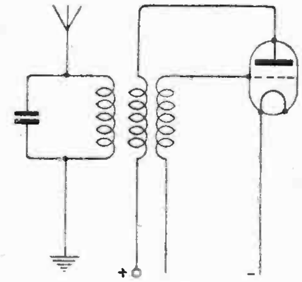


Fig. 7.—Probably the first oscillating valve circuit to be protected. The circuit is given by Von Strauss in his Austrian Patent applied for on 11th Dec., 1912.

patent on December 11th, 1912, for the invention shown in Fig. 7. The priority dates awarded to De Forest and Armstrong in the United States, Meissner's German patent, and Von Strauss's Austrian patent, however, have no effect upon the five British patents mentioned before, and are merely given as being of historical interest, for in this country the first inventor is Mr. C. S. Franklin, of the Marconi Co.

Reaction in Receiving Circuits.

The opening paragraph of Mr. Franklin's specification refers to the reflex circuit in the following words:—"It has been shown that an exhausted tube which contains a heated cathode consisting of a strip of metal covered with an oxide and two anodes, one of which is in the form of a plate with holes and which screens the cathode from the other anode, can be used in a wireless receiver for magnifying both the received oscillations and the telephone currents."

The specification then goes on to state: "According to this invention when such a tube is used for magnifying the received oscillations we make the circuit, in which the magnified oscillations occur, react on the circuit, in which the oscillations to be magnified occur by coupling these

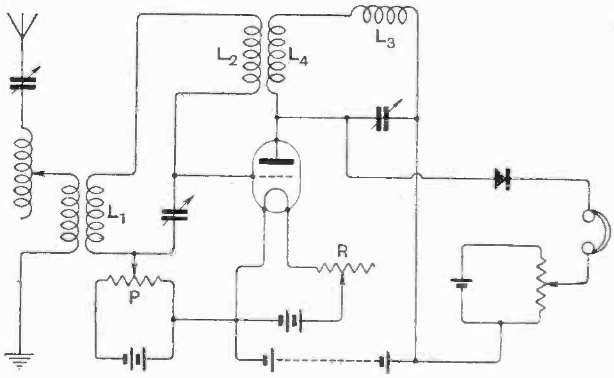


Fig. 8.—High-frequency amplifying circuit with coupled grid and plate inductances followed by crystal detector, shown by C. S. Franklin in his British Patent 13,636 of 12th June, 1913.

Fundamental Receiving Patents.—

circuits, either electrostatically or electro-magnetically, to a certain degree.

"If the coupling be too strong, the tube will be unstable and will itself tend to produce oscillations, but there is a certain critical strength of coupling below which the tube is unable to maintain oscillations. At a coupling a little below this critical strength the tube and circuits are stable but act while receiving oscillations as though the resistance in the circuits was very small.

"The result is that the damping of the receiving system can be reduced to any required degree and the tuning of the system is made very sharp."

The circuit illustrating Mr. Franklin's invention is reproduced in Fig. 8, and will be seen to comprise a high-frequency valve followed by a crystal detector, a reaction effect being brought about by coupling the anode circuit to the grid circuit.

In the light of present-day knowledge there is no need to describe how the circuit works, but I would like to draw attention to the idea of dividing the grid inductance L^1 and L^2 and the anode inductance L^3 and L^4 into two portions, and coupling only the portions L^2 and L^4. This arrangement avoids coupling the two comparatively large inductances L^2 and L^3, and, moreover, permits a better control of reaction. It will also be noted that a potentiometer P is provided to give the grid a suitable potential, the filament rheostat R being connected in the positive side of the L.T. battery. The British patents of Armstrong, Round, Arco, and Meissner are each of considerable interest, particularly Arco and Meissner's Patent, No. 252 of 1914, and these patents, together with Franklin's, cover the applications of the reaction principles to three electrode valves in this country.

Grid-leak Rectification.

We now come to Grid-leak Rectification. British Patent No. 147,148, dated October 29th, 1913, inventor Dr. Irving Langmuir, of America. Grid-leak rectification should not be confused with the use of a condenser in series with the grid electrode for rectification. The latter idea was probably first used by Dr. Lee de Forest in the days of "soft" valves, and, in fact, with a soft valve a leak across the condenser is not required owing to the presence of positive ions in the valve. In the case of "hard" valves in use to-day, positive ions are practically absent, and some means must be provided for bringing the grid potential to normal between successive trains of oscillations.

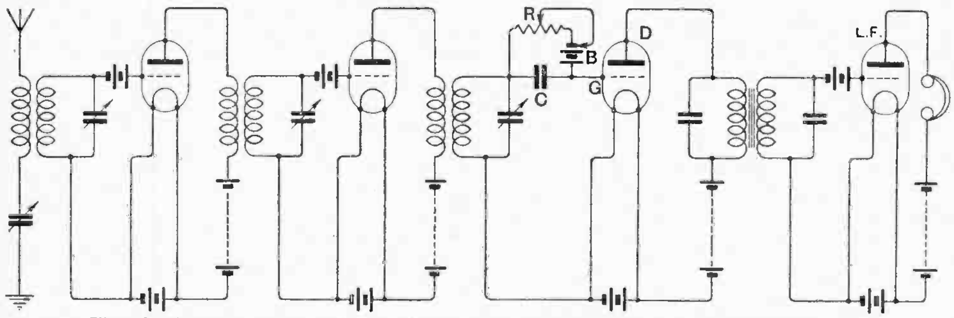


Fig. 9.—Leaky grid condenser rectification described by Dr. Langmuir in his Patent No. 147,148, dated 29th October, 1913.

With these facts in mind, it is not surprising to find Dr. Irving Langmuir as the inventor of the grid-leak method of rectification when it is remembered that this gentleman also invented the "hard" valve. At first sight there may not appear to be much invention in shunting a condenser in the grid circuit of a valve with a high resistance, but when it is remembered that nearly every set manufactured or constructed uses the grid-leak method of rectification, it cannot be denied that the method possesses considerable utility.

The receiving circuit chosen by Dr. Irving Langmuir to illustrate his invention is shown in Fig. 9, slightly redrawn in accordance with present-day conventions. The receiver will be seen to consist of two high-frequency stages followed by a valve detector, using the grid-leak method of rectification and one stage of low-frequency amplification.

The part of the circuit which concerns the invention is the detector valve D, showing the leakage path comprising the variable resistance R, and the variable source of potential B connected across the condenser C. The specification states that the capacity of the condenser C, the potential of the battery B, if one is used, and the resistance R, should be so chosen that the grid G will have resumed its equilibrium charge before the next wave train is impressed on it.

The two H.F. stages do not call for any particular comment in view of Alexanderson's multi-stage high-frequency amplifier, British Patent No. 147,147, already referred to, except to point out that Alexanderson's invention, Patent No. 147,147, and Langmuir's invention, Patent No. 147,148, were both filed on the same day, and although each show multi-stage high-frequency amplification and grid-leak rectification, the former is claimed in Patent No. 147,147 and the latter in Patent No. 147,148. Both of these patents were in this country filed in the name of the British Thomson-Houston Co., Ltd.

The low-frequency valve L.F., shown in Patent No. 147,148 is particularly interesting, since it is substantially identical with a present-day low-frequency amplifier.

In conclusion, I may state that as British Patents are granted for a term of sixteen years, those dated in the year 1913 will expire in 1929, those dated in the year 1914 expiring in 1930. When these Patents expire royalties will no longer be payable for the use of these fundamental inventions.

In addition to the valve receiving patents mentioned above, there are several patents for the now popular "Neutrodyne" method of reception, invented by Professor L. A. Hazeltine, of the United States of America, in 1919, and the equally popular "Superheterodyne" method invented by Mr. L. Levey, of France, in 1918.

Since the "Neutrodyne" and "Superheterodyne" patents are of much later date, royalties for the use of these patents will no doubt be demanded for several years after the 1913 and 1914 patents have expired.

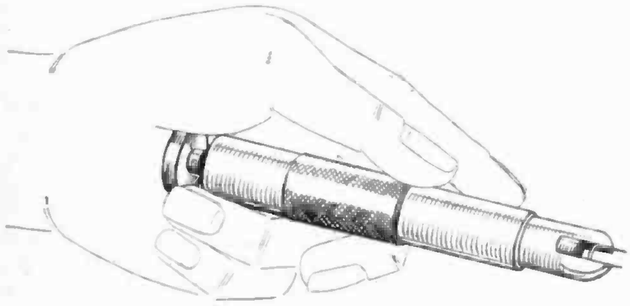
A Review of the Latest Products of the Manufacturers.

THE MARPLE STAPLE DRIVER.

In the construction of a wireless receiving set it frequently occurs that leads have to be attached to the inside of the cabinet for connecting up with grid cells. Such leads are often secured to somewhat inaccessible portions of the cabinet work, and to staple them in position is found to be difficult.

The Marple staple driver, obtainable from L. Tracy, The Avenue, Potter's Bar, Middlesex, can be used for driving small wire staples into parts of a cabinet which are normally quite inaccessible when using the ordinary staple driven home with a hammer. This staple driver will be found useful in the experimental workshop for a number of jobs. For instance, small wire staples can be driven into plaster or woodwork without any danger of breaking away the surface, as invariably occurs when using a hammer, the staple itself holding much more securely than if it had been hammer-driven.

The end of the driver is fitted with grooves into which a special type of staple exactly fits, while a plunger passing through the centre of the tool when depressed drives the staple firmly into the wall or woodwork. For really neat house wiring this staple driver is an indispensable tool.



The Marple staple driver, an indispensable tool for stapling wires in positions normally inaccessible when driving the staple by means of a hammer.

PANELS AND CABINETS.

A series of high grade cabinets are manufactured by W. and T. Lock, 15, St. Peter's Terrace, Bath, of the now popular American design making use of a vertical front panel. A feature of these cabinets is that they are fitted with front ebonite panels cut dead square and with highly polished surfaces. A suitable baseboard is also included with the cabinets, and thus the principal difficulties encountered by the home constructor of wood working and trueing up a panel are obviated. The process of home construction is thus reduced to drilling the panel, attaching the components, and wiring, operations which fall within the most modest workshop equipment.

A pamphlet giving the range of standard sizes can be obtained on application to the manufacturers.

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EBONART.

It has been appreciated by many amateurs for a long while that some departure is desirable from the continual use of black ebonite panels for set construction. The trend now in receiver design is perhaps to find some more attractive substitute for the typical black matt finish. Among the commercial sets will be found instances where polished mahogany is employed for carrying the tuning dials, whilst there are some receivers made up with metal front panels, such as figured brass or aluminium.

The construction of a special metal panel is beyond the scope of many home constructors, and a pleasing change from dull black ebonite will be found in the adoption of a new type of panel consisting of a special material produced by Redfern's Rubber Works, Ltd., of Hyde.

A marbling effect has been produced by the introduction of a red colouration, certain parts of the panel being of a brilliant red and other parts the usual dense black, with here and there varying degrees of redness produced in a wavy design. The panels are highly polished, the surface being more durable than the more usual matt finish, which, it is believed, was originally adopted partly to save the expense of polishing and also to ensure the removal of metallic compounds adhering to the face of the ebonite during the process of manufacture.

Marketed under the name of Ebonart, these panels can be relied upon to possess surface insulation equal to that of the highest grade ebonite, whilst the surface itself, as well as being polished, is perfectly flat, which is rather essential from the point of view of good appearance, as no distortion occurs in the images of objects to be seen by reflection into the face of the panel. By way of criticism it might be pointed out that engraving when filled in white at once spoils the attractiveness of the panel, and as a matter of taste engraving may perhaps be filled in with a gilding compound. It is to be hoped also that instrument dials of red or mottled ebonite will become available.

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EDDYSTONE L.F. TRANSFORMER.

Among intervalve L.F. transformers of moderate price might be mentioned the Eddystone, a product of Stratton and Co., Ltd., Balmoral Works, Bromsgrove Street, Birmingham.

Eddystone intervalve L.F. transformer.

The overall height is 3½in., while the bobbin is nearly 2in. in diameter by 1¼in. in height. It is obtainable with primary to secondary ratios of 1 : 3 and 1 : 5, whilst a power transformer is also supplied in this size having three tappings on the secondary winding.

An examination of the transformer revealed that the primary inductance was of the order of 10 henries, which is somewhat in excess of many transformers on the market, and it is high primary inductance that is the essential feature of good transformer design. The secondary inductance was 153 henries, whilst the insulation resistance between primary and secondary and between the windings and the frame was found to be infinity.

Broadcast Brevities

SAVOY HILL TOPICALITIES

By Our Special Correspondent.

Serial Broadcasts.

Experience has shown that the full three-act play, whether broadcast complete in one evening, or in the form of one act an evening, is not necessarily calculated to hold the attention of the majority of listeners; but while the tendency is to adhere to the short sketch of five minutes to half-an-hour's duration, a new experiment is to be tried, in a rather different direction. Reference has previously been made to this experiment, which embodies the reading of a serial story that will be either a new serial specially written for the B.B.C., or an old story specially prepared for serial broadcasting.

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"At the Villa Rose."

Mr. A. E. W. Mason will begin the feature on July 31st with his successful novel "At the Villa Rose," which he has adapted for broadcasting. The transmission will be spread over five evenings. Although this series is consecutive, which suggests that listeners who are able to do so should listen each night, the story has been framed so that each nightly episode is complete in itself. Inability to listen on any given night will not, therefore, spoil the enjoyment of the series as a whole.

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Gramophone Transmissions.

It is time that the situation as regards the broadcasting of gramophone records was reviewed, as numerous criticisms have been heard respecting the quality of some recent transmissions of new records. The system followed by the B.B.C. is to broadcast an equal number of records from each firm per week. The primary object is to keep listeners informed of new records as soon as they are produced. The quality of these records varies considerably. Some of them broadcast badly, and any value that might otherwise be derived from the transmission is lost. I imagine that some of the manufacturing firms must have realised this fact long ago.

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Microphone Technique.

As broadcasting is evolving a new type of play, so it is about to evolve a new type of artist. Some of the most prominent of stage artists who have appeared before the microphone have been quick to realise that the ordinary stage technique is of no earthly use to them for wireless purposes, and they have been far from satisfied with their studio performances

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Contrasts.

It is often amusing to witness the behaviour of people who have broadcast. The novice generally makes his exit without comment. The experienced artist, immediately "control" is switched off, anxiously demands to be told by everyone in the studio whether he has "got over" well or badly; the more conscious he has been of the absence of "props" the more perturbed he appears to be about the quality of his performance.

This is probably because the experienced performer has an "artistic conscience"; dare we suggest the novice lacks it?

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A Training School for Broadcasters.

An arrangement is therefore now under consideration for the training of would-be broadcasters. No school of broadcast acting is to be set up—at present at all events; but it is expected that co-operation may be established with some such body as the Royal Academy of Dramatic Art for the inauguration of a section devoted to the training of embryonic broadcast artists, with a gold medal and certificate as the award. The B.B.C. would thus be able to draw upon the right kind of dramatic talent.

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New Studios at 2LO.

A gain of two studios is in prospect when the plans which are now being prepared by the engineers at Savoy Hill are completed. One will be a studio for speech only, and the other, a more elaborate affair than any studio yet built, will be remarkable chiefly on account of the apparatus to be installed for securing realistic effects.

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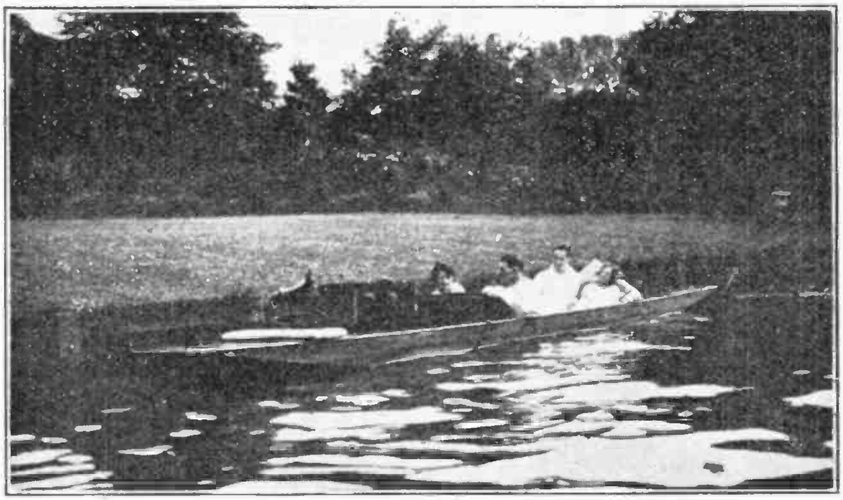
Scenic Effects.

Hitherto the scenic effects in the various studios have been obtained by rather primitive means. Running water, for instance, has had to be provided by a large-sized zinc bath, from which the water has been scooped up in a tin pannikin and emptied slowly back into the bath to typify a rippling stream. In order to secure a more realistic background, as and when required, for radio plays, the new studio will have a proper water system with a pipe fixed along the wall and spigots to control the flow of water, which will be regulated to represent Niagara Falls or a tinkling rivulet. A



MUSIC IN A PERFECT SETTING. A happy party photographed recently on the upper reaches of the Thames. Note the portable receiver and Amplion loud-speaker.

gulley in the floor will carry away the flowing water, and special apparatus will be constructed to bring it into circulation again, so as to avoid waste.

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Motor Cars and Doors.

Other "gadgets" will be a special machine to provide the natural sounds of a motor car engine with exhaust, and an ordinary door which will shut exactly like a door and not with a sudden percussion such as the somewhat unrealistic snap which is heard by listeners nowadays. Effects are going to play an increasingly important part in the radio drama of the future.

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The Whispering Baritone.

A half-hour's entertainment will be given by Mr. Jack Smith on July 28. He is the American singer of syncopated songs who has adopted the title of "The Whispering Baritone." His previous broadcast took place round about midnight, when not many listeners found it convenient to sit up to hear him. He is, therefore, appearing before the microphone at 9 p.m. on the 28th, and the peculiarly intimate way that he has of singing and of conveying his unusual personality to his audience should find him a larger number of listeners on this occasion.

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Sensitive Microphones.

Variations in the quality of reception which have been noticed recently are probably due to changes in the types of microphone used in the studios. Atmospheric conditions, therefore, must be absolved. The same effects were observed when the original carbon microphones were replaced by magnetophones, and now that "mikes" of greater sensitivity are taking the place of the magnetophones, it may be some time before the right balance is obtained in some piano and vocal features

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History Set to Music.

"Amyas Young," a pen-name which hides the identity of a clever young member of the dramatic producer's staff at Savoy Hill, has written up a series of dramatic incidents associated with famous melodies, and they will be broadcast on July 30. They include the following :— France, 1792—"The Marseillaise"; The Peninsula, 1810—"The Girl I Left Behind Me"; America, 1859—"John Brown's Body"; America, 1864—"Marching Through Georgia"; Scotland, 1745-1820—"The Hundred Pipers"; England, 1899—"Dolly Grey." If these little sketches maintain the standard of "Amyas Young's" broadcast version of "Westward Ho!" they will be widely appreciated.

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A Better Orchestra

The discussion of a scheme for establishing a really first-class broadcasting orchestra is being revived, but savings in other directions will have to be effected before the Company or its successors are likely to incur the large expenditure necessary on such an orchestra.

FUTURE FEATURES.

July 25th.

LONDON.—The Royal Parks Band relayed from Hyde Park Bandstand.

BIRMINGHAM. — Symphony Programme.

GLASGOW.—The Band of H.M. Scots Guards relayed from Kelvingrove Park.

MANCHESTER.—Songs, Sonatas and Solos.

NEWCASTLE.—Light Orchestral and Vocal Concert.

July 26th.

LONDON.—Chamber Music, Poetry and Variety.

BOURNEMOUTH.—Popular Overtures.

BELFAST.—Mirth and Melody.

CARDIFF. — "The Waterman" (Dibdin).

GLASGOW.—"Whiffs," No. 2: A Review of Things Old and New.

July 27th.

LONDON.—"At the Villa Rose"——Serial story continued throughout the week.

DAVENTRY. — Daventry Birthday Programme.

ABERDEEN. — Shakespeare Programme.

BIRMINGHAM. — Popular Programme.

BOURNEMOUTH.—Ballet Music and Instrumental Feature.

GLASGOW.—Music and a Play.

MANCHESTER.—Summer Scenes from Shakespeare.

July 28th.

LONDON.—Armada Programme.

ABERDEEN.—Solos and Duets.

BOURNEMOUTH.—Light String Programme.

GLASGOW.—The Clydebank Burgh Band.

NEWCASTLE. — "The Electric Sparks" Concert Party.

July 29th.

LONDON.—Variety Programme.

ABERDEEN.—Instrumental and Orchestral Concert.

BIRMINGHAM.—Dance and Song Through the Ages.

BOURNEMOUTH.—Music and Entertainers.

BELFAST.—Orchestral Concert.

CARDIFF.—Duets and Diversions.

MANCHESTER.—The Far East—Thr' Western Gates.

July 30th.

LONDON.—Songs of History.

DAVENTRY.—Daventry Pool.

ABERDEEN.—Scottish Hour.

CARDIFF.—"What He Won"—a Play by W. H. Williamson.

MANCHESTER. — The Minnehaha Amateur Minstrels.

NEWCASTLE.—Concert of Duets.

July 31st.

LONDON.—A Seaside Concert Party.

GLASGOW.—Light Opera and Musical Comedy.

Regional Station Programmes.

If and when regional stations are erected, say at London, Manchester, Cardiff (or Bristol) and Glasgow, the performances of a special orchestra would have to be shared by those stations, while smaller bodies of performers, as, for example, octets, would probably be sufficient for what might be described as routine work at other stations. First-class talent is found among the musical directors of the B.B.C. stations, and this talent could be usefully employed in connection with an orchestra equal, if not actually superior, to any in this country. In brief, a rearrangement such as that outlined would enable the B.B.C. to form a rota of musical directors to conduct ambitious programmes at the regional stations.

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A Mixed Broadcast.

The Duke of York's Camp at New Romney will furnish an interesting broadcast on August 6, when a sing-song will be relayed from this well-known holiday centre to 2LO and 5XX. The camp is visited by public school boys and factory lads, who, by spending a summer holiday together, have the opportunity of getting to know one another and of living in comradeship for a few weeks. Half-a-dozen popular songs and chanties will be included in the broadcast.

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Radio in Sweden.

It is reported from Stockholm that the erection of new broadcasting stations at Kalmar, Karlskrona, and Helsingborg to work in conjunction with the station at Malmö has stimulated Swedish interest in radio. The sale of expensive sets has increased, and the licence fee for receiving sets has been reduced to just over 11s. It is stated that at the end of last March there were about 182,000 licensed receiving sets in Sweden, an increase of approximately 63,000 during the preceding five months.

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International Programmes.

A new society (the Commission de Rapprochement Intellectuel Artistique et Social) has been formed at Geneva to promote wireless interchange of programmes between European countries. One of the proposals is to apportion a special evening to each of the nations interested in broadcasting, the programme to represent the best from a literary and musical standpoint that the nation itself can produce.

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H.R.H. to Speak Again.

The Prince of Wales's speech in the Sheldonian Main Hall at Oxford on August 4th, on the occasion of the annual meeting of the British Association, will be put on the ether.

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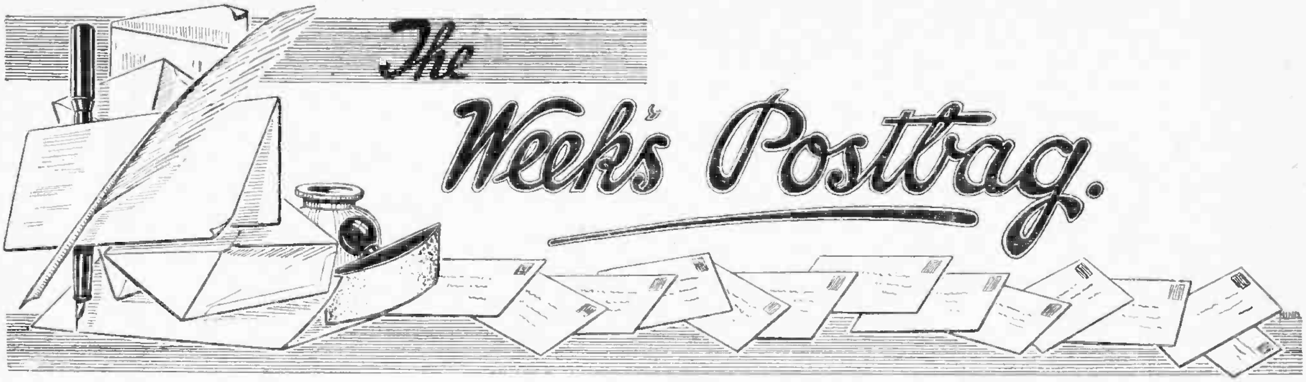
Juvenile Performers.

A novel feature will be introduced by the Edinburgh station on July 26th, in a half-hour's performance by four girls. Their programme will include violin and concertina solos, soprano songs, and recitations.



The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEURS IN NEW ZEALAND.

Sir,—I read with great surprise and much regret the correspondence dealing with interference by amateur transmitters in *The Wireless World*, March 31st, 1926. Now, to compare New Zealand conditions with English conditions.

We are allotted waves from 35 to 37 metres, 70 to about 95 metres, and 120 to 160 metres. For local work we find 70 to 95 metres the best. For DX work the 35 metre band. As far as we are concerned, we would not transmit on 200 metres even if we were allowed to. In fact, we never use the 120 to 160 band at all, owing to its inefficiency. The great majority of us use the 35 metre band. Just to show what can be done on 80 metres, in July, 1925, I worked several Australian stations on this wave, using only 100 volts from "B" batteries on a single UV201A tube with an average strength report of R4. The average distance was about 1,500 miles. Local reports in New Zealand gave my strength as R6. The circuit used was the loose-coupled shunt-feed Hartley, using no grid-leak or condenser. I usually radiated about R2 amps. Now I know from experience that the above is not possible on 200 metres.

Also I have never yet had a complaint from B.C.L.s about me jamming their reception. I would therefore suggest that the English "hams" used the 80-metre band for local work. That is, if they are allowed to use this wave.

I trust this short description of New Zealand conditions will be of interest to the English "hams."

Te Awamutu, New Zealand. NELSON WINCH, Z. 1AP.

COMMUNICATION ON LOW POWER.

Sir,—In these days of long-distance radio transmission on short waves with comparatively low power inputs, one hears claims put forward by various experimenters of "record DX" on extremely small power—claims which are generally accompanied by calculations showing "miles per watt." While admitting the possibility of these claims, would it not be more definite if the persons concerned could state whether *initial* communication was established while using that power, or whether it was the result of a test made on reduced power after first establishing contact with a greater input. This is an important point, as I maintain it is a simple matter to hold a station on reduced power once the QSO has been made, but it is an entirely different and considerably more creditable performance to effect contact with a low input.

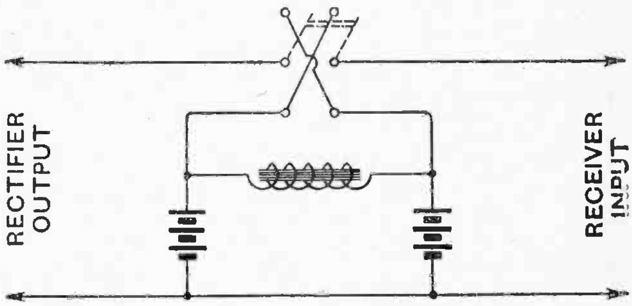
It would be interesting and instructive to all traxnsmitters if a world-wide low-power test could be arranged with, say, a maximum of 3 watts input, and all amateur stations would co-operate and stick to this power for the duration of the tests. Schedules could be arranged, and the whole conducted similar to the transatlantic tests organised a few years ago. May I add I should like to hear from serious experimenters who are interested in the scheme. The results should show interesting data regarding the efficiency of various transmitters.

G. A. EXETER, G 6YK.

142, Campden Hill Road, Kensington, W.8.

L.T. SUPPLY FROM A.C. MAIN.

Sir,—The article by Mr. F. H. Haynes in your issue of July 7th is undoubtedly one of considerable interest to a very large number of experimenters, and is so complete that it does not lend itself to much criticism. I have been, over a considerable time, experimenting with H.T. and L.T. supply from A.C. mains, and in connection with the latter have succeeded in bringing the trickle charging system to a point of utility which is practically perfect in its operation. The system I adopt is to employ two accumulator batteries of small capacity, the positive terminals of which are connected through a suitable iron core choke, and by this means it is quite feasible to be charging the battery nearest the rectifier at a somewhat higher rate than that supplied to receiver. By means of the 2-pole change-over switch the batteries can be periodically



Trickle charging system adopted by Mr. Childs.

interchanged in their position and thus worked evenly. I may add that the choke has sufficient resistance to ensure that the receiver battery delivers more current to the set than the rectifier battery, and this has the advantage that the cells do get a certain amount of discharge and are thus worked more in accordance with the best accumulator practice. I append a diagram of the scheme employed.

London, S.W.5. MAURICE CHILDS, London Telegraph Training College.

COUPLING L.F. VALVE.

Sir,—With reference to the article by N. P. Vincer-Minter under the above heading in your issue of May 26th, there is a point which does not appear to be dealt with fully, namely, why is it necessary to use a different valve in the detector stage from that used in the first L.F. position?

It is well known that when using the best transformers, by which one does not necessarily mean the most widely advertised ones, exceedingly fine results accompanied by great amplifications are to be obtained if a valve having an impedance of about 30,000 ohms. is used in both the detector and first L.F. positions, a power valve being, of course, essential in the last place immediately before the loud-speaker.

For good loud-speaker results it may generally be assumed that an alternating voltage of about 30 is required across the terminals of the loud-speaker, and, assuming that the speaker is connected in the plate circuit of a valve having an amplification factor of, say, five times, the alternating voltage impressed upon the grid of that valve will be in this case 6 volts. If this valve is preceded by a transformer as mentioned above and any ordinary valve having an amplification factor of, say, 10, the voltage impressed upon this preceding valve will be less than 1-30th of that impressed upon the grid of the power valve, and any ordinary valve is capable of dealing with such a signal without appreciable distortion, and better results are not to be obtained if a lower impedance valve is used in the first L.F. stage; in fact, as a rule the total amplification will be reduced since low impedance valves generally have low amplification factors.

Whilst it is, of course, possible to use transformers of higher ratio and consequent lower primary inductance, yet even so the results, at least as regards uniformity of amplification, are never so good as those to be obtained by using a lower ratio transformer with a corresponding higher inductance, which, with the valves now available, enable one to obtain all the amplification that one requires by the use of not more than two L.F. stages.

There is a further point, namely, that as is well known it is exceedingly difficult to operate three transformer coupled stages; moreover, it may be shown that if, when using transformers having a sufficiently higher impedance to enable use to be made of the major portion of the valve amplification factor, the resulting signal is not strong enough it indicates that the original signal is not sufficiently powerful to be rectified properly and that it is necessary to employ an H.F. stage.

New Moston, Manchester. JOHN BAGGS.

I am credibly informed locally that the interference has been definitely traced to this source, and, moreover, that representations from wireless dealers in the town have met with a blank refusal on the part of the cinema proprietor to allow any steps to be taken towards abating the trouble.

In cases of this kind, which must surely be by no means unique, it seems that legal powers are necessary, and that no body other than a Government Department can take effective action. While sharing the average Englishman's dislike of excessive bureaucratic control, I feel that you, together with the majority of your readers, will agree that some measure of protection should be afforded to the unfortunate licence-holder situated in similar circumstances. C. W. HUGHES.

London, W.7.

VALVE NOMENCLATURE.

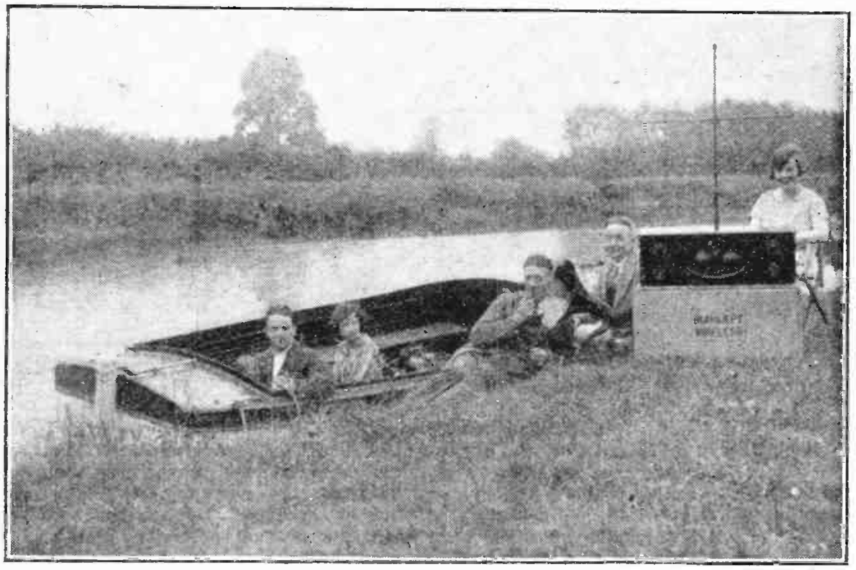
Sir,—Surely the time is ripe for the abandonment by valve manufacturers of the hoary old superstition of classifying their products under the headings of "H.F.", "det.", and "L.F." valves.

It is well known among experienced amateurs that such an arbitrary classification is only a pleasant fiction adopted by the manufacturers for the edification (or otherwise) of the uninitiated, and that the so-called "H.F." valve is only a valve of high impedance, the terms "detector" or "L.F." valve signifying one of medium impedance. Yet what person claiming any knowledge at all of radio engineering would think of using a high impedance or so-called "H.F." valve in the H.F. stages of a modern neutrodyne receiver, such, for instance, as you yourselves described in your issue of May 26th?

These arbitrary classifications were all very well three years ago when the tuned anode and resistance capacity methods were the only forms of H.F. coupling in use in this country, and the L.F. transformer the only method of L.F. coupling, but in these more enlightened days these terms have quite outlived their usefulness, and often, indeed, are the cause of confusion and failure to achieve results among the inexperienced. As an example, only the other day I was called in by a friend to diagnose the trouble in a Roberts reflex neutrodyne receiver built by him to your specifications. The sole cause of the trouble lay in the fact that he had been misled into purchasing the wrong valve.

I suggest that valves should be classified under three headings, according to their impedance, a low impedance class embracing those valves having less than 10,000 ohms impedance, a medium impedance class lying between 10,000 and 25,000 ohms, and, finally, a high impedance class embracing all valves above 25,000 ohms. Manufacturers and set designers could then state definitely which class of valve was to be used in the various positions in their receivers without resort to the fatuous and misleading terms now employed.

London, N.16. RED TOP.



CONTENTMENT ON THE CANAL. A party of picknickers on the Gloucester and Berkeley Canal find that wireless reception helps to create the atmosphere of "a perfect day." The set is a Burndept "Ethodyne."

INTERFERENCE FROM ELECTRICAL CIRCUITS.

Sir,—As the findings of the Broadcasting Commission seem likely to be put into effect at an early date, the time would appear to be opportune for an extension of the P.M.G.'s powers to permit of Post Office intervention in acute cases of interference from electrical machinery and apparatus.

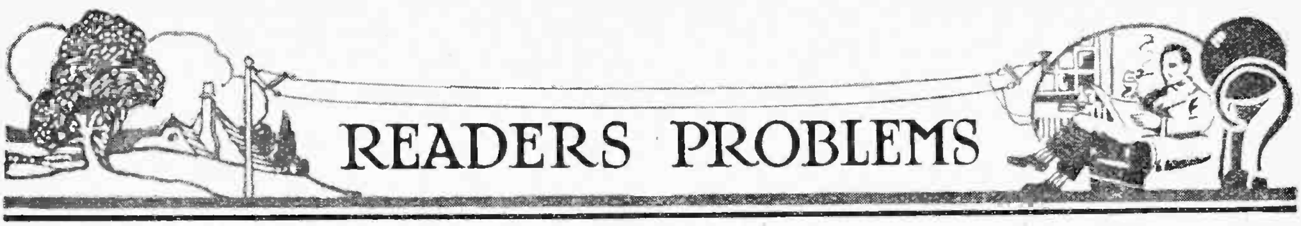
This suggestion is a result of my personal experience in a small provincial town, where, over a wide area, reception is rendered unpleasant, if not impossible, for the majority of the evening and sometimes in the afternoon by induction noises from the local cinema—probably from a rotary converter or its associated apparatus.

ARTIFICIAL AERIAL PERMITS.

It is a little difficult to understand why application should be made to the Post Office for a permit to conduct experiments with wireless apparatus when it is not the intention to set up ether waves for the purpose of communication. The Postmaster-General is only interested in the use of transmitting apparatus capable of communicating over a distance; if he considers that an applicant is not to be trusted with a wireless transmitter why does he imply that he controls the installation of non-radiating electrical apparatus by authorising the use of a frame aerial set?

Surely one may possess any quantity of transmitting gear without asking the P.M.G., providing one does not use it for the setting up of ether waves.

TURNED DOWN.



READERS PROBLEMS

"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal repty.

A Universal Detector Amplifier.

Some time ago you published complete constructional details of a universal detector amplifier, in front of which it was possible to connect any aerial tuning system or any type of H.F. amplifier. I have mislaid the issue in which this appeared, and should be glad if you could republish the diagram. A.E.F.

We publish in Fig. 1 the original theoretical diagram of this circuit. It will be evident that it is possible to couple this up to any type of aerial tuner, whether direct or loose-coupled. Terminal G connects of course to the aerial terminal of tuner, or to the high potential end of the secondary coil if loose coupling is employed. The earth terminal of the aerial coil, and also the low potential end of the secondary coil, may be coupled to either F+ or F−, the bottom end of the grid leak being connected to either L.T.+ or L.T.−, according to the characteristics of the detector valve, by joining terminal S to either F+ or F− by means of the link provided. If anode rectification is desired the terminal S should be tapped into one of the sockets of the grid bias battery by means of a wander plug, the link being, of course, removed. The reaction coil is connected to the terminals Rp and R+. If it is desired to couple the instrument to an existing H.F. amplifier, connections are similar, the secondary of the H.F. transformer connecting to G and to either F+ or F−. In this case of course the terminals F+ and F− must also connect along to the L.T.+ and L.T.− terminals of the H.F. amplifier. The reaction terminals may be short-circuited if desired. Using a tuned anode amplifier, it is necessary to make a connection direct from the anode of the final H.F. valve to terminal G, other connections being the same as for a transformer-coupled amplifier.

The first L.F. transformer of the unit should be of low ratio, a somewhat higher ratio being permissible in the last stage. The output transformer can either be of the step-down type if a 120 ohms loud-speaker is to be used, or can be of 1 to 1 ratio if a higher resistance loud-speaker is to be used. A large number of high-class firms, such as Messrs. W. G. Pye, Ltd., of Granta Works, Cambridge, supply telephone transformers of ratio suitable for coupling to 2,000 ohm or 120 ohm loud-speakers, and also transformers suitable for use with 750 ohm loud-speakers, such, for instance, as many of the Western Electric type. It will be noticed that telephones or loud-speaker may either be coupled directly in the plate circuit of the first valve by joining them to T_1, or by joining T_1 to T_2, and connecting the telephones to T_3, a choke filter circuit is brought into operation. Connection to T_4 couples them to the valve through the transformer. Alternatively, the loud-speaker may be attached by a single wire to T_3, the other terminal of the loud-speaker being earthed, this scheme being specially suitable when the loud-speaker is to be used at a distance from the set, as was described on page 217 of our February 10th issue. The first valve should be of the high impedance type, such as the D.E.5B; the second should be a low impedance D.E.5 type valve, whilst in the last stage it is preferable to use a special output valve like the D.E.5A.

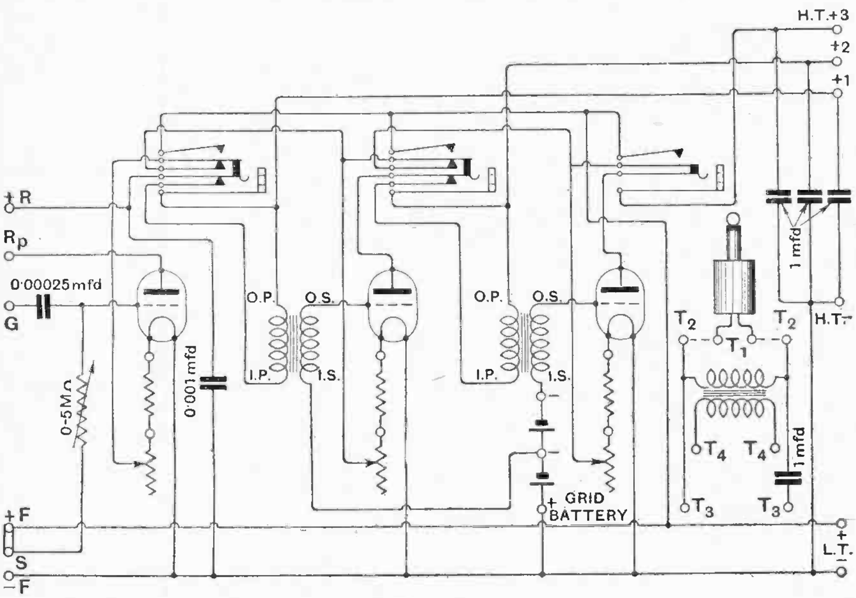


Fig. 1.—A useful instrument for the experimenter.

The system of jack switching should be specially noted, since by its use only the filaments of the valves actually in use light up. Thus, inserting the plug in the first jack lights up only the detector valve, whilst all valves light up when the plug is inserted in the final jack.

Variable rheostats may be employed if desired, whilst provision is made for inserting fixed resistors in series with them in order that the adjustment of filament temperature may be made foolproof.

It will be seen, therefore, that this unit is especially valuable to the experimenter who is constantly trying different types of aerial tuners or different systems of H.F. amplifiers. Full particulars, and also a practical wiring diagram, are given on page 275 of our issue dated April 8th, 1925, and readers desiring further information are advised to obtain this back issue from our publishers.

○○○○

How to Economise Plate Current.

I understand that by adopting resistance coupling a great saving of plate current can be obtained compared with the use of transformer coupling. Can you tell me if this is so, and if it is equally so in the case of choke coupling? C.C.R.

Undoubtedly a very great saving in plate current can be obtained by using resistance coupling, the problem resolving itself into a simple application of Ohm's Law. When considering the steady plate current flowing in the anode circuit of a valve, we are dealing with D.C. The average value of H.T. voltage used by amateurs in L.F. amplifiers is usually about 120 volts, irrespective of what form of coupling is used. It would be safe to say, also, that 80,000 ohms is a fair average value for the resistance used by most amateurs in amplifiers operating on the resistance capacity principle. From Ohm's fundamental law of $C=\frac{E}{R}$ we find that if we apply a difference of potential of 120 volts across the resistance of 80,000 ohms, the resultant current flow will be equal to $1\frac{1}{2}$ milliamperes. Thus, even ignoring the valve resistance altogether, we see that this current can never exceed $1\frac{1}{2}$ milliamperes, and no matter how large the emission of the valve, nor how much we "open" it by biassing the grid positively, we can never exceed this current. Even by using a plate voltage of 240 the current will never exceed 3 milliamperes. Now, when using a transformer or choke, we have only a few hundred ohms of D.C. resistance in the transformer primary or the choke, and our current flow will be mainly governed by the H.T. voltage, and the valve characteristics. Of course, we shall have the normal value of anode current flowing in the output valve of a resistance amplifier, since we have no high D.C. resistance in the plate circuit, but merely the low 2,000 ohms D.C. resistance of the loud-speaker or the choke, if we employ a choke-filter circuit.

oooo

A Meter Mistake.

I have constructed a small power transformer for stepping-down the voltage of my electric lighting mains, following carefully the instructions contained in the article published in THE WIRELESS WORLD *by Mr. W. James, but can get a scarcely appreciable movement of the needle, and yet I find that on connecting a small 4-volt pocket lamp bulb to the transformer it lights up to normal brilliancy. My voltmeter is a good one of high resistance, and functions normally when used to test my accumulator. Can you indicate a possible source of error?* *M.A.F.*

It is obvious from your letter that your voltmeter is an instrument designed for D.C. work only, and is probably of the moving coil type. When considering the use of a voltmeter or ammeter for measuring A.C. it must be remembered that we must take into consideration the reactance of the coil in the instrument (which is, of course, inductive). It is, therefore, necessary to design meters to measure only at a specific frequency or over a certain band of frequency, and such meters usually have their frequency marked on them. There is another type of instrument known as the hot wire meter, which is equally suitable for D.C. or for A.C. of any frequency. Such meters depend on the expansion of a length of wire of suitable material under the heating effect of a current passed through it. Since this wire is short and straight it is practically non-inductive, and its impedance is constant at all frequencies, and, of course, its A.C. impedance is the same as its D.C. resistance. Since your flash lamp bulb filament is similarly short and straight, its impedance to A.C. is the same as its resistance to D.C., and it lights equally well on either A.C. or D.C. provided the voltage is correct.

In order to effect your purpose, therefore, you will require either a hot-wire meter, or a coil-wound meter designed especially for the frequency of your mains.

oooo

The Function of the Fourth Electrode.

I understand that the purpose of the extra grid in the four-electrode valve is to enable the valve to be operated with a much lower plate potential than normally. Can you explain how this is brought about? *F. V. E. F.*

The purpose of this extra grid inserted between normal grid and filament, and connected externally to the positive side of the H.T. battery is to disperse the space charge collected in the vicinity of the filament, and so permit of the same plate current being maintained as normally, but with a much lower potential on the anode. If the filament of a valve is heated without any connections being made to the anode the filament will emit electrons which will nearly all return to the filament, owing, as it were, to there being no inducement for them to travel elsewhere. If, however, the plate is made slightly positive by the application of a few volts of H.T. many of these electrons are attracted towards the plate. At the same time many of them do not leave the vicinity of the filament, and tend to form a barrier repelling any fresh electrons leaving the filaments, the repelling effect occurring by reason of the fact of the charges both being of like sign, between which, of course, a repulsion effect exists. By raising the voltage of the H.T. battery, thus making the anode still more positive, a stronger attraction exists which causes this space charge barrier to move off in the direction of the anode. In order to effect this, however, the anode voltage must be kept fairly high. By inserting an extra grid close to the filament, however, and giving it a small positive potential, we can considerably reduce this space charge and cause a reasonable anode current to flow even when the actual anode voltage is reduced to a fairly low value.

oooo

Dangers of Remote Control Switches.

I have been having considerable trouble lately with my low-frequency transformers, the primaries breaking down after a comparatively short period of use. I have been told that this is due to the fact that I use a switch for turning on and off my filaments instead of a rheostat, and that if I wish to retain my switch I must abandon transformer coupling. I do not wish to abandon the switch as I make use of a remote control system, and should appreciate your advice on this matter. *C. P. A.*

The breakdown of your transformer primary is in all probability due to the use of a switch instead of a rheostat as has been suggested by you. When the filaments are extinguished suddenly by the switch the plate current which passes through the transformer primary windings is cut off with equal suddenness, resulting in the immediate collapse of the magnetic field associated with each transformer, this inducing a momentary high voltage across the windings which causes the breakdown. If a rheostat is used, the cutting off of the plate current and consequent collapse of the magnetic field is more gradual, and the induced voltage is considerably less. If choke coupling is used, there is an equal risk of a breakdown of the choke from the same cause, although, of course, a good choke is cheaper to replace than a good transformer.

If you wish to retain your switch and at the same time remove all risk of a breakdown of this type, it will be necessary for you to use resistance coupling. You should use a wire wound resistance for reasons frequently laid down in this journal, but although this is a wire wound device, you will not be troubled by a breakdown from this cause, because the resistance is non-inductive, and will have little or no magnetic field associated with it. Consequently, there will be no high voltage induced across the resistance by the sudden stopping or starting of the plate current. Undoubtedly, however, the best solution to your problem is to adopt the circuit given on page 899 of our June 30th issue, substituting resistances for the chokes.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

SUSPENSE.

WE referred in our issue of last week to the regrettable state of affairs existing in wireless to-day, due to the uncertainty of the lines upon which the future, both of the broadcasting service and the industry, would have to be remodelled in view of the pending changes. We pointed out how highly unsatisfactory it was that so many vital matters were, so to speak, still in the melting pot, so that no section of those concerned in the future of the broadcasting service was in a position to lay definite plans for the future.

In the time which has intervened since those comments were written we have been regretfully forced to the conclusion that the Government has no intention of enlightening the public as to the choice of the Commissioners who will regulate the future destinies of the broadcasting service until Parliament re-assembles for the autumn session. This, in spite of the fact that persistent rumours suggest that those who have been singled out for these appointments are already engaged in gathering the reins in preparation for taking over when the necessary authority is constituted.

CONTENTS.

Our View.

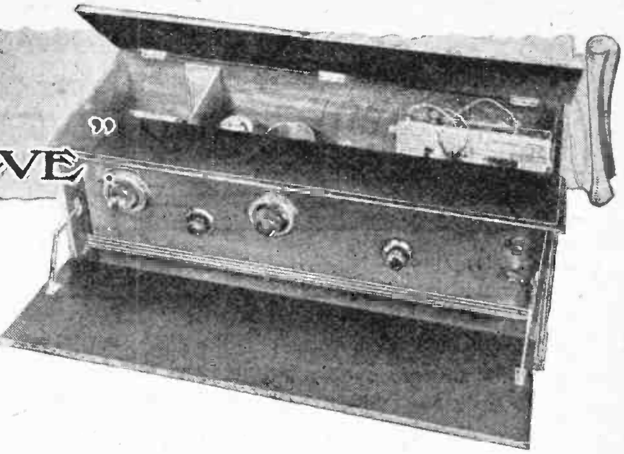
We have repeatedly expressed the opinion that in principle the recommendations of the Broadcasting Committee should be adopted, but we have never been in agreement with the suggestions that interested parties should not find representation on the controlling board. Further, we have emphasised that the whole future of the successful conduct of the broadcasting service depends upon the choice of the individual commissioners, and we are by no means satisfied to learn that the appointments will not be made until the autumn, because we consider that in order to take over the control of the broadcasting service at the end of the year the commissioners should have received their appointments by now, whilst we should strongly object to these appointments being confirmed without ample opportunity being given for the House to consider them.

B.B.C. Rumours.

The rumours which are going round at present regarding the pending changes in organisation and distribution of the broadcasting stations leave us uncertain as to what we have got to expect in this direction. Surely it is time that the B.B.C. issued an official statement as to what changes will take place and when they will come into operation, since the date of the change is of the utmost importance to us all; but as it is at present, instead of an official statement the public obtains its information from casual and unsatisfactory interviews with individual officials of the B.B.C. which are reported in the Press.

We think it is quite time that this haphazard distribution of information from the B.B.C. as to their future plans should come to an end, and that in place of it authoritative statements should be issued from time to time stating concisely and with ample notice what alterations will take place and when the changes are due to become operative.

"Everyman's Four-Valve"



A "Two Control" Receiver of Remarkable Efficiency.

By W. JAMES.

It is quite a common thing to see a two- or three-valve receiver with four or more knobs for tuning purposes; as one of these is usually for reaction and another for coupling, tuning-in a distant sending station demands considerable skill and experience. Receivers of this type are still being sold by manufacturers and described in technical papers, with the result that the average man with his two hands finds tuning difficult. Who can blame him for oscillating at times when his set has so many adjustments?

The Ideal Receiver.

Many people consider the ideal receiver to be one having but two tuning controls. Such receivers have, of course, been produced, but in the majority of instances these sets are suitable for receiving the local broadcast station only, and there seems to be a very prevalent idea that it is impossible to produce a simple two-control set which will receive distant stations. It is usually thought that unless adjustable reaction is provided in a straight set that it is necessary to use the supersonic system, with its six or seven valves, in order to make certain of receiving distant stations. But the strange thing is that designers of superheterodyne sets have a habit of adding knobs for reaction, for they find they cannot get those distant stations without it. To be sure, one of the knobs is usually for volume control, but that is no reason why we should be misled; in the majority of instances it is a critically adjustable reaction control with a harmless name.

In some cases two reaction controls are provided: one on the input circuit, and another on the beat frequency magnifier. When this is the case we can usually be sure that the designer of the set has dodged the problem of the design of the beat frequency magnifier and is relying upon reaction for sensitivity and selectivity. Thus the two-knob set has, in many instances, four tuning controls and we are no nearer the ideal receiver.

It is quite evident that a two-control set which is going to prove a satisfactory proposition must primarily be designed to magnify weak signals if they are to be reproduced at full loud-speaker strength, and, if we limit ourselves to four valves with relatively cheap couplings, steps must be taken to insure that each valve works at full capacity. If we decide on four valves and desire loud-speaker signals, we must necessarily use two low-frequency stages, which automatically settles the use which will be made of the two remaining valves, for one must be used as a detector and the other as a high-frequency amplifier with a tuned coupling.

Four Valves.

Our set, then, will have four valves, with one high-frequency amplifier, detector, and two low-frequency magnifiers. Now we have to tune the aerial circuit and the high-frequency valve coupling; these two tuned circuits, therefore, have variable condensers, and are the only controls on the set. Of course, it is necessary to turn the set on and off; a rheostat controlling all four valves is, therefore, used. It is also desirable to have means for reducing the strength of the local station, for it must be remembered that the set is to give strong loud-speaker signals from distant stations; a volume control should, therefore, be provided, but it must be a volume control pure and simple.

We have decided on the use to which the valves are to be put, and on the tuning controls, and it is now necessary to consider the design in detail. The set illustrated here will receive a dozen or more stations at full loud-speaker strength in daylight (jamming permitting) when used with a normal out-door aerial and earth, and we will consider its design step by step.

Main Features of the Set.

A glance at the theoretical diagram, Fig. 1, will show the essential features of the set. The aerial and earth are connected to the primary winding of an input transformer T_1 and the secondary coil of this transformer, tuned by condenser C_1 of 0.00027 mfd. capacity, is joined to the grid and filament of the first valve V_1 through a grid bias battery GB_1. This valve is the high-frequency amplifying valve, and is coupled to the detector V_2 by means of a tuned transformer T_2 having a double wound primary and a tuned secondary. The primary windings are marked P and N, the secondary S, and its tuning condenser C_2. Connected to the primary winding P is the plate circuit of the first valve, and to the second primary winding N a condenser C_4 of small capacity for stabilising the circuit.

For detecting, a valve set to work as an anode rectifier is used, and this is coupled to the first low-frequency valve by a resistance-condenser coupling, R_5, C_3, R_6. The third valve in turn is coupled through a low-fre-

"Everyman's Four-valve."—

quency transformer T_3 to the fourth valve, which is connected direct to the loud-speaker. Rheostat R_1 controls all the valves, and R_2 is the volume control.

The Input Circuit.

Now, the input circuit of a receiver can be represented accurately enough for practical purposes by a transformer with a condenser and resistance representing the effect of and filament of the high-frequency amplifying valve, and it is important to remember that the smallest possible load should be put on the transformer, for any loading will lower the applied voltage and reduce the selectivity. A single dry cell GB_1 is, therefore, connected in the grid return wire to give the grid of V_1 a negative bias and so to prevent grid current unless the amplitude of the incoming signal exceeds the voltage of the dry cell added to the normal bias of the grid. Grid current loading is

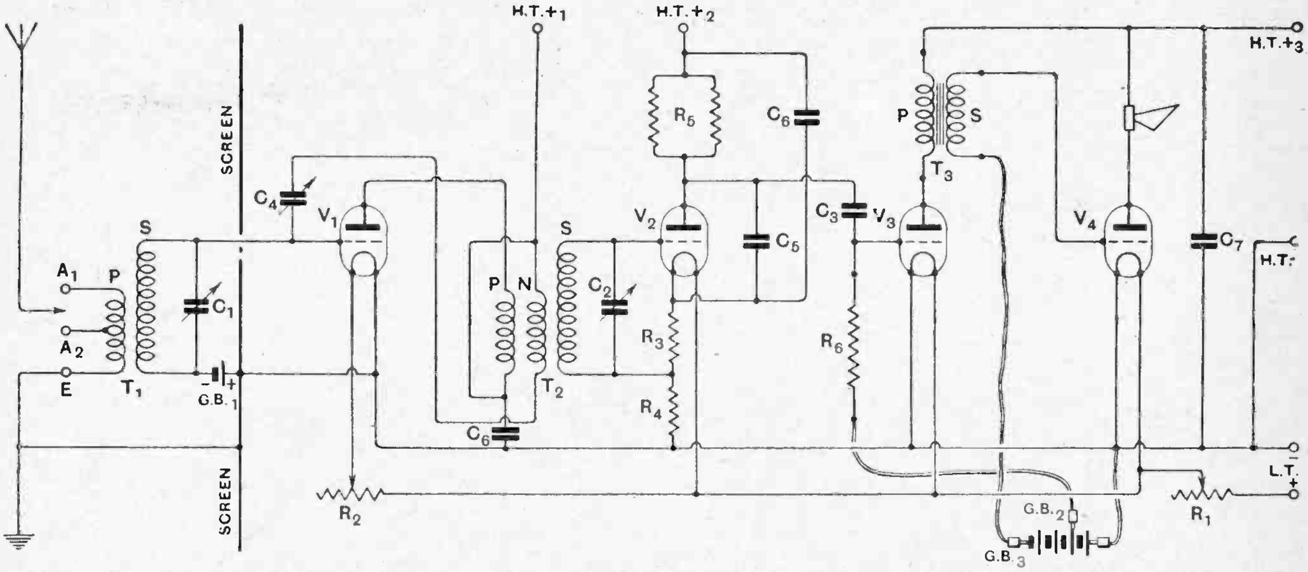


Fig. 1.—Schematic diagram of connections. T_1, aerial-grid transformer; T_2, high-frequency valve transformer; T_3, Ferranti 3.5:1 low-frequency transformer; C_1 C_2, 0.00027 mfd. square law tuning condenser; C_3, 0·01 mfd.; C_4, balancing condenser; C_5, 0.0005 mfd.; C_6, 1 mfd.; C_7, 2 mfd.; R_1, filament rheostat 2 ohms; R_2, rheostat 30 ohms; R_3 R_4 fixed resisters 15 and 7.5 ohms; R_5, 1 megohm each; R_6, 3 megohms; GB, 15 volt grid battery.

the aerial shunted across the primary, as in Fig. 2, and we may assume the signal voltage is applied in series with the resistance. This resistance represents the radiation resistance of the aerial, and if we knew its numerical value we could design the transformer to give a maximum voltage across the terminals of the tuning condenser, but the constants of aerial-earth systems vary so widely that it is not worth while making an exact calculation for a given case; instead, measurements were made of a transformer designed to suit an average aerial. It will be seen that the primary winding has a tap at A_2; when the aerial is connected to this point signal strength is a little less and the selectivity is better than when the aerial is connected to point A_2, it being assumed that the aerial is an outdoor one of normal size.

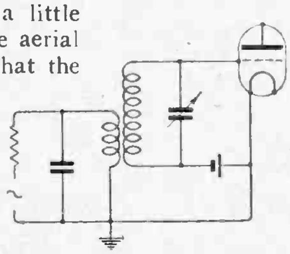


Fig. 2.—Representing the aerial connected to the transformer T_1.

For a given aerial the signal will produce the largest voltages across the secondary terminals when the transformer has a low resistance and a high ratio of inductance to capacity. The secondary winding of the transformer is, therefore, wound with "Litzendraht," and has an inductance of roughly 280 microhenries, while the primary is wound on the outside of the earthed end of the secondary; it consists of a single wire of small diameter. These two windings are wound to have a tight magnetic coupling, and their capacitative coupling is reduced to a minimum by the use of a fine wire primary. Now the ends of the secondary winding are connected to the grid not the only thing to be feared, however. Great care has to be taken to wire up with short connections and to prevent leakage paths through faulty insulation.

The High-frequency Transformer.

The high-frequency transformer is probably the most important part of the receiver, for we have to rely on it and the amplifying valve V_1 to magnify the high-frequency currents by pure high-frequency amplification and also by regeneration; incidentally, we have to make it ourselves, as there is not a good one on the market.

We will consider the coupling as a transformer first, and see what factors settle its operating characteristics when connected to the circuit. Now the first thing to be done is to decide on an amplifying valve V_1, and as the first requirement of this receiver is that it must receive distant stations at loud-speaker strength, it is evident that we must consider magnification first and put selectivity in the second place. The most suitable valve for V_1 is easily found by examining the valve manufacturers' catalogues, bearing in mind, of course, that as the set is to be operated from a dry cell plate circuit battery the valve chosen should take a relatively small anode current. We will choose an Osram D.E.5b, which has the filament rating of 5.5 volts 0.25 ampere, an impedance of 30,000 ohms, and an amplification factor of 20; but if

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a valve of this type is tested it will be found that its impedance falls off very rapidly as the plate voltage is increased. Several valves were tested at a plate voltage of 156 and grid bias of negative 1.5, and an average valve had an anode impedance of 21,000 ohms and an amplification factor of 18 at normal filament voltage. The anode current was a little over 3 mA.

With this valve as the starting point, we have to design a transformer which will tune over the broadcast range of wavelengths and give the highest possible magnification. Now the writer's method of designing a high-frequency transformer is to calculate the best number of turns for the primary and secondary windings, taking into account, as far as possible, the various factors which tend to make the actual amplification different from that which should be obtained according to theoretical considerations, and then with this as a starting point to put the transformer in the set and measure the amplification under actual operating conditions. As we would expect, the amplification actually obtained when the transformer is connected in the receiver is less than when it is measured under ideal conditions out of the set, for a number of things act to load the secondary and so to lower its voltage when it is in the receiver. When the maximum voltage amplification is desired, it is evident that the load on the secondary must be reduced to a minimum, the resistance of the transformer coil and tuning condenser must be as low as possible, and the ratio of the inductance of the secondary coil to the capacity of the condenser across the secondary must be as high as possible. Another thing of considerable importance is the coupling of the primary and secondary, for it is found that there is an optimum value for the magnetic coupling, while, in general, the capacitative coupling should be made very small.

Now the writer has described in earlier issues of this journal the construction of various high-frequency transformers. Each one was designed for a particular purpose, a compromise between amplification and selec-

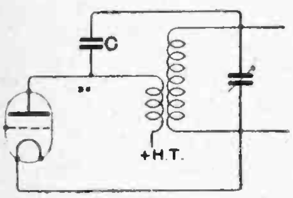

Fig. 3.—High-frequency transformer with added capacity C.

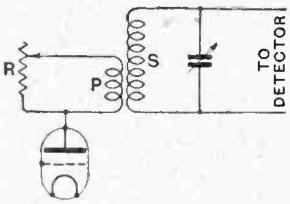

Fig. 4.—A volume control consisting of an adjustable non-inductive resistance R shunting the primary of the H.F. transformer.

tivity being effected in each case to suit what were thought to be the requirements of the receiver being designed. It is of interest to compare the voltage amplification obtained with two recent transformers and their valves with the transformer constructed for the present receiver. Table I gives the amplification of a transformer having a secondary winding of 55 turns of "Litzendraht" 3in. in diameter, with a tuning condenser of 0.0005 mfd. and a primary winding of 11 turns of No. 40 D.S.C.; the amplifying valve was a Burndept L.525, having an impedance of 6,500 ohms and an amplification factor of 6.5. The amplification obtained is seen to vary between 19 and 22.5. This transformer was used in the "Long Range Three Valve Receiver" described in *The Wireless World* of May 26th and June 2nd, 1926.

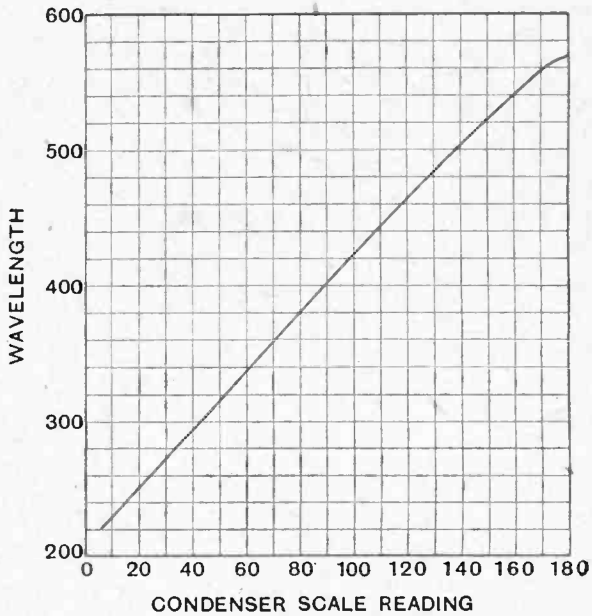

Fig. 5.—Wavelength range of intervalve high-frequency transformer. The curve is practically a straight line, which proves that the square law condenser used is of the corrected type.

TABLE I.

MEASURED AMPLIFICATION OF ONE STAGE, COMPRISING A HIGH-FREQUENCY TRANSFORMER AND VALVE OF 6,500 OHMS IMPEDANCE AND AMPLIFICATION FACTOR 6.5.

Wavelength. Metres.	Voltage Amplification.	Wavelength. Metres.	Voltage Amplification.
590	20.7	350	21.6
520	22.5	290	20.0
470	22.0	230	19.3
410	21.9		

The second transformer is the one used in the "No Battery Receiver" described in the issue of June 30th, and this also has a secondary of "Litzendraht" and a primary of No. 40 D.S.C. wire, having 72 turns and 10 turns respectively with a tuning condenser of 0.0003 mfd. The valve used had an impedance of 10,000 ohms and an amplification factor of 7.5. As shown by Table II, the voltage amplification for this transformer and valve ranged from 26 to 29.

TABLE II.

MEASURED AMPLIFICATION OF ONE STAGE, COMPRISING A HIGH-FREQUENCY TRANSFORMER AND A VALVE OF 10,000 OHMS IMPEDANCE AND AMPLIFICATION FACTOR 7.5.

Wavelength. Metres.	Voltage Amplification.	Wavelength. Metres.	Voltage Amplification.
540	26.0	375	28.2
480	26.5	320	29.0
430	26.5	260	29.4
400	27.3	230	28.5

"Everyman's Four-valve."—

In Table III is given the amplification obtained with the transformer designed for the present receiver. The transformer has a secondary coil of 74 turns of 27/42 "Litzendraht" 3in. in diameter and a primary of 16 turns of No. 40 D.S.C., and is tuned with a 0.00027 mfd. corrected square law condenser. It is seen that the amplification varies between 35.5 and 39.4; this is probably the largest amplification that it is possible to obtain without using "Litzendraht" of many more strands, which is much more expensive than that used in the transformer described.

It should clearly be understood that the figures given are for pure high-frequency amplification only; the effect of reaction is enormously to increase the total amplification as described below. Each of the transformers described was adjusted to give the optimum amplification with the valves used, and the reason for introducing them here is to show what can be done in the way of amplification when this is the main consideration. By way of comparison, it can be shown that the amplification of the transformer illustrated on page 35, July 14th issue, with the D.E.5 valve recommended is only 8 at the optimum wavelength.

The transformer-valve combination of Table I is, of course, much more selective than that of Table III, although the latter transformer when used in the set would be said to be quite selective when compared with the usual receiver having an ordinary tuned anode stage.

Effect of Stray Capacities.

We mentioned above that it is important to make the capacity coupling of primary to secondary as low as possible, and to show the effect of stray capacities such as might easily be introduced by bad wiring and placing of the transformer in the set, a tiny condenser having a capacity of only 10 micro-microfarads was connected between the plate end of the primary and the grid end of the secondary with thin connecting wires, Fig. 3, and the amplification of the transformer and valve was measured with it and without it. The figures given in Table IV show that the effect of connecting the condenser is to lower the amplification by a serious amount. In making the tests the fixed condenser was not removed, but only the wire connecting the condenser to the grid end of the coil was disconnected at the grid end.

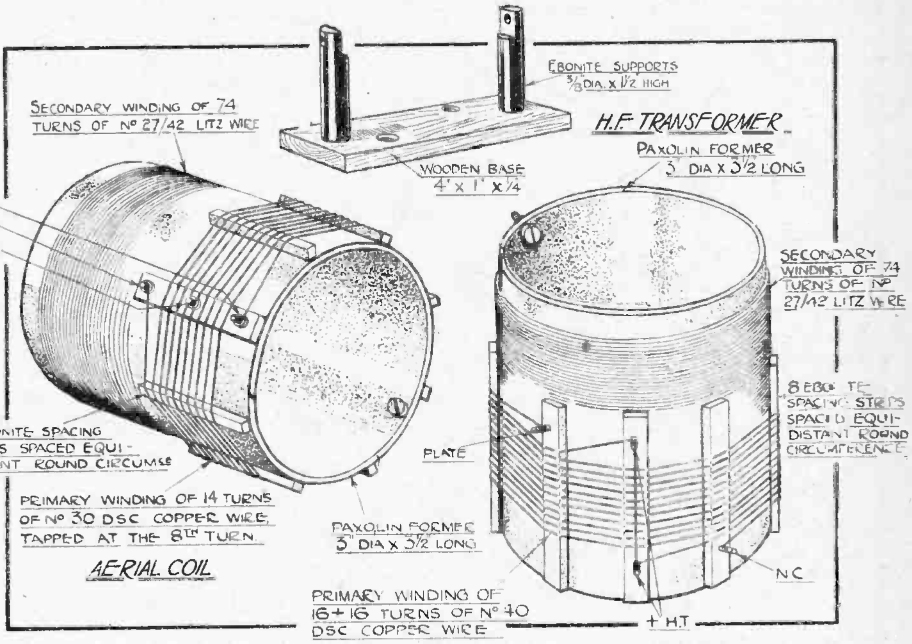

Fig 6.—Details of the two high-frequency transformers. The Litzendraht wire used has a single silk covering on each strand and double silk overall.

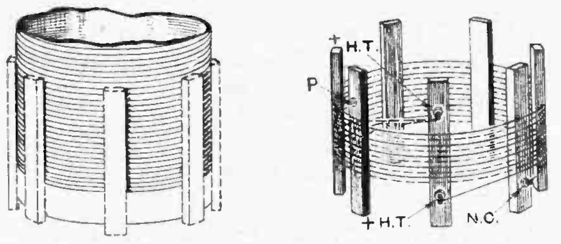

Fig. 7.—Showing the method of winding the primary windings on the intervalve high-frequency transformer.

TABLE III.

MEASURED AMPLIFICATION OF ONE STAGE, COMPRISING A HIGH-FREQUENCY TRANSFORMER AND D.E.5b VALVE OF 21,000 OHMS IMPEDANCE AND AMPLIFICATION FACTOR 18.

Condenser Reading. Degrees.	Approximate Wavelength. Metres.	Voltage Amplification.
160	540	35.5
125	470	37.0
105	430	37.5
90	400	39.4
65	350	39.2
45	300	39.4
15	240	39.0

TABLE IV.

EFFECT OF CONNECTING A VERY SMALL CAPACITY BETWEEN THE PRIMARY AND SECONDARY WINDINGS.

Wavelength. Metres.	Voltage Amplification.	Amplification with added Capacity of $10\mu\mu F$.
540	36.5	29.0
500	39.0	31.0
460	40.0	32.0
424	40.5	32.0
390	40.5	31.0
350	40.5	31.0
310	44.0	32.5
280	46.0	36.0

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This experiment shows us how important it is to keep the stray capacities as small as possible, and this has been taken into account when the placing of the connecting terminals of the transformer was being decided upon.

Combined Amplification.

The amplification of weak signals by the combined transformer and regenerative action is very great, so great, in fact, that it was found necessary to weaken the

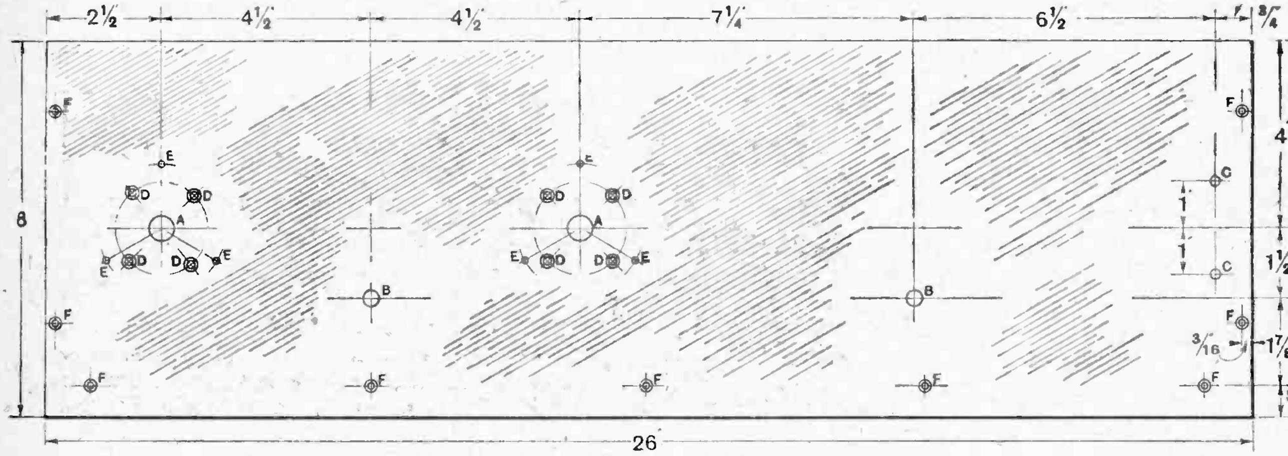

Fig. 8.—Details of the ebonite front panel. A, 1/2" dia.; B, 3/8" dia.; C 7/32" dia.; D, 5/32" dia.; E, 1/8" dia.; F, 1/8" dia. and countersunk.

TABLE V.

CHARACTERISTICS OF OSRAM D.E.5b VALVE.
H.T., 156. Grid Bias, 1.5.

Filament Volts.	Filament Amperes.	Amplification Factor.	Anode Impedance. Ohms.
5.5	0.245	18.0	20,800
5.0	0.23	18.0	21,700
4.5	0.218	18.5	23,000
4.0	0.2	18.7	25,300
3.5	0.185	19.7	35,000
3.25	0.18	17.5	85,000
3.0	0.175	16.0	155,000

Turning now to Fig. 1, it will be seen that the transformer has a third winding marked N, and that this is connected to the + H.T. end of the winding P and to one side of the condenser C_4. This coil and condenser are used to stabilise the circuit and it is found that condenser C_4, which may have a maximum capacity of 15 to 20 $\mu\mu F$, can be set at such a value that the receiver will not oscillate under any conditions. It is not set to balance the valve, *i.e.*, to make the valve a true one-way amplifier; it is deliberately set so that regeneration is made full use of, but the construction of the transformers T_1 and T_2 is such that condenser C_4 can be adjusted to give an extremely useful amount of reaction and yet allow the circuit to remain perfectly stable over the whole tuning range. This condenser C_4 is mounted inside the receiver, and it is adjusted when the receiver is first put to use; after this there is no need to touch it.

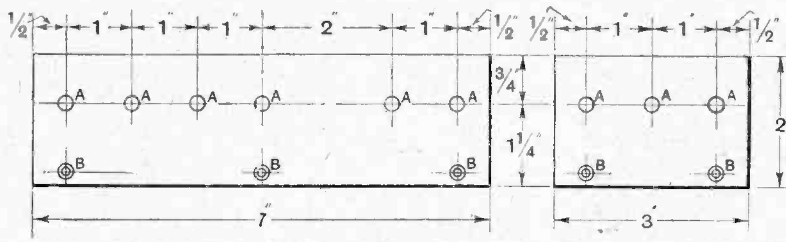

Fig. 9.—The two ebonite terminal strips. A 7/32" dia., B 1/8" dia. for No. 4 wood screws. Belling-Lee ebonite shrouded terminals are used, being marked Earth, Aerial 1, Aerial 2, LT+, LT−, HT−, H.T.+1, HT+2, HT+3.

signals from distant stations such as Birmingham, Bournemouth and Brussels, as received in London, because they overloaded the set. A simple volume control is, therefore, fitted, and takes the form of a rheostat R_2, Fig. 1, connected to the first valve.

Now the circuits of the first valve are adjusted with rheostat R_2 short circuited, and when it is desired to reduce the strength of the signal, R_2 is turned to as to lower the filament current. The effect of reducing the filament current is clearly shown in Table V, which gives the measured values of amplification and impedance for various filament currents. It is seen that as the filament current is reduced the anode impedance increases, whilst the amplification factor also varies a little. Thus the amplification is reduced as the filament current is reduced, and a very steady adjustment of volume is had by this simple method.

The reason for the lowering of amplification with reduction in filament current is not hard to understand if the transformer coupling is considered as a resistance connected in the plate circuit of the valve, for the amplification depends on the ratio of anode circuit resistance to the valve's anode resistance. As this ratio is reduced by dimming the filament the amplification is also reduced.

This form of volume control has the secondary effect of increasing the selectivity, but the effect is slight, because the increased selectivity of transformer T_2 is practically offset by the decreased selectivity of T_1.

A form of volume control which was tried and dis-

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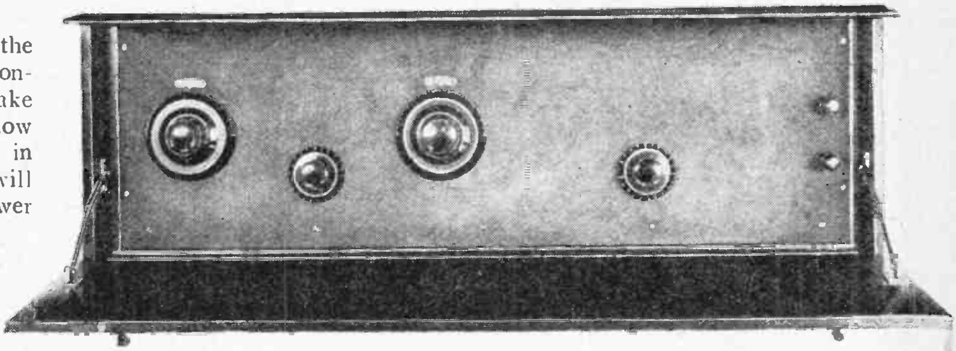
carded is shown in Fig. 4. Here a non-inductive resistance of about 30,000 ohms is connected across the primary, and volume control is had by reducing the resistance, which has the effect of lowering the effective resistance of the primary circuit of the transformer. While the control of volume is satisfactory, the effect of reducing the value of the resistance is very seriously to reduce the selectivity of the set.

Detector Connections.

The next item of interest in the set is the detector. When considerable trouble is taken to make transformer T_2 so that it has low losses, great care is necessary in setting up the detector or it will load the transformer and lower the amplification. A rectifier of the grid condenser and leak type is out of the question, and we have to use an anode detector because, in the first place, it can be so adjusted that a normal signal will not produce grid current, and, secondly, its output circuit can be so arranged that no appreciable load is introduced to the grid circuit.

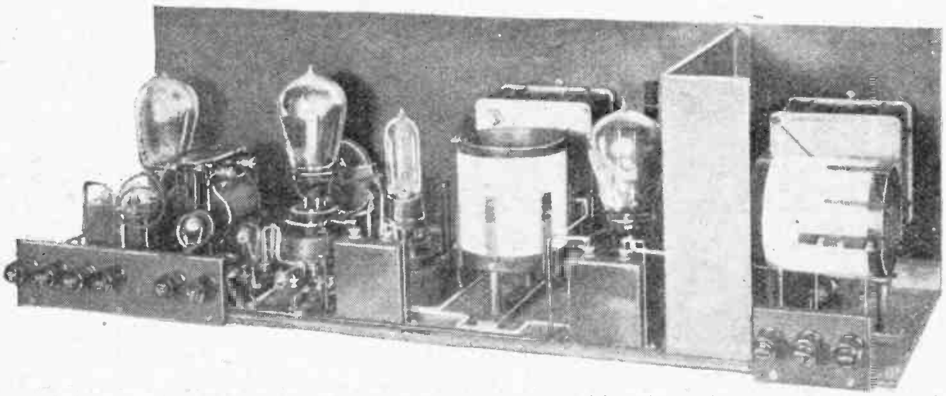


The completed receiver.

It is usually found that the best anode rectifiers are of the type taking a low filament voltage, and although 6-volt valves are used at V_1, V_3 and V_4, a valve taking less than 2 volts is used as the rectifier. The great efficiency of a valve of the low voltage type to weak signals will have been noticed by those who have taken an interest in this subject, so that no details will be discussed here.

A further requirement of a valve for use as an anode rectifier is that it should have a high amplification factor. One of the best for this purpose is the Cosmos SP18 Green Spot, which has an amplification factor of 17 and requires a filament heating current at 1.6 volts. This valve is a very convenient one to use here, because the fall in voltage across the resistance required to reduce the filament battery voltage from 6 to 1.6 volts can be utilised to give its grid a negative bias. A negative bias of 6 − 1.6, or 4.4 volts, was not found convenient because for the best rectification a rather high plate voltage was required. Two resistors are, therefore, used at R_3 and R_4, and the grid bias is settled by the value of R_3. These resistors have values of 15 ohms (R_3) and 7.5 ohms (R_4), so that the grid has a normal voltage of negative 3 volts. The Cosmos SP18 Green Spot valve does not give grid current until the grid is made about positive 1.5 volts. This is an important feature, since the peak value of a signal can be about 4.5 volts without grid current.

Now when a valve is set to rectify as an anode bend detector, its anode impedance is much higher than the normal value quoted by the makers; that of the SP18 Green Spot is about 150,000 ohms. Transformer coupling, therefore, cannot be used, and it is necessary to employ either a choke or resistance-condenser coupling. When the best quality is required resistance-condenser coupling is preferable, and a special form of this coupling is used. It will be seen upon referring to Fig. 1 that two resistances connected in parallel are used at R_5. These are grid leaks of 1 megohm each, giving a combined resistance of 0.5 megohm. Coupling condenser C_3 has a value of 0.01 mfd., and the grid leak R_6 is of 3 megohms. This combination gives an amplification of about 13, and low-frequencies are amplified to practically the same extent as the frequencies of about 1,000 cycles. Actually a 50 cycle note is amplified to within 10 per cent. of a 1,000 cycle note, but the interesting thing here is the amplification of the higher frequencies, for when high resistances are used the effect of stray and valve capacities is of considerable importance.



View of the back of the set, showing the position of the coils.

It should be mentioned, before proceeding further, that the object in using grid leaks as resistances is cheapness, since the whole coupling costs only about 10s. The valve is a cheap one, costing 12s. 6d., and the current taken from the anode battery is only a few microamps. Two resistances are used at R_5 because the writer has not had the opportunity of testing the life of grid leaks carrying current for a lengthy period, and is merely a precaution which is probably not necessary in view of the small current which flows through them.

LIST OF PARTS.

2 Variable condensers, square law, 0.00027 mfd. (Burndept Wireless, Ltd.).

2 Rheostats, 2 ohms and 30 ohms (ditto).

2 Resistors, 15 ohms and 7.5 ohms (ditto).

2 Resistor holders (ditto).

2 Condensers, 1 mfd. (Telegraph Condenser Co., Ltd.).

1 Condenser, 2 mfd. (ditto).

1 Neutrovernia (Gambrell Bros., Ltd., 76, Victoria Street, London, S.W.1).

1 Transformer A.F.3. 3½ to 1 (Ferranti, Ltd., Hollinwood, Lancs.).

1 "T" type (square) 1½-volt grid battery (Siemens Bros. and Co., Ltd., Woolwich, London, S.E.).

1 No. 620 fixed condenser 0.0005 mfd. (Dubilier Condenser Co., Ltd.).

1 No. 610 fixed condenser 0.01 mfd. (ditto).

1 Grid leak, 3 megohms, Dumetohm (ditto).

2 Grid leaks, 1 megohm (Edison Swan Electric Co., Ltd., 123-125, Queen Victoria Street, London, E.C.4).

3 Grid leak holders (Dubilier Condenser Co., Ltd.).

1 16-volt grid battery (Portable Electric Light Co., Ltd., 120, Shaftesbury Avenue, London, W.1).

50 yards Litzen wire (P. Ormiston and Sons, Ltd., 79, Clerkenwell Road, London, E.C.).

4 Lotus valve holders (Garnett, Whiteley and Co., Ltd., Lotus Works, Broadgreen Road, Liverpool).

2 Paxolin tubes (Micanite and Insulator Co., Ltd., Empire Works, Blackhorse Lane, Walthamstow, London, E.17).

2 Dial indicators (Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex).

11 Ebonite shrouded terminals (ditto).

Ebonite panel, 26in.×8in.×¼in.

1 Cabinet and baseboard, 26in.×8in.×8in. (Carrington Manufacturing Co., 18-20, Mitchell Street, Central Street, London, E.C.1).

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The stray and valve capacities shunting the resistance are much greater under working conditions than the static values of the capacities because of the amplifying property of the valve; further, it is necessary to shunt the plate circuit resistance with a condenser C_5 to limit the amount of high-frequency current which passes to the next low-frequency amplifying valve and also to improve the rectification efficiency of the detector. We would, therefore, expect to find that the higher notes of audio-frequency are reduced in strength. This is certainly the case, as can be seen by calculation, but it was also found that the effect of connecting a fairly large condenser across R_5 increased signal strength to a very marked extent. It was found that the signal strength as measured and also as received from a distant station increased with the value of the shunt condenser C_5 up to a value of 0.0005 mfd., and so a condenser of this value was included in the set. No weakening of the higher notes could be detected by listening and comparing with a normal resistance coupled amplifier, this being due perhaps to the fact that the ear is not usually able to distinguish the difference in amplification of, say, 30 per cent.

The third valve is a DE5b, and its grid has a negative bias of 3 volts from GB_2, the plate voltage being 156. In its plate circuit is connected a Ferranti 3.5 : 1 transformer, the inductance of the primary winding of this transformer being 80 henries. The anode current is 1.75 mA, and an amplification of about 75 is obtained. This is a very high amplification, and it should be noted that the amplification-frequency curve will be rather better at the low-frequency end of the scale than that shown by the makers because we are using a valve of 25,000 ohms impedance. Valve V_4 is a DE5, and works with a plate voltage of 156 and a grid bias of negative 12 volts. Its normal plate current is 4.75 mA. Thus the total plate current taken by the set is 10 mA., which is well within the capacity of a large size dry cell battery.

Construction of the Aerial-Grid Coil.

This coil stands upright in the set, and comprises a base of wood 4in. × 1in. × ¼in., with two ebonite supports ⅜in. in diameter and 1¾in. long. These supports are drilled and tapped 4B.A. at each end. The coil itself is wound on a Paxolin former 3in. in diameter × 3½in. long, and has 74 turns of 27/42 Litzendraht wire wound with the turns touching; the ends are terminated at tags held by small screws and nuts. Over this winding and at the earth end is placed 8 ebonite spacers cut from a length of ebonite tube 3in. in diameter with ⅛in. wall. These can be held by a rubber band; one of the spacers, which are 2in. long, has three No. 8 B.A. countersunk headed screws, which are held in position by nuts. The primary winding is wound in the same direction as the secondary of No. 30 D.S.C. copper wire, and has 14 turns, with a tap at the eighth turn.

The high-frequency transformer shown in Figs. 6 and 7 is also mounted on a wooden base, 4in. × 1in. × ¼in., carrying two ebonite supports ⅜in. diameter and 1½in. long. The secondary winding is of 74 turns of No. 27/42 Litzendraht wire and eight ebonite spacing strips are placed over its lower end. Reference to Fig. 6 will show that three of these strips have small screws attached, one strip having a screw at either end and two strips having a screw at one end. The primary winding, marked P in the diagram of Fig. 1, commences at the terminal marked +H.T., and has 16 turns of No. 40 D.S.C. wound in the same direction as the secondary, the end of this winding being terminated at the screw marked "Plate." The turns are wound 15 to the inch; the primary is the winding shown with a continuous line in the sketch of Fig. 7. The second primary winding, marked N in Fig. 1, is now put on; this winding is commenced at the screw marked NC. The wire is passed round the former and runs in the space between the turns of the primary winding, and terminates at the upper screw marked +H.T. This winding is the one shown by a broken line in Fig. 7. The two primary windings have 16 turns each of No. 40 D.S.C. copper wire.

The Ebonite Front Panel.

This panel measures 26in. long × 8in. high and is ¼in. thick. On it are mounted the two corrected square law condensers of 0.00027 mfd. capacity, and the two filament rheostats R_1 and R_2 of 2 and 30 ohms respectively; the 2 ohms rheostat is the one mounted on the right-hand side of the panel, and the 30 ohms rheostat is mounted between the two tuning condensers. On the extreme right-hand side two terminals for the loud-speaker connections are mounted. Just above the two tuning condensers will be seen two holes marked E on the panel; these are to take a name plate and pointer.

(To be concluded in the next issue.)

DRY CELLS FOR WIRELESS PURPOSES.

Length of Life that may be Expected from H.T. and L.T. Batteries.

By R. L. SMITH ROSE, Ph.D., M.Sc., A.M.I.E.E.

ONE of the industries which owes its existence on a wide scale at the present time to the popularity of wireless is that of the manufacture of dry cells and batteries. The industry is, of course, not a new one since, long before the war, most electrical firms produced dry batteries for use in connection with electric bells, telegraph, telephone, and railway signalling, portable electric lamps, etc. During the war, also, many British firms had to extend their facilities for dry battery manufacture in order to cope with the demands of the Services for batteries for wireless and other signalling purposes. But it is probable that the demand for dry batteries is much greater to-day than ever before. The greater part of this demand is for batteries for use as a high-tension supply for valve receivers, but with the modern development of the dull-emitter valve of low filament-current consumption there is also a demand for larger cells for use in completely portable receivers. With the earlier growth of broadcasting in America it is natural to find that the demand for dry cells was felt over there a year or two before it became urgent in this country. As early as 1923 it was estimated that the demand for dry batteries of all types was approximately 150,000,000 per annum.[1] The importance of standardising the sizes of the dry cells placed on the market was early realised in America, and in December, 1921, the 47 different sizes then prevailing were reduced to 15 standard sizes covering all the usual applications of such cells. In this country such complete standardisation appears to be still lacking, although in the course of time one or two sizes have become so widespread in their manufacture and use as to be almost equivalent to standardised products. Two sizes of cell in particular have been popular for many years. The larger of the two is a cylindrical cell, whose approximate overall dimensions are 6in. × 2½in. diameter, and which has been very largely used for electric bell and telephone work. The smaller cell, also cylindrical, is about 2in. × ⅝in. diameter, and it has been most commonly used in the standardised flash lamp battery containing three such cells. This type of cell was adopted as the unit for high-tension batteries for wireless valve receivers during the war, and as such these batteries still survive in a number of convenient voltages. It has been realised for some time, however, that the anode current consumed by multi-valve receivers, particularly when using power amplifying valves, is too large a drain on such small cells to give them a useful life; and a somewhat larger cell of approximate dimensions 2½in. × 1¼in. has since become practically standardised in assembled high tension batteries.

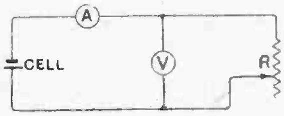

Fig. 1.—Simple circuit for life tests on dry cells at constant current.

In order to obtain some fairly definite idea of the effective life of dry cells under working conditions a few tests have been carried out on two typical sizes of cells which it was desired to use for high and low tension valve supplies respectively. Apart from the interest in obtaining some definite idea as to the total output which may be expected from such cells, and the comparison of cells of different makes, it is important to know at what point in the life of the cell it becomes uneconomical to continue to use it. For during the discharge of the cell the effective voltage available in the external circuit steadily decreases, and if a constant voltage supply is required it is necessary to adopt some method of adding new cells to the battery during the discharge. Now, in such instruments as portable receivers, screened oscillators, etc., the number of cells which can be used for, say, the L.T. battery is limited by the space allotted in the initial design of the instrument. This means that a definite knowledge is required of the voltage below which it is uneconomical to discharge the cell, and at which, therefore, it can be removed from the circuit. With this information the maximum number of cells likely to be required for a given voltage supply becomes known, and the instrument can then be designed to accommodate them. In the present instance no elaborate investigation of the behaviour of the cells was undertaken, and the reader who is deeply interested in this matter may be referred to Circular No. 79 of the Bureau of Standards, which summarises a large amount of available information on dry cells, including a discussion of their electrical characteristics and methods of testing them under a variety of conditions.

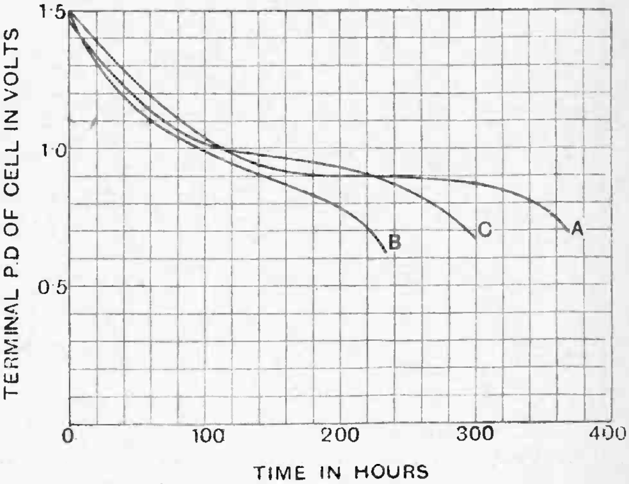

Fig. 2.—Discharge curves (0.025 amp., 4 hours per day) for three small type dry cells.

[1] *Circular of the Bureau of Standards*, No. 79, 1923.

Dry Cells for Wireless Purposes.—

The present experiments involved a simple life test carried out with the circuit shown in Fig. 1. The current drawn from the cell was controlled by the variable resistance R, and recorded on the ammeter A, the effective output voltage being measured under the load conditions by the voltmeter, V. The tests were made under constant current conditions over continuous daily periods of four hours' duration (Sundays excepted), as being fairly representative of the discharge conditions of a battery attached to a wireless receiver in constant use. During each daily period the current was maintained constant by making the necessary slight adjustments to the external resistance.

Types of Cells Tested.

Two sizes of cell and three different well-known makes of each size were tested. The first size of cell tested was the larger of those used in high-tension batteries, of approximate overall dimensions 2½in. × 1¼in. Formerly, these cells were obtained separately and made up into H.T. batteries, but it is now possible to obtain blocks of cells, assembled into batteries of convenient sizes. These smaller cells were discharged at 0.025 ampere (25 milliamperes), which is the order of the total anode current taken by multi-valve supersonic heterodyne receivers. To obtain comparative figures at a lower current output another cell of one of the types was tested at a discharge rate of 0.01 (10 milliamperes). The second size was that of approximate overall dimensions 6in. × 2½in., and this was discharged at 0.25 ampere over the above periods. While it may be remarked that this discharge is somewhat heavy for this size of cell it is to be noted that one of the cells tested was sold specifically for use with valves taking the above filament current. Further, in one piece of apparatus it was required to take such a current from cells whose size was severely limited. Comparative figures for smaller discharge rates can be obtained from the comparative tests made on the smaller size of cell as mentioned above. In all cases the tests were discontinued when the voltage had dropped to 0.7 volt, as this was considered to be the lower limit of the useful voltage.

TABLE I.

RESULTS OBTAINED IN DISCHARGING THREE MAKES OF CELL OF A SIMILAR TYPE AT A CONSTANT CURRENT OF 0.025 AMP. FOR 4 HOURS DAILY.

Cell No.	(a) Discharged to 1.0 Volt.		(b) Discharged to 0.7 Volt.		Ratio (a)/(b).
	Time in Hours.	Output in Ampere-hrs.	Time in Hours.	Output in Ampere-hrs.	
A	112	2.8	368	9.2	0.30
B	98	2.5	222	5.5	0.45
C	112	2.8	294	7.3	0.38

Results of the Tests.

(a) *Small size cell.*

The results of the tests on three different makes of the small size of cell are given in Fig. 2, which shows the terminal voltage of the cell on load against the time of discharge in hours. The most noticeable point about these results is that, while all three cells give very similar behaviour in discharging down to one volt, their subsequent performance differs considerably. For while cell B continues to drop in voltage at a fairly steady rate, cell A gives a prolonged discharge at a voltage in the neighbourhood of 0.9 before dropping off again towards the end of the test. It is thus evident that, while the total output is approximately the same for each of the three cells when discharged to one volt, the output from cell A is considerably greater than that of the others if the discharge is continued to 0.7 volt. It should be observed that tests carried out on different cells of the same type and make gave fairly consistent results, so that the features here being discussed are characteristic of the type and make rather than of the individual cells.

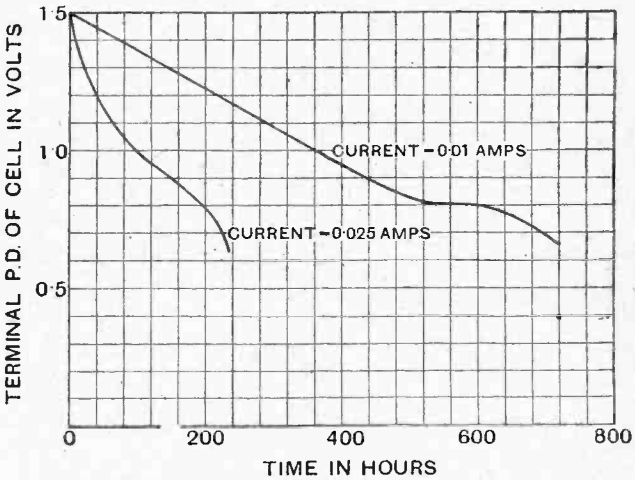

Fig. 3.—Comparative discharge curves for the same type of cell for currents of 0.025 and 0.01 amps. respectively.

In Table I the results are summarised for the above limiting conditions for the three cells.

If an effective voltage of 0.7 be taken as representing the end of the useful life of the cell, it is seen from this table that only from 30 per cent. to 45 per cent. of this life is utilised if the cell be discarded when the voltage has fallen to one volt. It is further evident from the shape of the curves in Fig. 2 towards the end of the test that there is little to be gained by continuing the discharge beyond the somewhat arbitrary value of 0.7 volt adopted throughout these tests.

TABLE II.

RESULTS OF DISCHARGING TWO CELLS OF THE SAME TYPE AT 0.025 AND 0.01 AMPERE RESPECTIVELY.

Final Voltage.	(a) Discharged at 0.01 amp.		(b) Discharged at 0.025 amp.		Ratio of Outputs (a)/(b).
	Time in Hours.	Output in Ampere-hrs.	Time in Hours.	Output in Ampere-hrs.	
1.0	360	3.6	98	2.5	1.44
0.7	690	6.9	222	5.5	1.25

With a second cell of type B the test was repeated under the same conditions but with the discharge current decreased to 0.01 ampere. The results of both tests carried out on this type of cell are shown in the curves in Fig. 3 and Table II. The curves show that the dis-

Dry Cells for Wireless Purposes.—
charge at the lower current was remarkably steady down to about 0.8 volt, while the table shows that the total output in ampere hours is from 20 to 40 per cent. greater when discharging at the lower current.

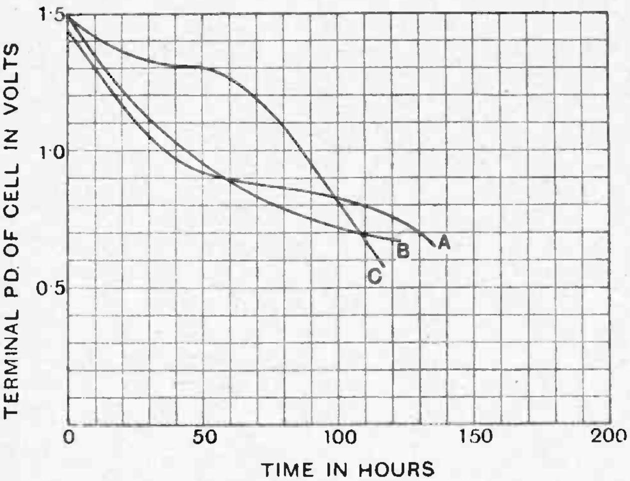

Fig. 4.—Discharge curves (0.25 amps., 4 hours per day) for three large type cells.

The slight irregularities which are evident in the accompanying curves are possibly due to variations of temperature during the tests, since no special arrangements were employed to keep this factor constant, and it is well known that the behaviour of dry cells is very susceptible to changes in temperature.[2]

(*b*) *Large Size Cell.*

The results of the tests on the three larger cells are shown in the curves in Fig. 4. Here it is seen that while cells A and B were very similar in their behaviour throughout the test, cell C showed a very distinct departure from them.

From the summarised results in Table III it is seen that in the case of cells A and B a large proportion of the effective life is lost if the cell is discarded when the voltage has fallen to 1.0 volt. Cell C, however, shows a marked superiority to the other two, for while it gives a total life of the same order as the other two, nearly 80 per cent. of this life is obtained while the cell is giving more than one volt at its terminals.

TABLE III.

RESULTS OBTAINED IN DISCHARGING THREE MAKES OF CELL OF A SIMILAR TYPE AT A CONSTANT CURRENT OF 0.25 AMPERE FOR 4 HOURS DAILY

Cell No.	(*a*) Discharged to 1.0 Volt.		(*b*) Discharged to 0.7 Volt.		Ratio (*a*)/(*b*).
	Time in Hours.	Output in Ampere-hrs.	Time in Hours.	Output in Ampere-hrs.	
A	35	8.8	130	33	0.38
B	43	10.7	108	27	0.25
C	86	21.0	108	27	0.78

Since these cells were of the same makes as the smaller cells referred to above, it may be inferred that the total output of these larger cells would be increased by about one-third if the discharged current were reduced from 0.25 to 0.10 ampere.

With the aid of such definite quantitative information it is a comparatively simple matter to calculate the probable life of a dry cell or battery when used under any of the usual conditions prevailing in wireless receivers. In cases where the cells are subject to a very light discharge load, it should be remembered that the cells have what is termed a "shelf" or "standing" life of the order of six to twelve months, even though no current is taken from the cell. It is this life which determines the period during which a grid biassing battery effectively performs its allotted function.

[2] See, for example, the Bureau of Standards Circular No. 79, 1923, already referred to.

TRANSMITTING NOTES AND QUERIES.

We are asked to state that Mr. Jamas, whose station FI 8QQ is so well known, will, after August 1st, be operating under the new call-sign IC 1B. Also that reports on the reception of recent signals from FI 8QQ will be welcomed by F 8JN (Messrs. Carrot & Levassor, Melun, Seine-et-Marne) or by LA 1X (Mr. J. O. Berven, Uelandsgt, 14, Stavanger), who have lately been unable to establish communication with him at the times agreed on.

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Mr. A. C. de Groot, Goenoeng Poentang Tea Estate, Rongga, Tjimahi, Java, will also be working on 30 to 45 metres at about 7.40 p.m. (G.M.T.), using the call-sign EI PK1, and will welcome reports.

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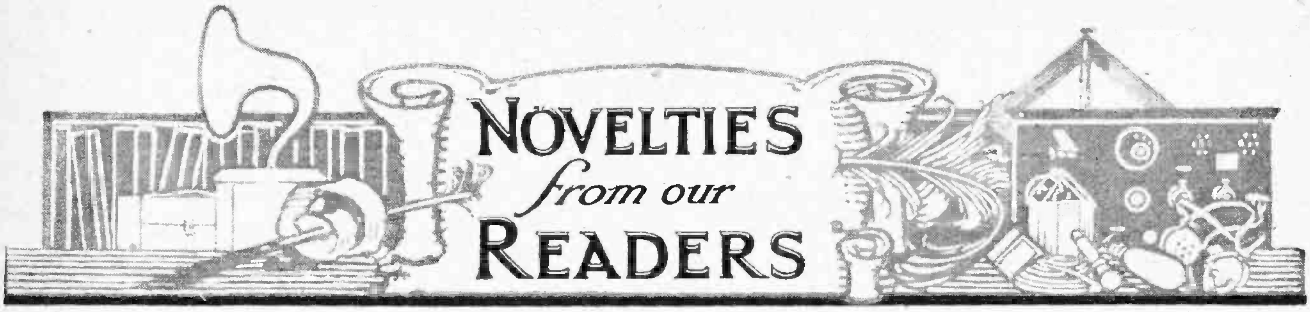
Mr. T. N. Baskerville, 9, Arthog Drive, Hale, reports having heard WPN on 37.5 and 16 metres. This is the well-known call-sign of s.s. "Bowdoin" of the MacMillan Arctic Expedition, which started for the North Pole on June 20th. He has also heard VOQ, the Newfoundland fishing schooner "Morrissey," which is taking out an expedition organised by the American Museum of Natural History, and at the time of writing was stationed at Etah in Greenland. VOQ was transmitting on 37.5 metres. The station is operated by Mr. E. Manley (U 8FJ).

"Calls Heard."

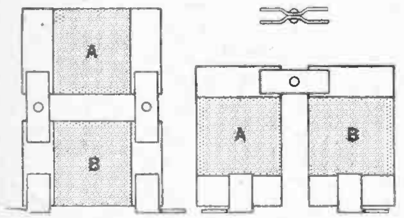
We would remind readers that the space available for printing extracts from their logs is very limited. We are always ready and willing to publish as many as possible of the lists we receive, believing them to be of real interest to very many of our readers. We would, however, ask our contributors to keep their lists as short as possible, to select only those stations which are of general interest, and only to record calls heard from foreign or distant stations. The working range of low-power stations is now so great that it is by no means uncommon for a transmitter in England to work with U.S.A. on only 2.5 watts. In selecting, from a pile of lists received, those we consider of most general interest, we try to choose representative lists from all parts of the world, and naturally give preference—all other things being equal—to those requiring least sub-editing. Readers who send us lists of calls heard are, therefore, asked to conform as far as possible to the following rules:—(1) Write (or preferably type) on one side of the page only; (2) Start with the town in which your station is situate and the dates between which the calls were heard; (3) only record foreign or distant stations unless there is any special reason for including one or two at short range; (4) give the international indicating prefix once only, after the name of each country; arrange each group of calls in alphabetical order and in capital letters; (5) for the sake of uniformity we prefer each group to be prefaced by the name of the country and *not* the nationality (*e.g.* "Holland" and not "Dutch"); (6) end with nature of receiver (*e.g.* 0-v-2), waveband on which the calls were heard, name and (if a transmitter) your own call-sign.



A Section Devoted to New Ideas and Practical Devices.

FIXED CONDENSER CONNECTIONS.

Small double-ended clips constructed according to the accompanying sketch are very useful in experimental work for connecting together fixed condensers of the McMichael type. No alteration to the existing



Fixed condenser connections.

spring clips is necessary, as these serve to hold the complete assembly of condensers. Two methods (series and parallel) of connecting a pair of condensers are indicated in the diagram.—S. W. F.

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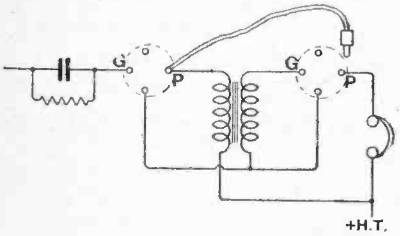
L.F. AMPLIFIER CONNECTIONS.

If a valve should give out in the L.F. stages of a receiver in which no arrangements have been made for switching, the remainder of the programme may be received if the following instructions are carried out.



Eliminating the last L.F. valve without altering internal connections.

The last valve of the receiver is withdrawn, and valves are changed round if necessary, so that all those remaining in circuit are good ones. A flexible lead is then joined between the plate leg of the valve in the last stage but one and the plate socket of the last valve holder. The diagram shows that the primary winding of the transformer remains in parallel with the loud-speaker, but this is not a serious objection in view of the temporary nature of the connection, and against it may be set the advantage that no alteration to the internal wiring of the set is necessary.—W. D.

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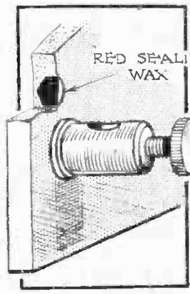
TERMINAL INDICATOR.

It is not necessary to go to the trouble of fitting special terminal indicators if it is only required to



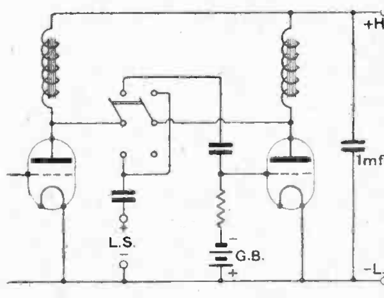
A simple method of distinguishing positive terminals.

distinguish between positive and negative battery terminals. A small blind hole drilled near the positive terminal and filled with red sealing wax is quite sufficient.—L. M.

oooo

CHOKE AMPLIFIER SWITCHING.

Low-frequency amplifiers coupled by means of chokes and condensers lend themselves to a neat form of switching which is shown in the accompanying circuit diagram. The change-over switch not only transfers the loud-speaker and its associated feed condenser from the plate of one valve to the other, but also disconnects the grid coupling condenser when the second valve is not in use—an essential precaution if full efficiency is to be maintained.

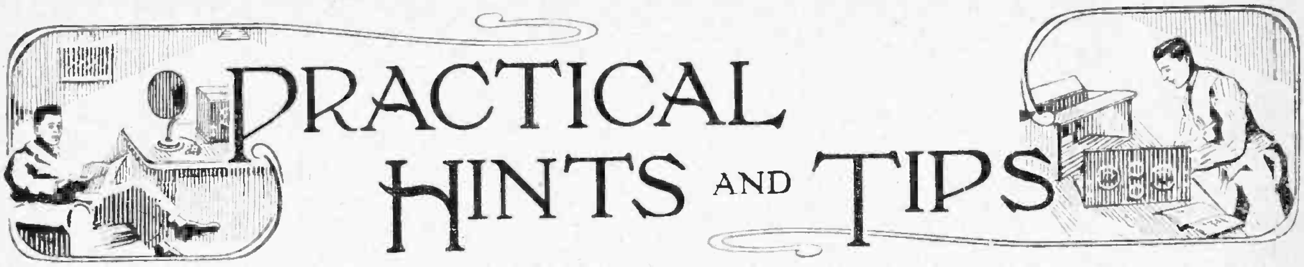


Circuit diagram of switching arrangement for choke coupled L.F. amplifiers.

A further advantage of this method of switching is that the separate coupling and feed condensers can be used and individual capacity values assigned for the particular function each has to perform. Thus the coupling condenser, which transfers voltage fluctuations to the grid of the last valve, may be given a value of 0.05 mfd., while the loud-speaker feed condenser, which is required to pass a considerable amount of electrical energy, may be given a capacity of 1 mfd.—T. J. C.

Valves for Readers.

For every practical idea submitted by a reader and accepted for publication in this section the Editor will forward by post a receiving valve of British make.



PRACTICAL HINTS AND TIPS

A Section Mainly for the New Reader.

CALIBRATING A FILAMENT RHEOSTAT.

The filaments of all dull-emitter valves are likely to be damaged by the application of an excessive voltage; in certain cases quite a small overload will appreciably reduce the life of the valve. Unfortunately, the average wireless user is not in possession of an accurate voltmeter or ammeter, and it is often a matter of some difficulty to decide whether the filament is being heated in the manner intended by the manufacturer.

If the controlling rheostat has approximately its rated resistance, and is of one of the more conventional patterns, it is possible to obtain a rough idea as to whether the actual voltage applied to the filament is correct by observing what proportion of the resistance element is actually in circuit. To take an example, we may consider the case of a valve rated at 0.3 ampere, and 1.7 volts, fed from a single 2-volt accumulator cell. The value of external resistance may be ascertained from the simplified formula: volts to be dropped in the resistance ÷ current taken by the valve (in amperes). This gives a required value of 1 ohm. Assuming that our rheostat has a total resistance of 5 ohms (a very usual figure), it is clear that only one-fifth of the wire comprising its resistance element will be needed in series with the valve. When the accumulator is freshly charged, however, a difference of potential of as much as 2.25 volts may exist across its terminals, when an external resistance of nearly 2 ohms will be necessary. This excess voltage will quickly fall on load.

It is clearly of advantage to have a fairly accurate knowledge of the resistance of filament rheostats, and the keen amateur would be well advised not to miss an opportunity of calibrating these components, should he at any time have access to suitable measuring instruments.

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ADAPTING A MULTI-VALVE SET FOR LOCAL WORK.

It has often been stated in this journal that the introduction of switching into an H.F. amplifier, particularly when designed to operate on the shorter wavelengths, is highly undesirable, on account of the likelihood of setting up losses and instability. It must, however, be admitted that the practice of using, say, two H.F. stages for reception of the local station is extremely wasteful, and there is a very real temptation to fit some switching device, even at the risk of sacrificing efficiency.

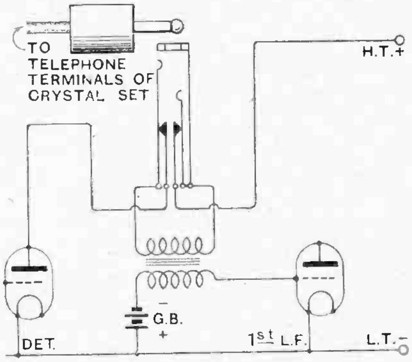

Fig. 1.—Modifying a multivalve set for local reception.

One of the best methods of solving the problem is to use a crystal set for short-range work, amplifying its output (for loud-speaker reproduction) by the use of the L.F. portion of the main set, in such a way that its high-frequency circuits are not interfered with in any way. A suitable and convenient method of making the necessary change-over is indicated in Fig. 1. For this scheme of connections, a jack, of the pattern known as the "double circuit, closed" is required. This is wired up in such a way that the primary of the first L.F. transformer normally occupies its usual position in series with the anode of the detector valve. When the plug is inserted, the springs of the jack are opened out, the anode and H.T. leads are disconnected, and the output leads of the crystal receiver (connected to the plug) are joined across the transformer.

It will, of course, be necessary at the same time to transfer the aerial and earth leads; this operation may be conveniently carried out by an externally-mounted D.P.D.T. switch. Needless to say, the filaments of the detector and all preceding valves should be extinguished when operating the L.F. amplifier from the crystal.

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SELECTIVE CRYSTAL RECEIVERS.

Further to the remarks made under this heading on page 85 of last week's issue of *The Wireless World*, it may be as well to add that there is a distinct advantage in using "low-loss" secondary coils in either of the circuits shown. This statement, however, is only true when special precautions, as recommended in the paragraph referred to, are taken to reduce crystal damping; there is little point in using a highly efficient inductance when a low-resistance crystal is connected directly across it. This applies, of course, to all crystal circuits, and not merely to those primarily designed for high selectivity.

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TESTING A FRAME AERIAL SET.

The constructor of a set operating on a frame aerial, who lives at some distance from a transmitting station, often experiences difficulty in making initial adjustments, particularly when there is some fault in his wiring or components, which, though trifling in itself, may be sufficient to prevent any signals from being heard, as it is possible that the very feeble impulses collected by the frame may be insufficient to operate the set, unless everything is in order.

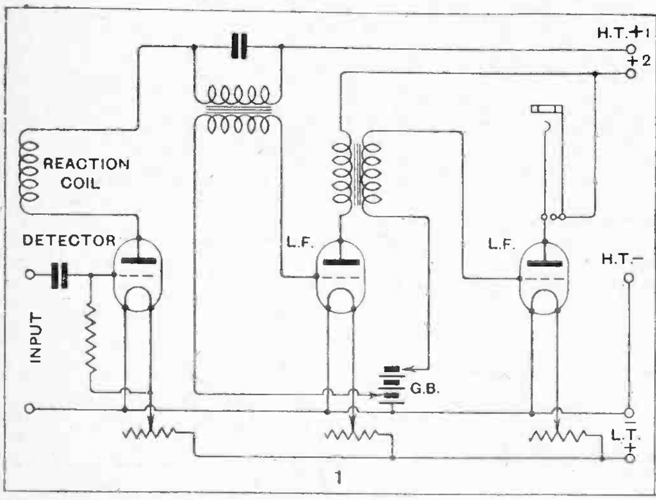
Experience shows that faults are more easily and quickly located when an incoming signal is audible. Under these conditions, the effect of any experimental alteration is clearly noticeable, and it is as well to attempt to obtain this signal by temporarily connecting an aerial-earth system to the set. This may fairly easily be done by earthing the L.T. battery and making a tapping on to the frame for connection to the aerial in such a way that one or two turns are included in this circuit.

DISSECTED DIAGRAMS.

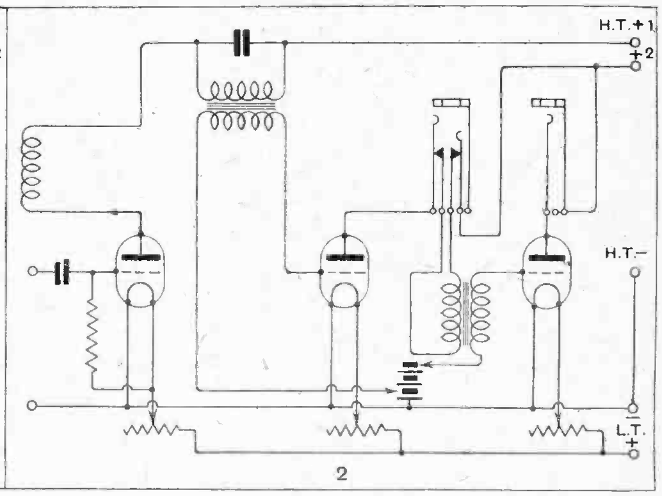
No. 38 (a).—Switching an O–v–2 Receiver with Jacks.

(To be continued.)

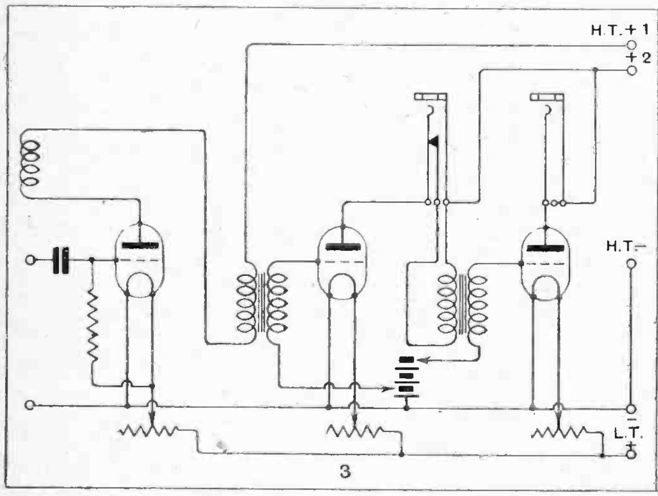
Plugs and jacks are sometimes used instead of switches for eliminating unwanted valves in an L.F. amplifier. Various practical circuits of the simpler kind are shown below.



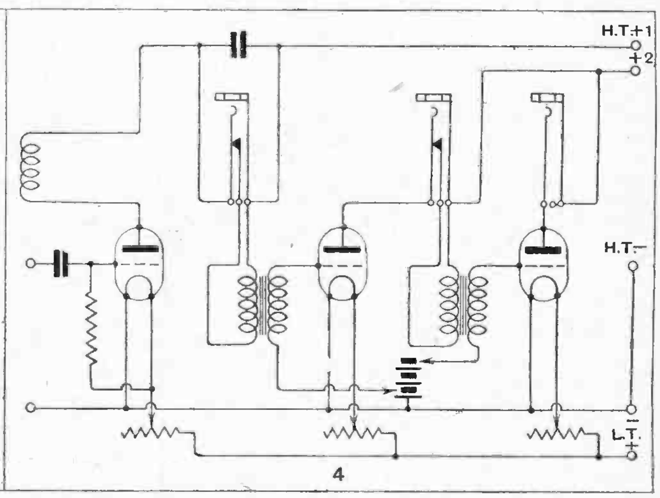
The basic circuit diagram, without switching. Apparatus preceding the detector valve is omitted. Note that a "single circuit open" jack is inserted in series with the anode of the output valve for connection to the phones (or loud-speaker) which are wired to a plug.



The second L.F. valve may be eliminated by inserting the plug into the "double circuit closed" jack in the anode circuit of the 1st L.F. valve. The plug opens out the springs, disconnects the L.F. transformer primary, and places the phones in series with the anode.



The jack shown in Fig. 2 may be replaced by a simpler pattern ("single circuit closed"). The insertion of the plug has the effect of transferring the anode output from transformer primary to phones. Connection between phones and H.T.+ is made through the frame of the jack.



Another "single circuit closed" jack is inserted in series with the anode of the detector valve, so that phones may be substituted for the transformer primary, thus eliminating both L.F. valves. In all these circuits the rheostats controlling valves not in use are turned off.

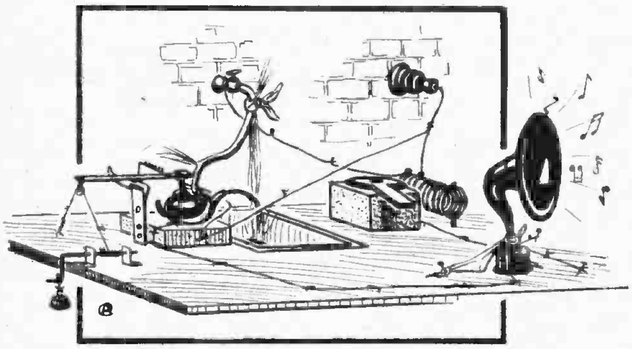
LOUD-SPEAKER CRYSTAL SETS.

How to Make Them Work.

By U. R. CORTAGEN.

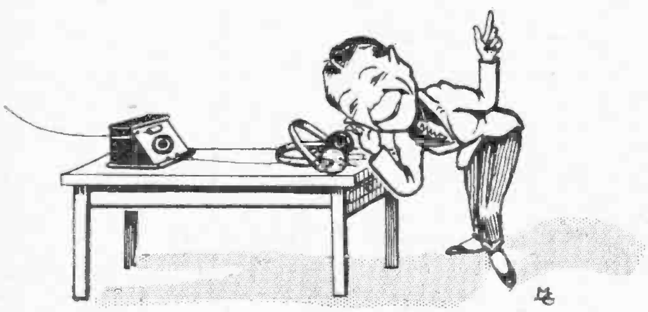
ONE hears fairly frequently of people who are able to receive the local broadcast station and, in some cases, other stations too on a loud-speaker, when using only a home-made crystal set.

The writer has carefully investigated some of these claims with a view to constructing a suitable set and is quite convinced that it is possible to obtain loud-speaker results, using only a crystal set for reception, provided that certain conditions are complied with and certain precautions, which will be discussed later, are taken.



Loud-speaker crystal sets are of weird design

These loud-speaker crystal sets, of course, are not commercial articles, but in the majority of cases are of very weird and wonderful design and contain many ingenious accessories, such as a super-charged or regenerative catwhisker and a water-cooled crystal cup, which are not yet available to the general public. If one stops to think, it is obvious that water-cooling the crystal is not really a luxury but a necessity when the crystal is handling enough power to operate the loud-speaker; otherwise the crystal is bound to overheat and thus get spoiled.



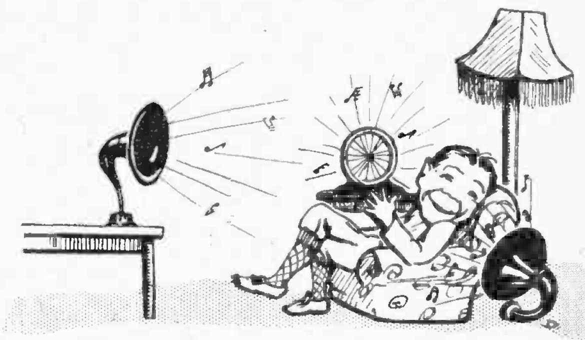
Some are satisfied with "phones on table" strength——

It is surprising, too, that the regenerative catwhisker is not more widely used, as the principle of regeneration by using a reaction coil is very well known indeed—one has only to listen for a distant station to be aware of that. If a small reaction coil of about half a dozen turns is wound so as to come either inside or outside the catwhisker spiral, one end being connected to the aerial and the other to the telephones, a surprising alteration in signal strength will be noticed.

To return to the conditions necessary for the successful operation of the set, we must first decide what sort of strength of reproduction we require. Some people are satisfied with "phones on table" strength, while others like a "comfortable loud-speaker" strength.

The first condition necessary for successful operation is that the aerial shall be of the full 100ft. length and, of course, as high as possible—in this case not "the higher the fewer" but the higher the better.

Secondly, for comfortable strength the aerial must be parallel to and not more than 100 ft. from the local broadcast aerial, but for "phones on table" strength distances up to three miles are possible; but anyway such weak signals do not come within the scope of this article.



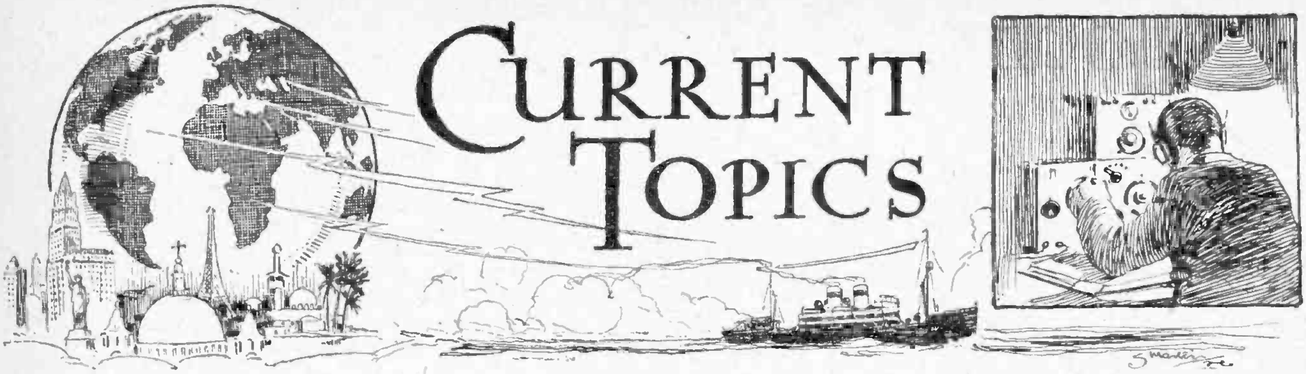
——Others like a "comfortable loud-speaker" strength.

As regards precautions necessary, it is as well to use asbestos cement sheet for the panel of the receiver instead of ebonite, as the latter is inclined to warp and even melt when heated.

In order to see whether water-cooling the crystal was an improvement at three miles, the writer undertook some measurements of power received from a 100-ft. aerial 35 ft. high and of power required to work a loud-speaker successfully, and found that the loud-speaker required 400 times the power rectified by the crystal. As a result of these measurements, it was decided that far from wanting water cooling, the crystal wanted "hotting up," and that perhaps the loud-speaker might be water cooled instead. However, these results were only obtained by using crystals which are already on the market, so that perhaps this was hardly a fair test.

In case it should be thought, in view of the above figures, that people who are getting real loud-speaker results with a crystal at three miles are getting something for nothing, it should be remembered that this discrepancy is no doubt adjusted in the broadcast licence fee.

CURRENT TOPICS



Events of the Week in Brief Review.

THE NON-STOP SHORT-WAVE

Transmissions on 35 metres from a Marconi school in Japan have been heard in U.S.A., Canada, Italy, and Russia.

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BRITAIN'S BROADCASTING WAVES.

The Office Internationale de Radiophonie at Geneva proposes to grant British stations at least seven "exclusive" wavelengths, and the number may ultimately run to ten.

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FRANKNESS AND THE FRANC.

During the descent of the franc last week, the French Posts and Telegraphs Department forbade the mention of exchange rates and stock prices in wireless bulletins.

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PROGRAMMES BY BARBED WIRE.

Mr. Perry Brown, a Kansas farmer, has connected his wireless set to the barbed wire fencing surrounding his estate. His neighbours are thus able to tap programmes received on Mr. Brown's aerial. The dry cedar posts supporting the barbed wire are stated to act as efficient insulators.

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FIGHTING INTERFERENCE IN AMERICA.

For a payment of $10 any American listener who is troubled with interference can have his case investigated by the U.S. Bureau of Weights and Measures.

Certain noises have been legalised, *i.e.*, those set up from sources such as ultra-violet ray machinery, which the Bureau has licensed, and in cases where complaints concern these noises, the Bureau recommends methods of overcoming the trouble. Washington listeners, says *Radio Broadcast*, are reported to be actively supporting a Bill before the State Legislative intended to eliminate interference by these "electro-radiant" systems.

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COMMUNICATION ON TRAINS.

Successful tests for intercommunication between the locomotive and guard's van of goods trains have been carried out on the New York Central Railway. Special transmitting and receiving apparatus was fitted in both engine and guard's van, using a wavelength of 115 metres.

WIRELESS POLES

From Poland comes the news of a wireless boom which is stated to be at its height in Warsaw.

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NOT GOOD ENOUGH.

Fined last week for omitting to take out a wireless licence, a Covent Garden porter pleaded that he had built the set himself.

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DOOM OF ATMOSPHERICS ?

A device evolved by the Dutch inventor, Professor Enthoven, and adopted by his son for wireless purposes, is creating a stir among Dutch telegraph authorities. According to the *Handelsblad*, the invention will, it is hoped, reduce the effect of atmospheric disturbances to a minimum. Transmission tests using the new device are being carried out between Holland and the Dutch East Indies.

WIRELESS IN THE WILD.

In the House of Commons last week Mr. Amery stated that the Government of Tanganyika Territory intend to erect a wireless station at Dar-es-Salaam during the current financial year.

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PROF. HAZELTINE'S VISIT.

Professor L. A. Hazeltine, of the Hazeltine Corporation, U.S.A., whose name is associated with the Neutrodyne Circuit, is at present on a short visit to this country.

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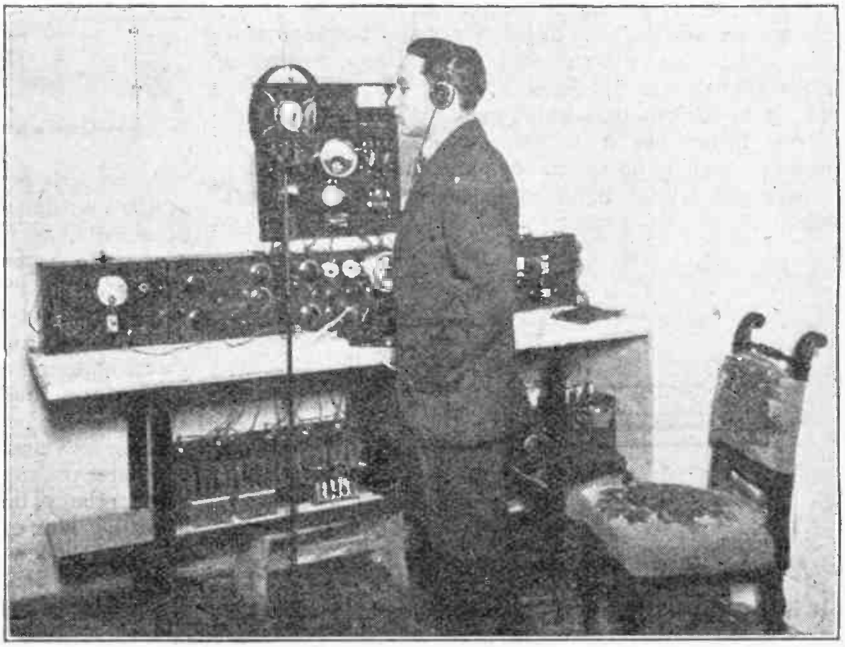
BROADCASTING MONOPOLY IN U.S. ?

WEAF, the well-known broadcasting station in New York, has been sold by the American Telephone and Telegraph Company to the Radio Corporation of America. In American wireless circles this is construed as part of a movement towards the creation of a broadcasting monopoly by the principal companies.



THE QUEST FOR SECRECY. A claim to have secured secrecy in wireless telephony transmission and reception has been put forward by an Austrian inventor, Emil Marek, who makes use of a synchronised transmitter and receiver of changing wavelengths. Engineer Hans Neuhauer is seen in the photograph speaking into the microphone.

PEACE IN U.S. ETHER?

The Dill Radio Bill, which involves the formation of an independent commission to control American broadcasting, was passed by the U.S. Senate on July 2nd.

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QUARTZ CRYSTALS SCARCE.

A shortage of quartz suitable for use in radio oscillators is reported by the U.S. Bureau of Standards. Crude quartz is abundant, but the optical discrepancies which it contains make it useless for delicate work.

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PCGG AGAIN ON THE ETHER.

The Netherland Association Idzerda-Radio has received a transmitting licence, and PCGG, which has been closed down, owing to financial difficulties, since 1924, will again be heard from the Hague on a wavelength of 1,150 metres.

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WIRELESS GROWTH IN CANADA

Canada is steadily becoming less dependent of the United States in the matter of radio apparatus. Statistics for 1925 show that Canadian manufacturers produced 48,498 complete sets during that year, while the production of valves was valued at £259,936—more than double that of the preceding year.

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WANTED: A FACE LIKE A MICROPHONE.

To overcome nervousness in the broadcasting studio a newspaper correspondent suggests that the best method is to visualise just *one* face in the microphone and talk or sing to that face. This seems a good idea, though much might depend upon what face you visualise. The illusion naturally falls flat if a feminine face is chosen because the microphone never contradicts.

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AN AMATEUR WORLD CHAMPIONSHIP.

"World's records for transmission on low power by wireless amateurs will be shattered within the next few days," is the statement made by Capt. Geo. T. Droste, president of the Executive of the Radio Council of the U.S. Second Amateur District. The Captain refers to the competition which has been organised in connection with the Radio World's Fair in New York to be held during the autumn.

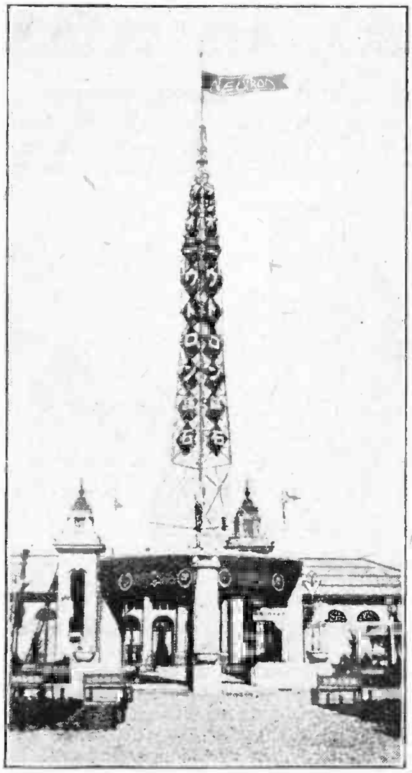
According to the information we have received "all 'hams' are eligible for the competition," which opened on July 15th and continues until August 15th. A loving cup will be presented to the amateur who transmits and receives a key message in the shortest space of time, using lowest power and achieving the greatest distance. His record must be complete and an acknowledgment in the form of a QSL card will be required. Owing to the inevitable delays in forwarding cards over great distances, no time limit is fixed as to the definite award, except that no card dated after August 15th figures in the test.

Correspondence relating to the competition should be addressed to the Organisers, Radio World's Fair, Times Building, New York City U.S.A.

LONGITUDE BY WIRELESS.

A world longitude determination by wireless signals is to be conducted by the U.S. Naval Observatory, beginning October 1st and ending on December 1st, 1926, for the purpose of determining the differences in longitude with great accuracy. The chief stations employed will be those at the U.S. Naval Base, San Diego, Cal., at Algiers Observatory in Africa, and Shanghai in China. Other observatories will probably take part, including Washington, Greenwich, and Paris.

Rhythmic signals will be transmitted three times daily from Annapolis, Bellevue, Honolulu, Saigon, Bordeaux, and Issy (near Paris).



IN THE LAND OF CHRYSANTHEMUMS. The imposing entrance gate to the Japanese Wireless Exhibition recently held in Tokio. Popular enthusiasm for broadcasting is rapidly growing.

TWO AUTUMN WIRELESS EXHIBITIONS.

It is interesting to note that the organisers of the National Radio Exhibition in London have this year put back the date of the gathering, so that for the first time it will run concurrently with the German Wireless Exhibition in Berlin, thus wiping out the advantage (if any) which the latter had last year of being first in the field with the autumn exhibition. However, as the London exhibition extends from September 4th to the 18th, and the Berlin one only from September 3rd to 12th, it will still be possible for the keen wireless enthusiast or trader to ascertain by actual inspection of show models exactly what advances have been made in this rapidly changing industry, and to compare the relative progress of both countries, both commercially and technically.

This year there is evidence that the size of the exhibitions will be more equally balanced. For the past two years the Berlin exhibition has been the larger, with a total number of exhibitors which has exceeded 200 upon both occasions, this is owing to the larger field of manufacturers and distributors embraced by the German industry, while both the main English exhibitions (that of the organised manufacturers with 67 exhibitors, and the Horticultural Hall with another 60) have dispersed effort to a considerable extent by appealing to one section only of the trade. This year, as the London exhibition is now open to a wider field of manufacturers and distributors, more than 130 exhibitors have already taken space according to the latest press reports, and though there are as yet no figures available respecting the Berlin exhibition, as no allotment has yet taken place, it is probable that the total number of entries will remain in the neighbourhood of 200 as in previous years. It is understood that negotiations are taking place at the present time with a view to throwing open certain of the more important German radio works for inspection by British visitors during the first part of September.

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WIRELESS ACT RESUSCITATED.

The Wireless Telegraphy Act, 1904, figures among the Acts scheduled in the Expiring Laws Continuance Bill, the text of which has just been issued. It is proposed to continue the Act until the end of 1927.

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WHO OWN U.S. BROADCASTING STATIONS?

A perusal of the long list of American broadcasting stations in America serves to reveal the astonishing number of interests which make use of the microphone. Schools and colleges head the array with 94 stations; wireless and electric stores come next with 73.

Then come the miscellaneous stores with 65. Churches and religious organisations operate 44 stations, papers and publishers 37, and electric equipment manufacturers 30. Eighteen stations are controlled by states and municipalities, while 10 are described as belonging to broadcasting corporations. Banks and other financial bodies broadcast from 15 stations, and hotels have 12. Several stations are operated by theatres and by wireless clubs.

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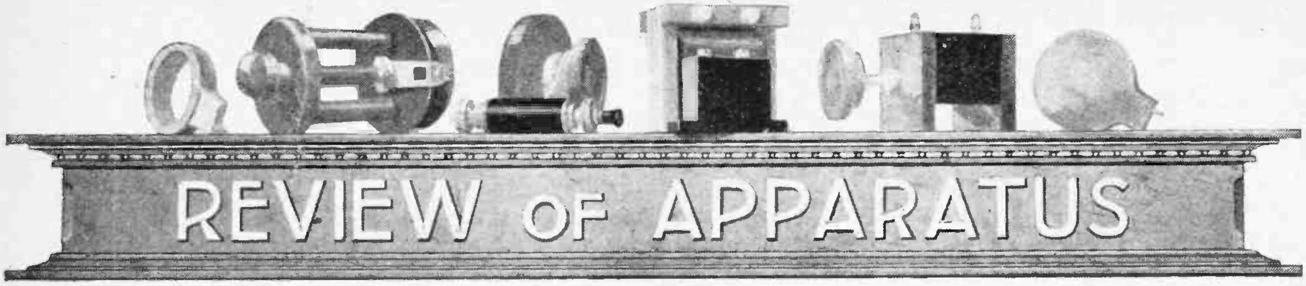
CABLE AND WIRELESS IN GREECE.

For the first time in history a company has been granted a concession for a joint wireless and cable service The concession has been granted by the Greek Government to the Eastern Telegraph Company, who will be responsible for the dual service in Greece for the next fifty years.

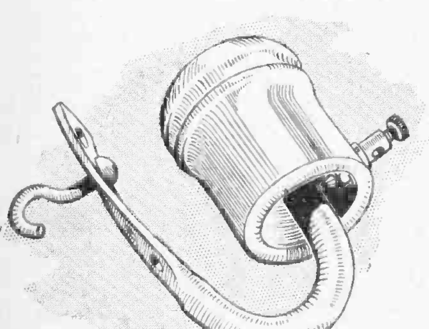


Latest Products of the Manufacturers.

WATERPROOFED AERIAL INSULATOR.

The aims in aerial insulator design are firstly an infinite resistance under all weather conditions; next, a negligible capacity between the points of attaching aerial and halyard; and thirdly, mechanical strength. Porcelain as an aerial insulator is probably to be preferred to any other insulating material, though when saturated with water surface leakage is apt to develop. The porcelain insulators used for ordinary telegraph work maintain a high insulation resistance owing to the fact that the inside of the insulator is kept dry, and this means of maintaining good insulation has been adopted in the new Sarbolt aerial insulator, a product of Hatton Supply Co., Hatton, Middlesex.

A porcelain insulator is attached to a substantial galvanised iron bracket, the aerial and halyard being attached between a terminal on the porcelain and a hook on the bracket. In order that the interior of the insulator may be kept free from moisture it is essential for it to hang in a position with the domed portion uppermost. This is accomplished by the provision of several holes in the bracket, and according to the slant of the aerial the hook can be secured in a particular hole so that a point of balance is produced which will cause the heavy part of the bracket to hang downwards, thus supporting the insulator in the correct position.



The Sarbolt "Shedded" Insulator is arranged to hang in such a position that the interior of the insulator is dry, so as to maintain good surface insulation. A lightning arrester point is also provided.

Another feature is the provision of a sparking point between the aerial terminal and the bracket, so that by using a wire halyard the aerial is adequately protected against damage by lightning, the discharge being taken to earth through the halyard and kept entirely away from the lead-in wire and the receiving apparatus.

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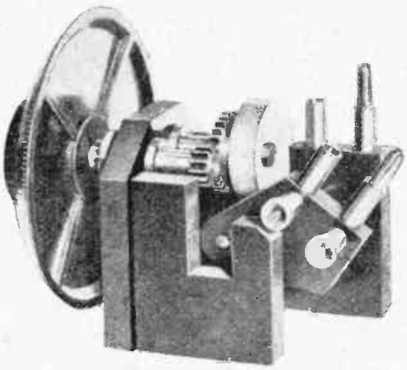
CAM-DRIVEN TWO-COIL HOLDER.

There is a preference among amateurs to make use of coil-holders designed for mounting behind the instrument panel.



Visicam geared coil holder for mounting behind the instrument panel.

Many of the types in common use make use of a swinging holder, so that when the knob is operated from the front of the panel the coil sweeps across the space immediately behind, preventing the fitting of other components within the range of movement covered by the swinging coil.

This difficulty has been overcome to some extent by employing a worm and pinion drive so that the moving coil, instead of being tilted out of the plane of the fixed coil, is caused to swing away from it though maintaining a parallel position. The worm and pinion design is apt to possess an undesirable degree of backlash to such an extent that it is impossible to indicate the exact extent of coupling by the use of a dial secured to the operating spindle.

An improved form of construction is shown in the accompanying photograph known as the Visicam coil holder, and made by Frank Smith, Basil Street, Rusholme, Manchester. The spindle carrying the dial connects with a small pinion driving an auxiliary shaft, which is fitted with a cam riding on a bar, which in turn imparts the required movement to the swinging holder. One revolution of the dial moves the coil from the maximum to minimum position, and with a 360° calibration the extent of coupling can be recorded. Backlash is avoided by means of a spring which forces the bar in rigid contact with the cam, and as the spring acts in the same direction as gravity a heavy coil can be operated without the risk of it falling out of position.

The brass parts are well machined, bearings adequate in length, and the cam large in diameter. The coil-holder is attached to the panel by means of one hole fixing.

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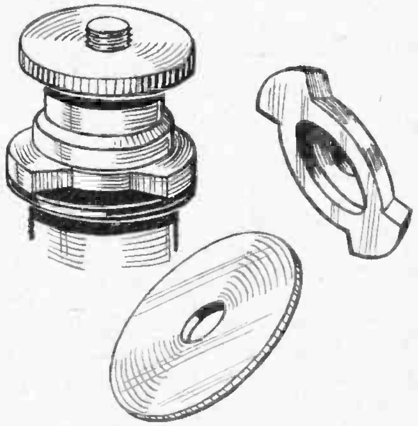
PREVENTING CORRODED TERMINALS.

Battery terminals usually become corroded by the creeping of acid along the lug or by acid spraying over on to the brass terminal. In any case the presence of acid at the junction between the brass terminal and the leaden lug results in the brass becoming rapidly corroded away.

Corrosion is prevented in many commercial batteries by the provision of grease-retaining cups beneath the terminals.



Vaseline retaining cups which, inserted under accumulator terminals, will prevent corrosion.

Batteries which are not so fitted can be protected by fitting under the terminal the new Deckorem vaseline cups recently introduced by A. F. Bulgin & Co., 9-11, Cursitor Street, Chancery Lane, London, E.C.4. A leaden piece recessed on the other side is fitted under the terminal and vaseline is retained against the face of a celluloid disc. Red and black discs are supplied for indicating polarity.

WIRELESS CIRCUITS
in Theory and Practice.
17.—Reaction.

By S. O. PEARSON, B.Sc., A.M.I.E.E.

WHEN a three-electrode valve is used as an amplifier, or even as a detector, the power represented by the oscillations in the plate circuit, or output side of the valve, is many times greater than the power in the grid circuit. It was pointed out in a previous instalment that the energy in the plate circuit was drawn from the local high-tension battery, and did not come from the transmitting station. Now in the tuning circuits of a receiver there are several sources of energy loss which lower the resonance voltages produced by the incoming signals, and so weaken the actual sounds heard in the telephones. Up to the present the only means which we have discussed for increasing the signal strength is the reduction of losses by keeping the effective resistance of the circuits as low as possible. We also saw that low losses resulted in sharper tuning and greater selectivity. By the proper use of a three-electrode valve we can compensate for the losses which take place in the tuned grid circuit by transferring some of the amplified energy of the plate circuit back to the grid circuit, and this process is referred to as *reaction* or *regeneration*. Sometimes the term "feed-back" is used because some of the energy in the plate circuit is *fed back* to the grid circuit. When this is done the amplitude of the original oscillations in the grid circuit will be increased and the oscillating component of the plate current will be larger still, resulting in much greater amplification of the incoming signals. The effect is the same as if we had simply lowered the resistance of the tuned circuit.

In order that some of the energy in the plate circuit

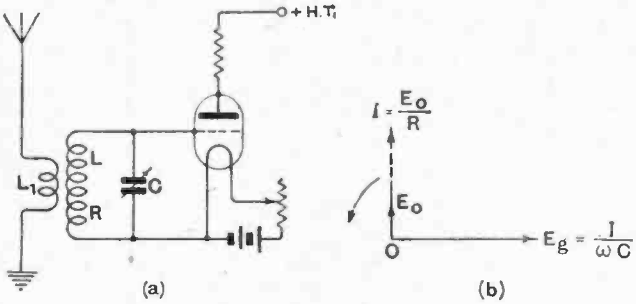


Fig. 1.—(a) Simple valve-receiving circuit without reaction; (b) Vector diagram showing phase relations of currents and E.M.F. in grid circuit.

shall be fed back to the grid circuit, these two circuits must be suitably coupled together. This can be effected either (*a*) *inductively*, (*b*) *conductively*, or (*c*) *capacitatively*. It will be appreciated that in order to increase the amplitude of the grid circuit oscillations, the alternating electromotive force introduced into it from the plate circuit of the valve must have the correct phase relation, that is, it must be in phase with, or have a component in phase with, the signal voltage *producing* the oscillations in the circuit, and not necessarily in phase with the voltage produced across the tuned circuit and applied to the grid.

These facts are made clear by considering the simple circuit of Fig. 1 (a). A high-frequence voltage E_0 is induced by the coil L_1 into the tuned circuit LC, and the resonant voltage thus built up across the condenser is applied between the grid and filament of the valve as

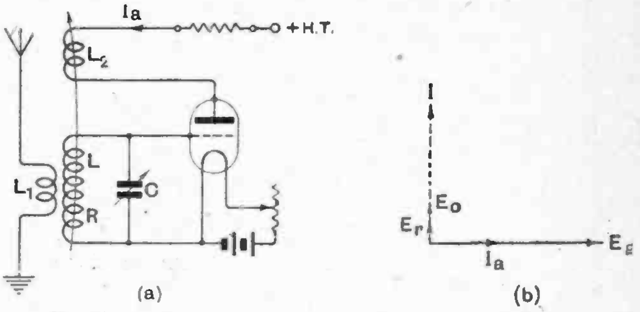


Fig. 2.—(a) Simple circuit employing reaction; (b) Vector diagram for case where oscillating plate current is in phase with grid voltage E_g.

shown. Suppose for the present that there is no coupling whatever between the plate and grid circuits, so that the oscillations in the latter are independent of the resulting amplified oscillations set up in the plate circuit. It was shown that for a tuned circuit such as LC, the oscillating current flowing round the loop was exactly in phase with the E.M.F. induced into the coil L (see Part 6, March 3rd issue, page 345). Now, since the current taken by a condenser leads the voltage by 90°, it follows that the oscillating voltage applied to the grid of the valve is 90 degrees out of phase with the voltage being induced into the tuned circuit. If R is the effective resistance of the tuned circuit LC, the current in it is given by $I = \frac{E_0}{R}$, where E_0 is the voltage induced into the coil L. The voltage across the condenser is $E_g = I/\omega C = E_0/\omega CR$, where $\omega = 2\pi \times$ frequency. These quantities are shown by the vector diagram of Fig. 1 (*b*), from which it will be noted that the voltage E_g applied to the grid leads the current I and the applied voltage E_0 by an angle of 90 degrees.

Simple Reaction Circuit.

It is clear from the above that to increase the amplitude of the oscillations in LC we must induce into the coil L an E.M.F. which is in phase with the original induced voltage E_0, and not in phase with the grid voltage E_g, as might at first be supposed. The simplest way of obtaining this extra induced electromotive force is by

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connecting an inductance coil or "reaction coil" L_2 in series with the plate circuit and coupling it inductively to the tuning coil L, as shown in Fig. 2 (*a*). The oscillating component of the plate current produces an alternating magnetic field which in turn induces an E.M.F. in the coil L.

Phase Relations in Grid and Anode Circuits.

It is now necessary to see whether this voltage is in phase with the original E.M.F. produced by the coil L_1 or not. It will be shown that this depends entirely on the nature of the plate circuit; to begin with, we shall take the case where, apart from the comparatively small inductance of the reaction coil, the plate circuit contains resistance only, as in the case of resistance-capacity coupling of valves. Under these conditions, if μ is the amplification factor of the valve, the equivalent alternating voltage μE_g introduced into the plate circuit, due to the voltage E_g impressed on the grid, will cause an oscillating current I_a to flow in the plate circuit and through the reaction coil L_2. This current will be almost in phase with μE_g, and therefore in phase also with E_g, the voltage on the grid. We see then that the current in the reaction coil is 90° out of phase with the original voltage E_o induced into the tuned circuit LC. Now at any instant the E.M.F. induced into the coil L by the current in the reaction coil will be proportional to the rate at which the current is changing, and will therefore be 90° out of phase with the current I_a. Thus, by reference to the vector diagram of Fig. 2 (b) the voltage E_r induced into the tuning coil L by the current in the reaction coil L_2 will be either in phase with the original applied voltage E_o, or 180 degrees out of phase, according to which way round the reaction coil is

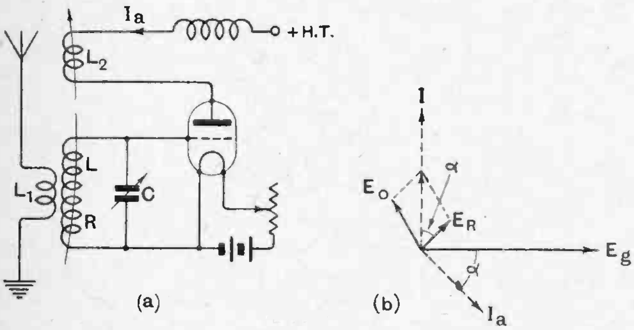

Fig. 3.—Circuit and vector diagram for the case where the plate current lags behind the grid voltage by an angle α.

connected. Obviously, this coil must be so connected that the signals are increased in strength as it is moved nearer to the tuning coil L.

The foregoing makes it clear that when regeneration is effected by means of a coil in the plate current of the valve, coupled inductively to a tuned grid circuit, the best conditions are obtained when the plate current is in phase with the oscillating grid voltage producing it. As we have already seen, this condition exists when the external plate circuit consists of a pure non-inductive resistance, and with very little consideration we see that it is also true when the external plate circuit consists of an inductance tuned by means of a condenser to resonance with the oscillation frequency, because for a tuned circuit the current is exactly in phase with the applied voltage. The above reasoning, therefore, applies equally well when the "tuned anode" method of coupling valves is employed.

On the other hand, where a large reactance, such as that of a high-frequency choke, is connected in the plate circuit, as shown in Fig. 3 (a), the current will lag by a considerable angle behind the oscillating voltage on the grid, with the result that the E.M.F. introduced into the grid circuit will not be in phase with the original applied

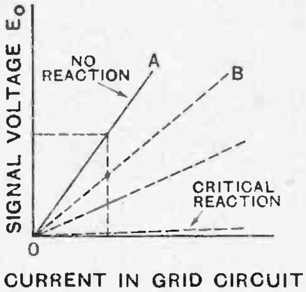

Fig. 4.—Curves showing relation between signal voltage induced into the grid circuit and the resulting current in that circuit with and without reaction.

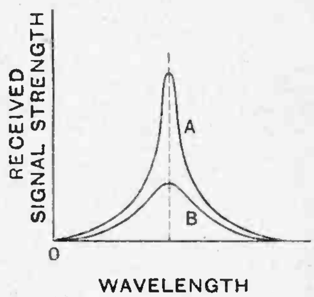

Fig. 5.—Resonance curves of received signal strength with and without reaction.

voltage E_o, but will differ by a phase angle equal to that in the plate circuit. The vector diagram showing this is given in Fig. 3 (b). Only that component of E_r which is in phase with E_o is effective in producing reaction, and therefore the greater the angle of lag in the plate circuit the closer will the reaction coil have to be brought up to the tuning coil in order to increase the signal strength by a given percentage. We see then that it is necessary for the phase relations of the various quantities to be correct if efficient regenerative effects are to be obtained.

Effect of Reaction on Circuit Resistance.

We now come to consider more closely what is actually happening in a valve circuit using reaction. Considering the tuned grid circuit LC of Fig. 1 (a), where there is no reactive effect whatever, if we plot a curve showing the relation between the voltage E_o being induced into the coil, and the resulting current I flowing round the loop we obtain a straight line, because for a tuned circuit of this nature the current is given by Ohm's law. The full line OA of Fig. 4 shows how the current in the circuit depends on the applied voltage. This line is called the "resistance line" of the circuit because its slope or steepness, given by the ratio of volts to amps. at any point, is equal to the resistance. The lower the resistance of the coil L the less steep will the resistance line be. It must be remembered that the oscillating voltage applied to the grid is directly proportional to the current flowing round the circuit LC, and therefore inversely proportional to the resistance.

Suppose now that a reaction coil L_2 is included in the plate circuit, as shown in Fig. 2 (a), and coupled inductively to the tuning coil L. If L_2 is connected the right way round the current flowing round the loop circuit will

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be greater than before for a given value of applied voltage E_0. If the reaction coil is held in a fixed position and the applied signal voltage varied, the current flowing round the loop circuit LC will again be proportional to the applied voltage and its graph will be another straight line, such as the dotted line OB of Fig. 4. This line gives the equivalent resistance of the tuned circuit when reaction is employed, and is not so steep as the original resistance line OA, that is to say, the ratio of volts to amps. is less when reaction is employed, so that the introduction of reaction has exactly the same effect as lowering the resistance of the grid circuit. It was shown in the section on tuned circuits that the resonant voltage was inversely proportional to the resistance of the inductance coil, and that the resonance curve was very much more sharp or pointed for low values of resistance, resulting in increased signal strength and greater selectivity respectively. Since reaction has the same effect as lowering the resistance of the grid circuit, both the sensitivity and selectivity of the receiver will be improved by its use. If a signal of constant voltage, but gradually increasing wavelength, is induced into the coil L of Fig. 1 (a), where no reaction is employed and the resulting oscillating component of the plate current or the grid current is plotted against the applied voltage, we obtain a resonance curve similar to that shown at A in Fig. 5, the curve reaching its highest point at the wavelength to which the circuit LC is tuned. If now the same process is repeated for the circuit of Fig. 2 (a), where reaction is used, a new resonance curve B is obtained whose maximum value is much higher than that of curve A, the peak itself being more pointed, showing that both the signal strength and selectivity have been improved.

Critical Reaction.

By coupling the coil L_2 more closely to the tuning coil L the effects of the reaction are increased, and it must next be considered what are the limits to which reaction can be increased. Referring again to the resistance lines of Fig. 4, it will be obvious that there will be a separate equivalent resistance line for each setting of the coupling. The tighter the coupling the steeper will the resistance line be and the lower the equivalent resistance of the grid circuit. This equivalent resistance can be assumed to be made up of two separate resistances : (*a*) the actual high-frequency resistance R of the coil itself, and (*b*) a negative resistance R^1 due to the reactive effect; so that the equivalent resistance of the grid circuit may be written $R_e = R - R^1$. R is constant and R^1 increases as the coupling between the coils is tightened. If the reaction is increased until R^1 becomes just equal to R, the equivalent resistance of the grid circuit would become zero, and theoretically the current would go on building up to an infinitely great value. This, of course, cannot happen in practice, because the valve itself sets a limit to the amplitude of oscillations which can be obtained. When the reaction is made sufficiently great to bring the equivalent resistance of the grid circuit down to zero, the oscillations will persist in the valve circuit even when the applied oscillation is removed; that is to say, oscillations are being maintained by the valve itself and "self-oscillation" is said to have set in.

For the moment we are not directly concerned with the production of self-oscillation, but rather with the critical value of the reaction for which self-oscillation is just on the point of occurring. The maximum extent to which reaction can be used without setting up self-oscillation in the circuit is called "critical reaction," and is that value which makes the equivalent resistance of the grid circuit almost, but not quite, zero. Under this condition the maximum degree of signal strength and selectivity is obtained. It was shown that for increasing degrees of reaction the corresponding resistance lines of Fig. 4 became less steep. When reaction is applied to such an extent that the resistance line becomes horizontal, we reach the limiting condition where the equivalent resistance, given by the slope of the line, is zero, and self-oscillation commences. The critical condition where the circuit is only just free from self-oscillation is given by that resistance line which is very nearly but not quite horizontal.

In practice it is sometimes very difficult to move the reaction coil up towards the tuning coil sufficiently slowly and to set it to give the greatest possible degree of regeneration without causing the set to break into self-oscillation. To overcome this difficulty quite a large number of slow-motion devices have been placed on the market, most of them intended for use with plug-in coils. The slow motion of the movable coil is effected by means of gearing or some form of cam arrangement. For the simple reaction circuit of Fig. 2 (a) an ordinary three-coil holder would be used, the centre or fixed coil being the main tuning coil L. Slow motion or "vernier" control should be provided for the other two coils to enable critical adjustments to be made.

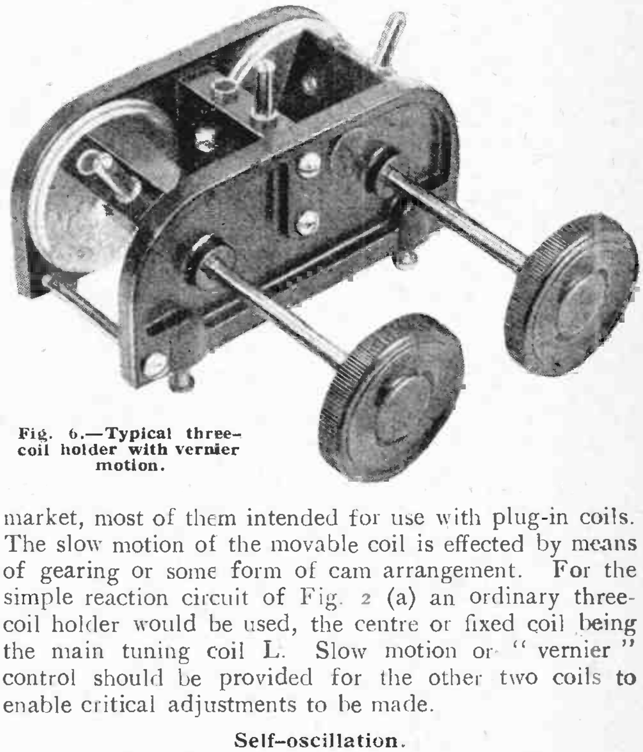

Fig. 6.—Typical three-coil holder with vernier motion.

Self-oscillation.

When the reaction is increased beyond the critical value mentioned above, self-oscillation takes place, and these oscillations will continue whether there are any incoming signals or not. Their amplitude will build up to such a value that the losses in the grid circuit are exactly compensated for by the energy being transferred back from the plate circuit. By tightening the reaction coupling the amplitude or strength of the self-oscillation is increased.

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The frequency of the self-oscillations is determined chiefly by the inductance L and capacity C of the tuned grid circuit, the equivalent wavelength being given by $\lambda = 1885 \sqrt{LC}$ metres, when L and C are in microhenries and microfarads respectively.

Interference.

If it is attempted to receive telephony signals when the reaction coupling is tight enough to produce strong self-oscillation, these local oscillations will mingle with the received oscillations and will usually make the received speech quite unintelligible or distort the music so badly that it ceases to be music. Then, again, if the receiver is close to the transmitting station, so that the incoming oscillations are strong and the reaction is adjusted just beyond the critical value at which self-oscillation commences, these local oscillations are more or less overpowered by the signal oscillations, and the former will be actually pulled into step with the latter and the usual squealing noises will not be heard in the receiver; but, nevertheless, the speech or music will be distorted, acquiring a characteristic quality which is easily recognised by those who have a little experience in the control of valve receivers.

When self-oscillation does occur in a valve receiver it is almost impossible to prevent these oscillations from exciting the aerial and actually sending out radio waves. These waves are picked up by all the receivers in the neighbourhood, and thus cause interference in the form of whistling noises or distortion of the signals received.

From every point of view, then, it is important that excessive reaction should not be employed, as it ruins the quality of speech or music reproduced not only by the receiver in question, but that of other receivers as well. In the case where the local oscillations are pulled into step with the received carrier wave, the presence of local oscillation is often fairly difficult to detect, especially by the novice, and very often the transmitting station is blamed for the peculiar deep-toned quality of the music. When loud notes occur sometimes the oscillations fall out of step momentarily, causing the musical notes to be totally broken up, and this effect is also passed on to neighbouring sets by re-radiation in varying degrees, according to the proximity of the station experiencing the interference.

Calls Heard.

Extracts from Readers' Logs.

Hale, Cheshire.

Sunday, June 6. 0530-0750 B.S.T.

U.S.A. :—1BJK, 1CMX, 1CMY, 2AIM, 2XS, 2CZN, 2AIE, 2CAZ, 2CXL, 2CTY, 3CM, 3CEY, 8ATC, 8BJP, WIZ. New Zealand :—1AO, 1AX, 2AC, 3AM, 4AC, 4AA, 4AK, 4AM, 2AE. Australia :—2CM, 2LM, 3BQ, 3EF, 5KN. Pacific :—KFUH.

(June 16th to July 11th.)

U.S.A. :—U 5OQ, 5ZAI, 5AGN, 5QL, 5YB, 5ACL, 6CTO, 6BJP, 6DAQ, 6CGW, 7HL, 7DX, WGY, KDKA, NTT, NOT, NIDK, NISS, VOQ, WNP, WVY, NAR, NDF, NKF, KEGK, KEIH, KJOE. Australia :—A 2BK, 2LM, 2CM, 2TM, 2LK, 2YI, 3BD, 3WM, 3OE, 4AN, 5KN, 7CW, 7HL. New Zealand :—Z 1AX, 2AC, 2AE, 2XA, 2DD, 3AK, 4AA, 4AV, 4AM, 4AS. Canada :—C 1AR, 1CX, 2AX, 3JP, 9CK. Argentine :—R FC6. Mexico :—M XAM, XDA, M9A. Honolulu :—HU 6BPG. 30-45 metres.

F. N. Baskerville.

Sheffield.

(May 22nd to June 22nd.)

U.S.A. :—1BVL, 1CIB, 1ACI, 1AMD, 1ALW, 1UW, 1AXA, 1AFW, 1CMX, 1CKP, 1AEP, 1BGC, 1AFN, 1DL, 1MV, 1RF, 1JE, 1BYX, 1AAY, 1ALA, 1AAP, 1BQT, 1CH, 1BTF, 1ADM, 1BLB, 1ARX, 1AXII, 1CO, 1ARE, 1AMP, 1BZP, 1MY, 1AIJ, 1KC, 1AMS, 1SI, 1PR, 1AFL, 1RA, 1XV, 1AXX, 1AAO, 1NT, 1BHR, 1GP, 1ADE, 1CAW, 1WP, 1CCX, 2XAF, 2FF, 2NF, 2GY, 2BBB, 2APV, 2AXQ, 2AHM, 2MM, 2GK, 2OW, 2MD, 2ZV, 2ARC, 2CDC, 2KF, 2UO, 2ATC, 2CXL, 2CJE, 2CKP, 2CRD, 2CVU, 2HA, 2EV, 2BUY, 2CVJ, 2AWK, 2AEV, 2ALC, 2TB, 2WH, 2VA, 2AGB, 2XQ, 2BGI, 2CFT, 2BSL, 2CMU, 2LR, 2RV, 2AGT, 2AXD, 2ANM, 3AHA, 3AGC, 3CJN, 3AGU, 3BVA, 3BNF, 3HG, 3BK, 3AY, 4NI, 4TV, 4HX, 4ER, 4NH, 4OY, 4SL, 4QJ, 4HR, 4VH, 4HK, 4PI, 4PK, 5ZAZ, 8DHW, 8XE, 8ADE, 8CLI, 8QB, 8CAU, 8BRC, 8BOF, 8AOL, 8CUG, 9EJI, WIZ, WNP, NBA, NOT, NTT, NISS. Brazil :—1AK, 1BH, 1AE, 1IB, 1AO, 1BI, 1BD, 1AQ, 1AW, 1AM, 1AR, 1AL, 1AD, 1AJ, 2AD, 2AB, 2AJ, 2AM, 5AA, 5AB, 9QA, MU. Canada :—1ED, 1CX, 1DD, 1AR, VGJL. Chile :—2LD, 2AB, 3IJ. Porto Rico :—4JE, 4AR, 4RL, 4UR, 4RX. Poland :—PAX, PAW, PX. Algeria :—8MCO, 8RIT. Tunis :—TUN2. Austria :—AA, HL, WA, GP. Hong Kong :—BXY. India :—1CD. Yugo Slav :—7XX. Italy :—1GW, 1FP, 1SRA, 1CO, 1BK, 1NO, 1AP, 1AY, 1GN, 1DC, 1BO. Norway :—1A, 1SE. Denmark :—7BX, 7EW, 7MT, 7XU, 7AX. Finland :—2NM, 2CO, 2NL, 2NS, 2ND, 3NB. Spain :—EAC2, EAR28, EAR10. Sweden :—SMTN, SMSY, SMWQ, SMSW, SMXV, SMVL, SMUK, SMYG, SMUA, SMWR, SMUS, SMVG, SMUV, SMWS, SAB, SDK.

(0-v-1) Indoor aerial.

H. Hizett.

Patricroft.

(June 16th to July 1st.)

U.S.A. :—1AE, 1AO, 1AQ, 1BQ, 1BO, 1CH, 1IP, 1MV, 1CU, 1CIB, 1AWW, 1TUV, 1IBX, 1CIB, 1XAM, 2MC, 2AF, 2BB, 2FF, 2ARY, 2CTF, 2APV, 2CRB, 2ATC, 2ALM, 2CTU, 2AHM, 2XAF, 2UTI, 3MV, 3AFN, 3AIN, 4MX, 4OO, 7BDE, 8DON, 8AOL, 9CXC, 9WA, 9BDT, 9XA, WGY, WIZ, KDKA. Great Britain :—2BQ, 2WN, 2CS, 2UD, 2CO, 2TO, 2IT, 2NT, 2JJ, 5NU, 5XD, 5JW, 5DH, 5KZ, 5MU, 5SK, 5MS, 5WT, 5UW, 5TZ, 5YK, 5SA, 5JW, 6OT, 6YK, 6QB, 6FG, 6YD, 6WT, 6TG, 6YQ, 6UT. France :—8UT, 8BX, 8FZ, 8DB, 8FR, 8EE, 8CL, 8VU, 8FMH, 8XIX, 8CAX, 8UDI, 8WEL, 8TDY, OC-8MC, OCNG, OCMV, OCTU. Belgium :—D2, E1, V33, E9, K2, J9, B4, M8, B19. Brazil :—1AR, 1BD, 1AX, 1AO, 2AA, 1AW, 1AJ, 1AP. Sweden :—SMWS, SMWQ, SMUU, SMUK, SMWY, SMUA, SMZN, SMVL, SMSS. Italy :—1AD, 1BF, 1RO, 1GW, 1NO. Germany :—W6, W1. Denmark :—7BX. Holland :—PB3. Yugo-Slavia :—7XX. Canada :—1ED. Norway :—LA-1X. Finland :—2CO. Tunis :—7HC. New Zealand :—1AF. Chile :—2LD. Austria :—OFP. Unclassified :—ABC, UFM-7MA, UB-12, AR-1GP, 3GX, 3WK.

(0-v-1.)

Wm. Lucas.

Harborne, Birmingham.

Australia :—A 2CM, 2YI, 3XO, 3BD, 3BQ, 3QH, 3EF, 3KB, 2TM, 2LM, 3WM, 2RC, 3HL, 2CS, 2CG, 5KN, 2BK, 4AN, 2BV, 2IJ, 3OT, 4CM, 3BH, 3YX, 2LK. Tasmania :—A 7BQ, 7HL, 7DX, 7CW. New Zealand :—Z 4AA, 4AM, 4AG, 4AK, 4AL, 4AU, 4AV, 4AO, 2AC, 2AQ, 2BX, 2AE, 3AL, 3AM, 3AC, 3AI, 3AJ. U.S.A. :—U 6AFS, 6AWT, 6BAF, 6CGW, 6CTO, 6FZ, 6HM, 7DF, 7VZ. Argentine :—R DH5, FA3, AS7, FF9, CB8, DB2, HA2, AF1, DE3, KA9, FC6, EF2. Uruguay :—X ZCP, 1CD, 1CG, 1BU, 1AS, 2AK. Chile :—CH 3IJ, 2AR, 2LD, 3AT, 2AB. Mexico :—M 1AA, 1B, 1G, 1N, 1J, 5C, 9A, XDA, XAM. South Africa :—O A4Z, A6N, A3B, A3Z, A4V, A7H, 1SR. Various :—NPG, NBA, Pi CD8, N1DK, NISS, XCD, Y XBC.

(0-v-1.) T. S. Calder.

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S

22.—The Early Experiments of Preece.

THE first practical wireless system, that is to say, one that was actually used for commercial purposes, was that evolved by Sir W. H. Preece, at one time engineer-in-chief of the General Post Office.

William Henry Preece was born in Wales on February 15th, 1834, and was educated at King's College, London, He became a civil engineer, but in 1853 joined the Electric and International Telegraph Co., from whence (in 1869) he reverted to the Civil Service. In 1877 he was appointed electrician to the Post Office; in 1899, engineer-in-chief; and, after his retirement, consulting engineer. He died at Penrhos, Carnarvon, on November 6th, 1913.

As we have already learned, Preece was deputed (in 1854) to examine J. B. Lindsay's system of wireless communication, and no doubt this early acquaintance with the subject had directed his attention to the problem—to which he devoted more particular attention, perhaps, after he had entered the service of the Post Office. Between 1882 and 1898 he contributed several papers on the subjects of induction and signalling without wires to the British Association, Society of Arts, and other scientific bodies.

Sir William H. Preece

The Earth Return.

In his first paper, "Recent Progress in Telephony," he said:—"The discovery of the telephone has made us acquainted with many strange phenomena. It has enabled us, amongst other things to establish beyond a doubt the fact that electric currents actually traverse the earth's crust. The theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-basket. . . . Telephones have been fixed upon a wire passing from the ground floor to the top of a large building (the gas-pipes being used in place of a return wire), and Morse signals, sent from a telegraph office 250 yards distant, have been distinctly read. There are several cases on record of telephone circuits miles away from any telegraph wires, but in a line with the earth terminals, picking up telegraphic signals; and when an electric-light system uses the earth, it is stoppage to all telephonic communication in its neighbourhood. Thus, communication on the Manchester telephones was not long ago broken down from this cause; while in London the effect was at one time so strong as not only to destroy all correspondence, but to ring the telephone-call bells. A telephone system, using the earth in place of return wires, acts, in fact, as a shunt to the earth, picking up the currents that are passing in proportion to the relative resistances of the earth and the wire."

Signals Across the Solent by Conduction.

In March, 1882, the cable across the Solent broke down from some unknown cause, and it became of great importance to know if communication across could be established by any other means. Sir William "thought it a timely opportunity to test the ideas that had been promulgated by Professor Trowbridge."

The arrangements he suggested were similar to those used by Morse (in 1842) and Lindsay (in 1854), with both of which systems we know Preece was already familiar. Over these two pioneers of conductive transmission, however, Sir William had the considerable advantage of the then recently invented telephone for reception, and he used a rapidly vibrating reed, or "buzzer," to transmit the signals.

A plate of copper, about 6ft. square, was immersed in the sea at the end of Ryde Pier. From thence an overhead wire passed to Newport and to the sea at Sconce Point, ending in another copper plate. On the opposite shore at Hurst Castle was another copper plate, connected by a wire running through Southampton to Portsmouth, and terminating in a fourth plate at Southsea Pier. Thus a complete circuit was formed, if the water is included, starting from Southampton to Southsea Pier (28 miles), across the Solent to Ryde (6 miles), and on through Newport to Sconce Point (20 miles), across the Solent again to Hurst Castle ($1\frac{1}{4}$ miles), and back to Southampton (24 miles).

Loud-speaking Gower-Bell telephones were first tried in the circuit, but conversation was found to be impossible. With a Theiler's sounder, or buzzer, a Morse key and 30 Leclanché cells at Southampton, however, it was quite possible to hear the Morse signals in a telephone at Newport, and *vice versa*. Although the cable

Pioneers of Wireless.—
was repaired on the day following these experiments and further tests were thus rendered unnecessary, Sir William's interest in the subject did not abate, and he neglected no opportunity of adding to his knowledge of wireless telegraphy.

In the course of his duties at the Post Office Sir William had noticed many cases of the telephone picking up telegraphic signals from distant circuits. Of this there was no more remarkable instance than that of the famous Gray's Inn Road case, which occurred in 1884. Here it was discovered that telegraphic signals could be heard in telephone circuits that ran parallel to the underground cables. This was found to be possible, even though the telephone wires were carried on poles over the roofs of houses some 80ft. above the telegraph cables, which were buried in iron tubes at some depth beneath the roadway.[1] There were many other similar cases about the same time, one particularly interesting being that of the City and South London Electric Railway, the currents of which deflected the delicate galvanometers at the Greenwich Observatory, 4½ miles distant.

During the following year (1885) Sir William arranged numerous experiments with a view to testing the properties of induction in telephone wires and to determining to what distance parallel wires could be removed from each other before the inductive influence ceased to operate.

Two separate squares (the sides of which were 440 yards in length) of insulated wire were laid on the Town Moor at Newcastle, parallel to each other and a quarter of a mile distance apart. A conversation was easily carried on between the two circuits, and even when the squares were separated by 1,000 yards, inductive effects were still appreciable. It was found, however, that when the distance between the parallel wires exceeded the length of the wires themselves, the strength of the induced current in the second wire was considerably diminished.

Several similar trials were held (in 1886) in different parts of the country. Between Durham and Darlington, the ordinary working currents in one line were clearly heard in a telephone on another line, running parallel but 10¼ miles distant! Similar inductive effects were even obtained on the east and west coasts between Newcastle and Gretna on parallel lines 40 miles apart.

One of the most interesting of these experiments took place (also in 1886) on the Severn, between Gloucester and Bristol. Here there were no intermediate lines that could exercise a disturbing influence for a length of 14 miles, and an average distance apart of four and a half miles. The experiments, although conclusive, showed that the range of audibility of the apparatus employed had been exceeded. It is interesting to note that in these tests it was unexpectedly found that the results were the same no matter whether the circuits were completely metallic or earthed at the end.

At Porthcawl, in South Wales, Sir William's assistant, Gavey, carried out (1886) experiments on a wide stretch of sand. Two horizontal squares of insulated wire, 300 yards in length on each side, were laid side by side at varying distances apart. Then one of the squares was suspended 15ft. in the air above the other, which was covered by water at high tide. The signals were found to be similar in strength, no matter whether the intervening space was air or water, or a combination of both.

As a result of these experiments Sir William came to the conclusion that around the wire was a magnetic field that extended uninterruptedly through the earth as well as through the air. He suggested that if a circuit was arranged in a space beneath the ground, a current could be induced in it from a second circuit superimposed above ground.

As we shall later learn, when dealing with the pioneer work of the brothers Heaviside, the theory was tested out by erecting a circuit of 2¼ miles in length above a coal mine, when telephonic conversation was established by induction, in a second circuit in the workings 360ft. beneath.

[1] This undesirable state of affairs was only eliminated when the telegraph wires were removed to a more distant route.

NEXT INSTALMENT.
Preece Instals the First Practical Wireless System.

TRADE NOTES.

A Station Log Sheet.

Designed especially for the needs of short wave experimenters, the new station log pad, produced by Messrs. B. Matthews and Sons, 9, Holland Road, Aston, Birmingham, appears to include space for every transmission and reception detail that the experimenter is likely to require.

The forms are available in pads of 100, price 1s. per pad.

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Forty Years of Patents.

To mark the completion of forty years' practice by the managing director, Mr. Benj. T. King, Messrs. King's Patent Agency, Ltd., 146a, Queen Victoria St., E.C.4, have issued a revised edition of "Patents for Inventions," a useful little handbook containing general information for the would-be patentee.

oooo

New London Showrooms.

Messrs. Stratton and Co., Ltd., manufacturers of "Eddystone" receivers and wireless accessories, have opened new showrooms at "Stratnoid House," 3, Hornsell St., Jewin St., London, E.C.1 ('Phone: Central 1342).

oooo

A Useful Coil Mount.

The fragility of the average basket coil is frequently a source of inconvenience. A successful attempt to overcome the difficulty is the new Eelex anti-capacity coil mount manufactured by Messrs. J. J. Eastick, Eelex House, 118, Bunhill Row, E.C.4. This and other components are described in the company's new catalogue.

BOOKS RECEIVED.

"Les Filtres Electriques."—Théorie, construction, application, by Pierre David, with preface by General Ferrié. Pp. 130, with 76 diagrams and reference tables. Published by Gauthier-Villars et Cie, Paris, price 25 francs.

oooo

"Rubber and Engineering."—A short account of the preparation and properties of rubber, with particular reference to its uses in the engineering industry, by H. P. Stevens, M.A., Ph.D., F.I.C., and B. D. Porritt, M.Sc., F.I.C., F.R.S.E., pp. 32, with 4 diagrams. Issued by the Propaganda Dept. of the Rubber Growers' Association, Inc., London.

Savoy Hill Topicalities: By Our Special Correspondent.

Government Control of Broadcasting.

Is a form of Government control already at work at the B.B.C.? Whether the nucleus of the new Broadcasting Corporation is actually functioning or not, a marked tightening-up in respect of some sections of the programmes has become apparent and a more rigid censorship is being exercised, particularly over anything which can by a stretch of the imagination be called controversial.

oooo

Is G.B.S. Too Controversial?

The refusal to allow Mr. Bernard Shaw to be broadcast from the House of Commons, when he was entertained at dinner in celebration of his seventieth birthday, was the most recent example of the lengths to which official prohibition may go. "G.B.S." must have had his tongue in his cheek when he suggested that he would be violently controversial. It required a Government official to take him seriously and to prevent his remarks from reaching listeners.

oooo

P.O. Too Censorious.

Another interdiction for the Post Office concerned the discussion between Mr. Hubert Henderson, of *The Nation*, and Mr. Raymond Swing, of the *Philadelphia Public Ledger*, on "American Debts," which would have made a brilliant contribution to the wireless programmes a fortnight ago; and a third embargo was that on the Boot and Shoe Trades' conciliation scheme. These, with a very large number of other prohibitions, suggest that the Post Office is making a fetish of controversy and a martyr of free speech.

oooo

Another Torchlight Tattoo.

I suggested a few weeks ago that it would be a good thing if the B.B.C. could keep an eye on the Torchlight Tattoo of the Royal Marines at Deal, with the view of broadcasting this function in the same way as the Aldershot Tattoo was broadcast in June. I learn that arrangements have now been made to broadcast the Deal Tattoo on August 6. The performers will be recruits under training at the Depot Royal Marines, Deal, whilst the band will be the Royal Marines Band which accompanied the Prince of Wales on his tour of South Africa and South America.

An Unusual Invitation.

An appreciative listener, anxious to give some token of the enjoyment which he obtains from 2LO programmes, has offered to lend his caravan to any two members of the staff at Savoy Hill, to enable them to spend their summer vacation on the Chilterns. Offers of floral and other gifts are not uncommon; but the offer of a free caravan holiday is unique. I imagine that it is with some reluctance that the offer is declined with thanks.

oooo

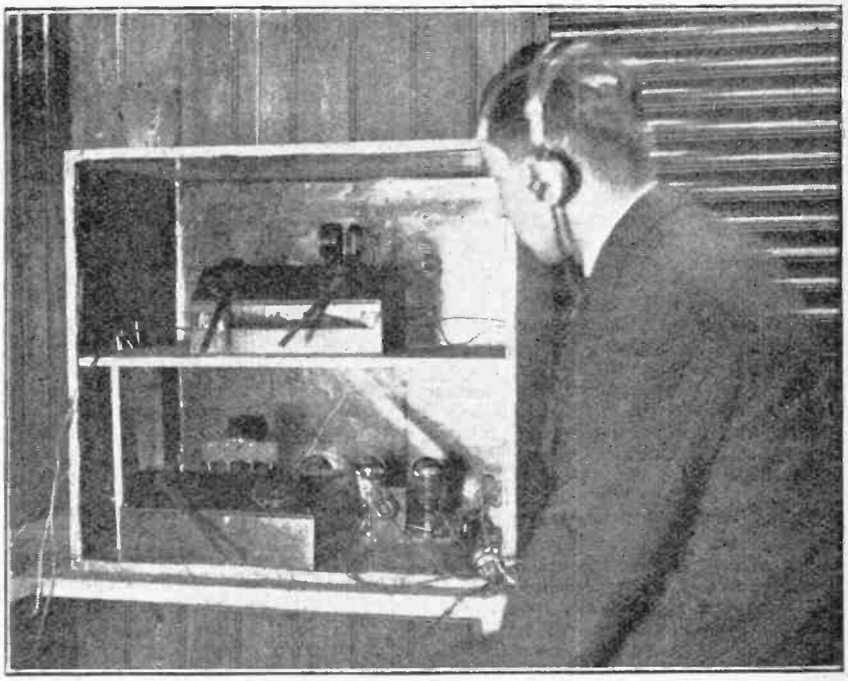
The King's English.

The Advisory Committee on Pronunciation, concerning whose appointment I gave the first intimation in these columns a fortnight ago, has held several meetings and is compiling quite a large dictionary of words for the guidance of announcers. Some of the decisions already reached will be open to question, as, for instance, the pronunciation of "vagary" as va-*gay*-ry, and not as *vay*-ga-ry. The Committee seemed none too certain about "precedent," for in the initial list of decisions the word was given as pre-ceed-ent and in a later list as press-ed-ent.

oooo

Loud Speakers in the Garden.

Should the loud speaker in the garden be tolerated? The revival of the question this years seems to point to its becoming a hardy annual. Unfortunately the difficulty of answering it to everyone's satisfaction is not decreased by the growing tendency of listeners in a row of suburban gardens to try to outvie each other in providing out-of-door performances of a kind which do not suggest that the owners of the apparatus are disciples of Capt. Eckersley's formula, "Quality, not Quantity."



PROGRAMMES FROM AMERICA. The short-wave superheterodyne set which has been installed at the B.B.C.'s special receiving station at Keston for the purpose of relaying programmes from the short-wave American broadcasting stations. The receiver is completely screened

Neighbourliness.

The matter is one calling for neighbourly and amicable arrangement. More good can be done in discussing with the owner of an offending loud speaker the inconvenience which is being caused by these garden performances than in getting on one's hind legs, so to speak, and threatening to set the law in motion. If a friendly word should not prove effective, although it generally does, the offended party can always sustain himself with the thought that fine evenings in England are so exceptional that the loud-speaker has to be kept indoors for upwards of three hundred nights during the year.

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A Popular Band.

The Besses o' th' Barn appear before the microphone at Manchester on August 6, with Miss Jo Lamb, volinist, and Mr. Roy Henderson, baritone. Miss Jo Lamb is a young artist, who is rapidly achieving success in the musical world. A pupil of Dr. Brodsky at the Royal Manchester College of Music, she comes of an artistic family, her grandfather, the late Thomas Heatherley, being the founder of the Heatherley School of Art in London. Mr. Clifford Heatherley, the actor, is her brother.

oooo

The Kneller Hall Band.

Miss Kathleen Moorhouse, soloist of the Hallé Orchestra, and who is well known to northern audiences, is to play at the Manchester station on August 1, when orchestral items will be provided by the Kneller Hall Band, conducted by Lieut. H. E. Adkins, Mus. Bac. This is, of course, the band of the Royal Military School of Music at Twickenham, of which Lieut. Adkins is the musical director.

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An International Programme.

Among forthcoming events of unusual interest at the Liverpool station is a programme of an international character, to be broadcast on August 5. The first fifty minutes will be devoted to Russian composers, and will include Moussorgsky's tone poem, "A Night on the Lonely Mountains." The station symphony orchestra will open the second part of the programme, "Operatic Favourites," with the Overture to Stanford's opera, "Shamus O'Brien," which was recently performed in Liverpool. The vocalist for both these sections will be Mr. Walton Pritchard, a local baritone. This feature will be followed by a "Transatlantic" programme, in which listeners are to hear Mr. G. H. Carlisle, the American entertainer.

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A British Legion Programme.

The central feature of the programme on August 4 will be the speech of the Prince of Wales, relayed from Oxford on the occasion of the annual meeting of the British Association. This will occupy the period from 8.30 to approximately 9.10 p.m. The remainder of the evening programme will be arranged by the British Legion. At 7.40 the stations will go over to Manchester to hear "Marching Songs of the Great War."

FUTURE FEATURES.

Sunday, August 1st.

LONDON.—Popular Classics.

BIRMINGHAM.—Gounod Programme.

BOURNEMOUTH.—Symphony Concert.

GLASGOW.—Request Orchestral Programme and Folk Songs.

Monday, August 2nd.

LONDON. — "Benkoldy" — Three short scenes by Keble Howard.

ABERDEEN.—Russian Songs and Scenes.

BOURNEMOUTH.—Bank Holiday Programme.

CARDIFF.—The Band of H.M. Royal Marines (Chatham) and the Bristol Harmonic Male Choir, relayed from the Royal Victoria Park, Bath.

MANCHESTER.—The Whitworth Vale and Healey Prize Band.

Tuesday, August 3rd.

LONDON.—"Force, Wits and a Woman," a dramatic episode.

DAVENTRY.—Daventry Pool.

GLASGOW.—Old Scots Songs and Melodies.

Wednesday, August 4th.

LONDON. — British Legion Programme.

BIRMINGHAM.—Light Music.

NEWCASTLE.—The Harton Colliery Band Brass Quartet.

Thursday, August 5th.

LONDON.—The Emery Glee Club.

BIRMINGHAM.—Popular Programme.

BOURNEMOUTH.—Light Symphony.

CARDIFF.—The Valve Set Concert Party.

GLASGOW.—A Mozart Programme.

Friday, August 6th.

LONDON.—A Sing Song from the Duke of York's Camp.

ABERDEEN. — The London Radio Repertory Players in "The Missing Link."

BIRMINGHAM.—Chamber Music.

BELFAST.—Grand Opera.

MANCHESTER.—The Besses o' th' Barn Band.

NEWCASTLE.—A Popular Concert.

Saturday, August 7th.

LONDON.—The Radio Follies Concert Party.

ABERDEEN.—The Aberdeen Fisher Girls' Choir and Police Pipe Band.

GLASGOW.—Ballad Concert.

MANCHESTER.—Dance and Dialect.

Champion Mouth Organist.

2LO is including in its programme of August 3 a newcomer in the person of S. Haywood, described as the champion mouth organist. This is an S.B. item.

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A Busman's Holiday.

Busmen are not the only people who hold special views on the subject of holidays. Bournemouth listeners, who have heard rumours from their friends in the Midland of the fine work that Mr. Joseph Lewis has done as Musical Director of the Birmingham station, will be pleased to hear that Mr. Lewis is going to Bournemouth, and that during next week he will conduct the Bournemouth Wireless Orchestra.

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Box and Cox.

While "Joe" Lewis is playing "Box" in Bournemouth, Capt. W. A. Featherstone, the musical director at the Hants station, will play "Cox" at Brum. This interchange of musical directors is a healthy sign, as its effect should be to keep both orchestra and conductor up to concert pitch and widen their outlook on broadcast music.

oooo

Dual Transmission Tests.

The figures quoted by Capt. Eckersley in a general Press statement last week, respecting dual transmissions, confirm the announcement made in these columns at the time of the tests, which were carried out from the Oxford Street Station and Marconi House on June 26th and July 1st. That announcement was to the effect that the result of the first scrutiny of listeners' reports showed that seventy per cent. of crystal users and ninety-six per cent. of valve users were successful in separating the two transmissions.

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New Wavelengths.

These results were sufficient for the purpose of proving the feasibility of alternative programmes from certain definite points, as represented by higher-power stations erected at convenient centres outside large towns. No more tests of the kind are necessary in the meantime. The next step will be the introduction, in the second week of September next, of exclusive wavelengths for the existing main stations. These wavelengths, with, perhaps, one exception, will fall within the 300-500 metres waveband, and no other station or stations in Europe will use the same wavelength. When this scheme, now ratified by Geneva, is in operation, attention will be concentrated on the preparation of a plan for alternative programmes, and these are likely to become a *fait accompli* next year. The likelihood of this development being retarded by the establishment of the projected Broadcasting Corporation is remote; as the Postmaster General has indicated that the executive work of the Company will not suffer any interference. The staff will, therefore, go on executing in the interests of the broadcasting service.

THE VALVE TO USE IN A WAVEMETER.

How Small Changes of Filament and Plate Potential Affect the Calibration.

By E. W. SUTTON, B.Sc.

THE following experiments were carried out, during the reconstruction and calibration of a valve wavemeter, with the object of deciding which of several available valves was best from the point of view of constancy of calibration. The conditions of voltage under which the valve operates were found to have a much larger effect on the frequency, with a given circuit arrangement, than the writer anticipated, and it was thought that the results of the experiments made might be of use to others similarly engaged.

Design of the Wavemeter.

The wavemeter is frequently used, in the writer's case, as an oscillator for resistance measurements, and also as a source of E.M.F. of known frequency in some experiments where it is necessary to enclose everything, including batteries, in a metal "shield." Several considerations, therefore, influence the choice of the valve. Constancy of frequency over a period of an hour or more demands a filament accumulator of fairly large amperehour capacity. On the other hand, a large 6-volt accumulator necessitates a shield which is undesirably large for the latter experiment.[1] The output of power required in both cases is rather too great to permit of undue reduction of the filament current below the rated value. Two valves of the dull-emitter type were, therefore, selected for test, together with two bright-emitters, in the hope that one of the former might prove satisfactory. They were as follow:—

(1) M.O. D.E.R.—Two individual valves were used: a recently purchased "gettered" one, and an old one manufactured before the employment of "gettering." The difference between these was found to be so small that the results are not given separately.

(2) Loewe-Audion, L.A.75.—Filament rating, 2.0-2.5 volts, 0.15 amp.

(3) Mullard O.R.A.

(4) M.O. V.24.

The circuit diagram of the meter is shown in Fig. 1. It will be seen that a double-range voltmeter (a small Weston instrument) is fitted. A two-way switch enables anode or filament voltage to be quickly noted and adjusted. The coils are wound on small four-pin H.F. transformer bobbins, plugging in to a valve holder, so that the range of frequency may be rapidly changed as required. With a 0.0005 microfarad condenser, these ranges are roughly 50-100 metres, 100-200, 200-500, etc. The number of turns on the reaction coil of each range has been adjusted to give maximum output at about 0.00025 microfarad capacity.

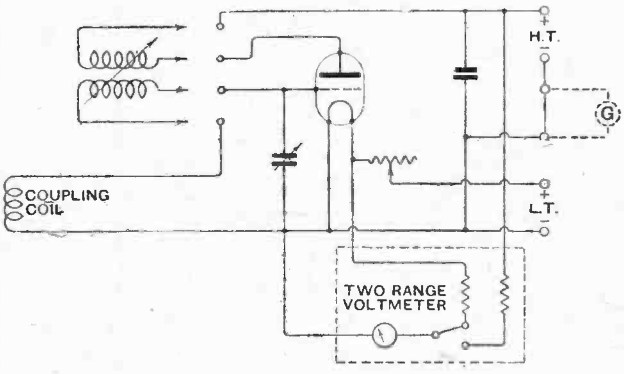


Fig. 1.—The wavemeter circuit. The tuning coils are fitted with plug-in four-pin mounts. A two-range voltmeter shows filament and anode potentials.

The frequency calibration and the determination of frequency change with differing conditions were carried out with the aid of a standardised quartz crystal (f = 265.480. λ = 1,129 metres). The method used is that described by Prof. E. Mallet and V. J. Terry.[2]

The Effect of Changes of Filament and Anode Potential on Frequency.

The first experiment was to observe the effect of alteration of filament voltage on the frequency of oscillation,

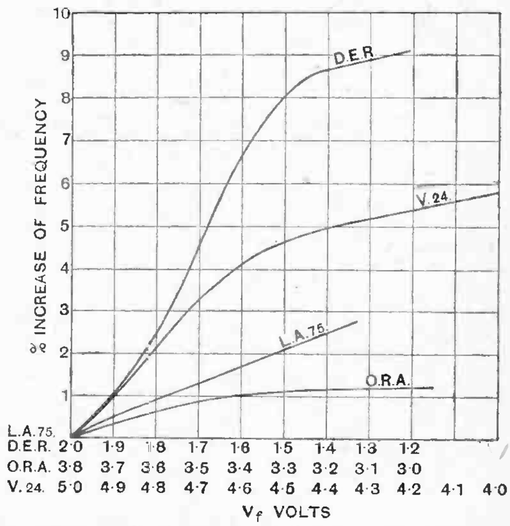


Fig. 2.—The effect of filament voltage on the frequency of an oscillator. Increasing the brightness of the filament raises the frequency and the change is more marked in the case of a dull emitter valve.

the anode voltage being maintained at 50. The results are shown in Fig. 2. The frequency changes by as much as 9 per cent. in the case of the D.E.R., and only by 1.2 per cent. in the case of the O.R.A. The general shape of these curves is what might be expected—decrease of filament voltage, and consequently of emission current leading to a decrease of damping of the tuned circuit and consequent decrease of periodic time or increase of frequency.

On the steepest part of the curve the frequency of the D.E.R. valve changes by 1 per cent. for an alteration of

[1] Earth capacities being important.

[2] *The Wireless World*, June 24th, 1925, and illustrated in Fig. 10 of that article.

The Valve to Use in a Wavemeter.—

0.045 volt in filament potential. The filament voltage can be adjusted to about 0.02 volts with the aid of the voltmeter fitted, so that the frequency can be regulated, at this point, only to about 0.45 per cent. The O.R.A. valve is considerably better in this respect. At its worst the frequency changes by 1 per cent. for 0.34 volt, and filament voltage may be read to about 0.04 volt, so that the possible variation in *f* is about 0.12 per cent. It will be seen that the curves for all except the L.A.75 tend to become horizontal with reduction of filament brightness. The frequency change for the O.R.A. valve under these conditions was found to be about 1 part in 1,160, as potential was reduced from 3.20 volts to 2.96.

The D.E.R. valve and the O.R.A. were then examined in greater detail. A succession of readings of frequency (for a given setting of the wavemeter condenser) and anode voltage for a series of values of filament voltage was obtained, and the results are shown in Fig. 3.

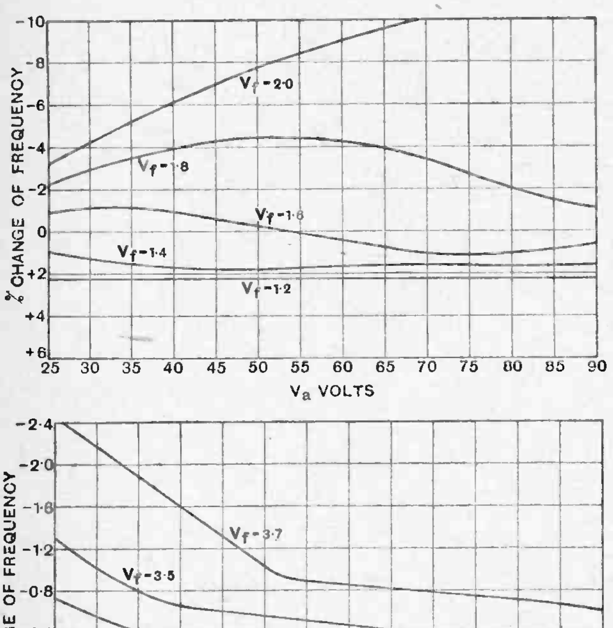


Fig. 3.—Change of frequency with anode voltage for different values of filament voltage. The upper set of curves refers to a D.E.R. valve and percentages are referred to an anode voltage of 50 and a filament voltage 1.6 the lower curves are for an O.R.A. valve, the standard voltages being 50 and 3.0 respectively

The curves in the case of the Fig. 3 D.E.R. valve appear somewhat irregular, and it was not until repetition had confirmed their shape that the writer was satisfied that this was not to be accounted for by experimental error. There is doubtless a reason for the complicated shapes of the curves obtained with filament potentials of 2.0, 1.8, and 1.6, but it is sufficient to note that until the voltage is reduced to about 1.4 the rate of change of frequency with anode voltage renders this type of valve unsuitable for the present purpose. If the valve is used on the reduced value of filament potential, the power output is too low for many purposes, such as the measurement of resistance.[3]

From the curves in Fig. 3 it will be seen that the O.R.A. is considerably superior to the others for the present purpose. The tests on the L.A.75 were not carried any further than the curve shown in Fig. 2, since that showed no tendency to become horizontal. The V.24 showed no promise of rivalling the O.R.A., and, in addition, has the disadvantage of needing a 6-volt accumulator.

If it is decided to use the O.R.A. valve with filament and anode potentials of about 3.3 and 50 volts, the following figures are seen to apply :—

(*a*) 0.2 volt change in filament potential produce 0.15 per cent. change in frequency, *i.e.*, with the given voltmeter the regulation is within 0.03 per cent.

(*b*) 10 volts change in anode potential produce 0.08 per cent. change in frequency, *i.e.*, if plate voltage is altered by steps of 1.5 volts, the regulation is within 0.01_2 per cent.

The best solution of the problem under consideration is probably the use of a bright-emitter *power* valve under the conditions indicated above, that is, with reduced filament current, and not too small an anode voltage.

Other Conditions Affecting Calibration.

Such constancy of frequency as is discussed above cannot be maintained unless the wiring of the meter is rigid, sufficient shielding is provided, and a good variable air-condenser is used. The condenser should be of rigid construction, with ample bearing surfaces for the rotor, and having a larger distance between plates than is common in many present-day models. The increased bulk necessary if the spacing is increased is of little disadvantage in the present case. These facts are illustrated by the following figures.

The condenser reading (with a given coil) corresponding to the frequency of the quartz crystal was noted on successive days, with following results :—

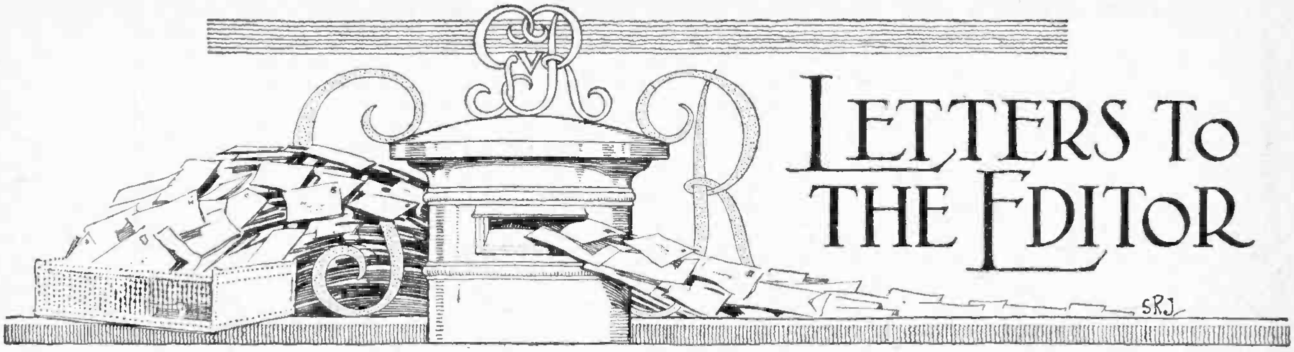
Day	1	2	3	4	5	6	7
Condenser setting ...	25.3°	24.5°	24.7°	24.3°	25.6°	25.1°	25.2°

The maximum frequency change, corresponding to the difference between 24.3° and 25.6°, is about 0.8 per cent.

As this test was first carried out on a particular dull-emitter valve, it was thought to be due to changes in the valve. Subsequently, it was found, by noting the changes with four different valves, that it was practically all due to variations in the circuit. It was not possible to account for any measurable proportion by valve changes. The substitution of a better condenser effected the necessary improvement in constancy.

It is probable that the introduction of a grid bias battery would enable a larger emission to be employed with less rapid frequency changes, but this would have to be of considerable voltage, and introduces a third variable quantity.

[3] If it is used under these conditions the coupling between oscillator and circuit under measurement will probably have to be so large that the $\frac{\omega^2 M^2}{R}$ error will become appreciable.



LETTERS TO THE EDITOR

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

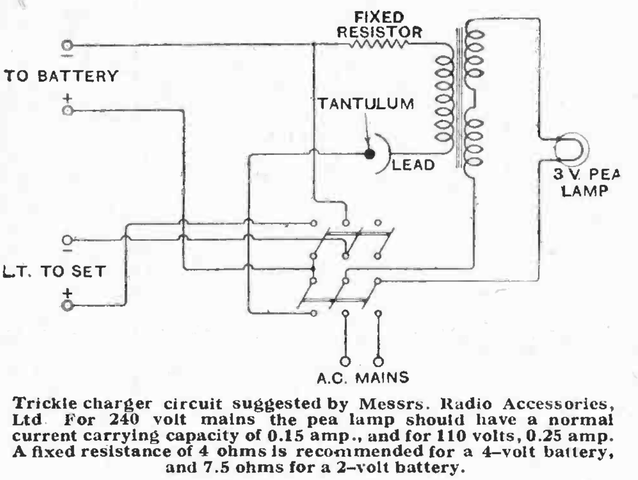
TRICKLE CHARGER FOR L.T. BATTERIES.

Sir,—We have read with interest the article in this week's issue by N. P. Vincer-Minter upon the subject of trickle charging for L.T. batteries.

This article is very interesting, and we write this to suggest certain improvements, which, in the course of our manufacture, we have found useful.

In the first place, instead of using an expensive ammeter in the battery circuit and a fuse in the main supply circuit, we have found a pea-lamp to be all that is necessary. This lamp glows when the rectifier is functioning, thereby enabling a user to tell at once whether his batteries are on charge or not. It further acts as a fuse. We have not found it necessary to incorporate an ammeter in the secondary circuit, as the transformer and cell are so proportioned that the charging current varies from 0.4 to 0.6 amp., depending on the primary voltage supply to the transformer.

We show below a more simple diagram of connections than that shown by your correspondent, which is incorporated in our standard trickle charger, and may be of interest to your readers. We do not incorporate in our instrument an adjustable rheostat, but we supply a small plug and socket arrangement whereby batteries of 2, 4, or 6 volts may be charged without overloading the rectifying cell.



Trickle charger circuit suggested by Messrs. Radio Accessories, Ltd. For 240 volt mains the pea lamp should have a normal current carrying capacity of 0.15 amp., and for 110 volts, 0.25 amp. A fixed resistance of 4 ohms is recommended for a 4-volt battery, and 7.5 ohms for a 2-volt battery.

This is achieved by the screwing-in of a fixed resistor or a shorting plug.

We note that your correspondent recommends a piece of rubber tubing to be fitted to the vent-pipe on the cell to allow for the escape of gas. With our charger the vent-pipe is brought through a hole in the lid of the box, and into the vent-pipe is inserted a dip rod. This dip rod has two functions: first, by withdrawing it, it is possible to tell the depth of the electrolyte; and secondly, when the cell is functioning, this dip rod acts as a condensing rod, and small particles of sulphuric acid which are thrown up from the surface of the electrolyte are deposited on the inner walls of the vent-pipe and on the dip rod, and after a period of accumulation, while drops are being formed, the acid falls back into the cell.

Without the dip rod we have found that these particles of acid spray escape from the vent-pipe.

N. H. HAMILTON,
Radio Accessories, Ltd.
London, N.W.10.

A SUGGESTION FOR THE B.B.C.

Sir,—It frequently happens in the case of an experimenter trying out new circuits on the B.B.C. wavelengths, or in the case of an ordinary broadcast listener endeavouring to tune in one of the B.B.C. stations, that he switches on in the middle of a prolonged interval, and, not having heard the announcer's "three minutes please" is at a loss to know whether his receiver is at fault or not. It might be argued by unscrupulous people that he could easily find out whether his receiver was in order by throwing it into oscillation and heterodyning the carrier wave, but Heaven forbid that I, at any rate, should be guilty of this criminality. There must be many people, however, who, either through ignorance or wilful disregard of their fellow-listeners, are thus encouraged to indulge in this pernicious practice. Indeed, I have myself frequently suffered in this respect from Ham Handed Henry, who, having missed the announcement of the interval, imagines he has "lost" the station and makes frantic efforts to pick it up again.

I suggest that it would go a long way towards mitigating the oscillation nuisance if the B.B.C. installed a small carbon microphone in the studio clock and gave instructions to the announcer to switch this in immediately an interval was announced so that the ticking of the clock would reassure listeners who had missed the announcement that their receivers were not at fault.

Were this suggestion adopted I feel sure that a marked decrease in oscillation would follow, and it would be interesting to know the opinion of other readers concerning this matter.

Aberdeen. J. McTAVISH.

DO TRANSMITTING STATIONS SUFFER FROM FATIGUE?

Sir,—I was interested in the letter under the above heading, from "Observer at Sea," in your issue of July 14th, regarding the apparent falling-off in efficiency of a newly constructed station after its first few weeks' working. Many other observers have doubtless noticed the same effect; spark, C.W., and telephony stations seem to be equally affected. Your correspondent puts forward some ingenious suggestions as to the possible causes of this phenomenon, but seems to have overlooked what is, to me at any rate, the more obvious solution—namely, the human element.

A new station is, prior to and immediately after being handed over to the operating authority, worked up to its maximum efficiency by a staff of highly skilled engineers, employed by the installing contractors, who are thoroughly familiar with the apparatus. Although those responsible for its subsequent maintenance may have the fullest possible theoretical knowledge of their subject, they probably have no experience with the actual set, and so a temporary falling-off is only to be expected. The lost efficiency may be regained later, but in the meanwhile the idea that the effectiveness of the station has diminished will have gained general currency. F. A. LAW.

Leicester.

UNDERGROUND AERIALS.

Sir,—I have been experimenting with an underground aerial for some time now. At last I have discovered a fairly efficient one. The space occupied by it is 3ft. by 3ft. 9in. The volume of signals is about 10 per cent. less than ordinary type of outdoor aerial. It has just about the same range. The one big advantage is that signals are much clearer, being free from mush and atmospherics. Also this should overcome the problem of unsightly aerials. A. G. L. ACLAND. (2UD).

Chatham.

THE Q.S.L. QUESTION.

Sir,—I have seen in your columns from time to time correspondence from readers concerning Q.S.L. Cards.

It is quite appreciated that cards from one's immediate surroundings, in the case of DX merchants, are useless, and can only be classed as "wallpaper," but apparently real DX Cards are often treated as little more. Out of all the Cards I have sent to amateurs in Europe, not more than 10 per cent. have been acknowledged. The demand, too, for more information is also appreciated, but how often do transmitters give such particulars when replying? In my case I give barometer and thermometer readings, weather, moon and, often, percentage of humidity. In only two instances have I had barometer readings quoted (namely G5NN and G2FM) and never have I had any weather particulars given.

If real co-operative working is required it is necessary that more information be given in answer to Q.S.L.'s, especially where DX work with the tropics is concerned.

Apropos Mr. G. E. Hughes' letter in your issue of May 5th, I would like to state that I wrote to the B.B.C. with reference to broadcasting on the short waves, and I received an answer saying that the B.B.C. had applied for permission to use the 100 metre wavelength, which was, however, refused by the P.M.G. Personally I find no difficulty in receiving Daventry on a 4-valve tuned-anode 1-v-2 set.

Cawnpore, India. ARTHUR H. MOORE, Y2PM.

LIFE OF RECTIFYING VALVES.

Sir,—Referring to the article on the trickle charger in your issue of July 14th, my experience of what I think must be the 25s. rectifying valve mentioned has been very much more favourable than your article would indicate. I installed a set just on 4 years ago, rated to give on one 6 valve accumulator 5 amps., and on 2 in series 3 amps. I use a good deal more than most amateurs in wireless work alone, and in addition a fair amount for my professional work. I cannot estimate the total hours the bulb has run, but probably 12 hours per week underestimates. It charges 12 volts at 4.5, and would do more, and 18 volts at 2½ amps. It has never given me one second's trouble, except once to replace a fuse, and it runs as merrily as ever, the last run being 16 hours at 4 amps. It is rather more expensive than some, but in my opinion worth its money twice over.

London, S.W.5. J. H. REEVES.

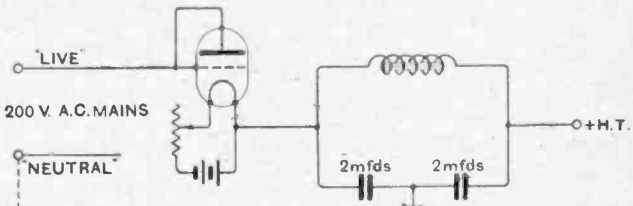
H.T. FROM A.C. MAINS.

Sir,—For the past two years I have had in use a single-valve rectifier operating *directly* off the 200-volt A.C. mains for supplying H.T. to the low-frequency amplifying valves on my receiver, and it has given every satisfaction.

I say *directly* because the mains are taken straight to the valve and not through the medium of a transformer.

This would appear to be against the Board of Trade regulations, since the "neutral" wire (the one nearest earth potential) must be earthed only at one point determined by the Electricity Company, I believe. But if the accompanying circuit is examined it will be seen that the "neutral" wire is not made use of in any way!

The "live" wire is connected on to a fairly low impedance



Rectifier and smoothing unit for obtaining H.T. from A.C. mains.

valve (such as a 2-volt D.E.R.), grid and plate connections being strapped, as shown. The H.T. output is taken from the filament of this valve, through the choke coil (a low-frequency transformer with primary and secondary joined inductively in series will serve admirably here), and on to the plates of the amplifiers, the earth return being made by these valves, whose filaments are connected to earth in the normal way.

One side of each 2 mfd. condenser is also connected directly to earth. These are, naturally, for smoothing purposes, as is also the choke.

This rectifier is very inexpensive to make, and will supply three low-frequency amplifiers (transformer, choke or resistance-capacity coupled) without trace of "hum" provided that sufficient grid bias is used. J. HANSON (G 6YU).

Coventry.

VALVES FOR A.C. MAINS UNITS.

Sir,—Replying to your letter of the 16th inst., in connection with the recent article on "How to Construct the Unit for A.C. Mains," your readers need not have any difficulty in obtaining the Philips valves type 328, if application is made to this address.

Our policy only permits this valve to be sold with our instruments or as replacements, and consequently supplies are not stocked by the average wholesale trader.

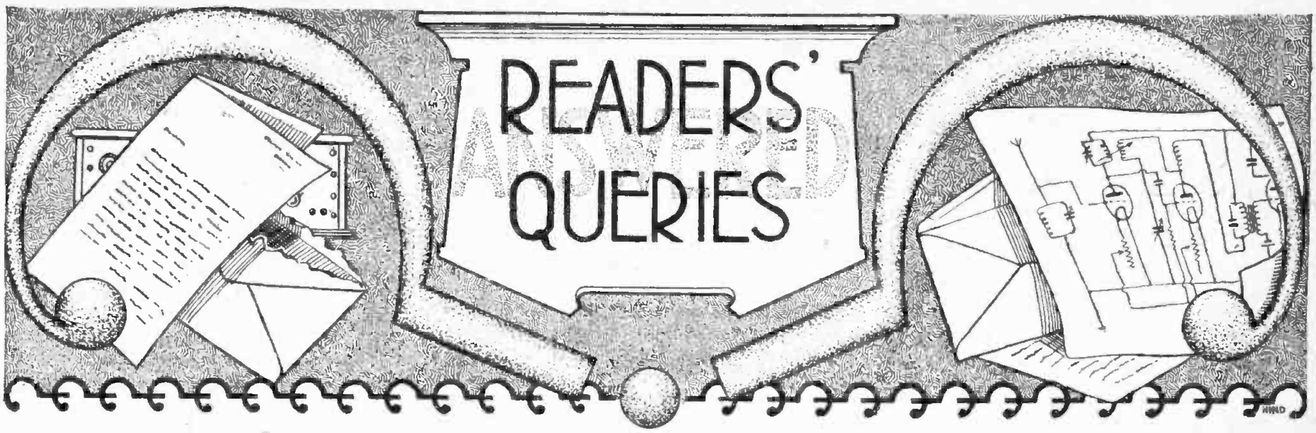
We are prepared to supply individual requirements coming under such schemes as the one referred to above; the price is 12s. 6d., and delivery can be effected direct from stock.

We would suggest in the interests of your readers that an announcement is made to this effect in your current issue, should you see your way clear to do so.

PHILIPS LAMPS, LTD.

145, Charing Cross Road, W.C.2.

The amateur experimental station 2BLG owned by Mr. E. R. Martin, at Castlemount, Worksop, Notts. The QSL cards displayed indicate reception from widely distant stations. The receiver is tunable to wavelengths from 8 to 3,000 metres.



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Misleading Valve Curves.

I have repeatedly seen reference to the "static" and to the "dynamic" characteristic curves of a valve and should appreciate an explanation of these terms. *M. C. M.*

The static characteristic curve is the curve usually published by valve manufacturers and included in the box with the valve. It is *not* taken under working conditions. That is to say, a milliameter is connected in series with the H.T. battery and the plate-filament path of the valve, and various potentials are applied to the grid by means of a battery, and the reading of the plate current milliameter noted for each value of grid potential, and, by taking a large number of these points and joining them up, the normal grid volts—anode current curve is obtained, and this is the curve usually published. Thus, by performing this operation with a D.E.5 valve having a plate voltage of 120, it is found in this manner that a negative grid potential of about $4\frac{1}{2}$ volts will bring the operating point midway on the curve, 9 volts bringing it down to the commencement of the bottom bend.

Under working conditions, however, the plate circuit of the valve is usually "loaded" by a large inductance such as a choke or transformer primary connected in its anode circuit, and if we therefore now reproduce actual working conditions by inserting a large choke in series with the milliameter, we shall find that the characteristic curve is very greatly altered, and is actually "straightened out," so that a much larger value of negative bias has to be applied to the grid to bring the working point down to the midway position, and to the bottom bend respectively. In the case of a high impedance detector valve (whose normal "straight line" portion of curve is not very great) with a 150.000 ohm resistance in its anode circuit, this "flattening out" process is still more marked. If, therefore, an examination of the static curve leads us to suppose that with 120 volts H.T. a $4\frac{1}{2}$ volts negative bias is necessary, we should actually try a much larger bias than this, say 6 to 8 volts in order to make sure that the valve is working on the correct portion of its characteristic curve. It will be noticed that in *The Wireless World* receivers instructions are usually given to this effect. It would seem, therefore, that it would be more practical if the dynamic or actual working curve of valves were published rather than the more customary static curve.

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A Modified Hartley Receiver.

I have been experimenting with various forms of reaction control, including Reinartz, Hartley, and tuned plate, besides the more conventional method employing a moving coil, and have come to the conclusion that the Hartley and the tuned plate method are productive of the best results, and am wondering whether it would not be possible to combine the two methods. I might mention that I wish to use a frame aerial, my idea being to incorporate the system into a portable receiver. *H. J. C.*

The arrangement which you suggest is quite possible, and is adopted by many amateurs. We reproduce the circuit herewith in Fig. 1. This circuit is similar in its action to the Hartley circuit, in which the variometer is substituted by an H.F. choke, and the 0.001 blocking condeser between plate and frame by a small single plate variable condenser. The choke prevents the H.F. energy passing to filament *via* the phones and H.T. battery, and causes it to be fed back to the frame *via* the small condenser. The amount of feed back is controlled by the setting of this condenser, and usually the value of capacity necessary to produce actual oscillation is very small, namely, about 0.00003 mfd. In the modified circuit shown in Fig. 1 the variable condenser is replaced by a fixed 0.001 mfd. condenser, so that, if the choke were still there, the set would oscillate perpetually. In place of the choke, however, we use a variometer. Now, when the variometer is tuned to the wavelength of the signals being received, it acts as a choke of high impedance, and consequently, all the H.F. energy is deflected through the blocking condenser to the frame, and so causes oscillation. Upon slightly detuning the variometer, its impedance falls enormously, and thus oscillation stops. since part of the energy escapes *via* the variometer windings. By manipulating the variometer so that it is almost but not quite in tune, the amount of energy deflected back through the blocking condenser is controllable, and so we are able to vary the degree of reaction to our requirements. When the variometer is completely detuned its impedance is negligible, and practically all the H.F. energy escapes *via* variometer windings and phones to the filament, and none fed back to the frame.

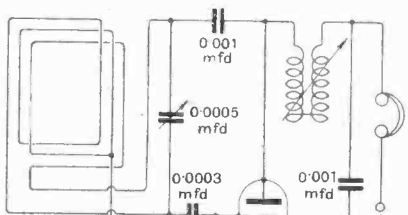

Fig. 1.—Modified Hartley circuit for portable set.

The variometer may, of course, be substituted by a plug-in coil and condenser, or any other tuning arrangement. This blocking condenser may be of any size greater than 0.001 mfd., but may not be dispensed with entirely, and a direct connection made, or obviously the H.T. battery will become connected in series with telephones, variometer and frame, thus causing a current to flow which would speedily exhaust it.

Correct Value of Grid Condenser and Leak.

I notice that the normal values given for the grid condensers and leak in the average receiver are 0.0003 mfd. and 2 megohms respectively. Is there any advantage to be obtained from experimenting with other values? D. C. L.

On the normal wavelength used for broadcasting it will usually be found that a condenser having a capacity between 0.0002 mfd. and 0.0003 mfd. is the most satisfactory value to use. With regard to the normal value of 2 megohms for the grid leak, it may be said that this represents a compromise between signal strength and selectivity. If the receiver is mainly designed to give good quality on the local station, a much lower value should be used, 0.25 megohm being none too small. Indeed, provided the value does not exceed a quarter of a megohm, none of the usual distortion associated with grid rectification will occur, and there is no need to adopt anode or crystal rectification. The actual maximum value, above which distortion will occur, is fixed by the strength of signals received. Since, however, the lower the value of leak the less the signal strength, it is necessary to experiment with the value according to local circumstances. Those, in fact, who reside under the shadow of the aerial of a powerful broadcasting station may well use a 100,000 ohm anode resistance as a grid leak, whilst those a considerably greater distance away may find that the use of a 0.5 megohm or a 1 megohm leak may be used without the strength of signals being so great as to cause distortion due to this method of rectification. In the same manner those readers who live in remote localities may find that a three or four megohm leak may be used, thereby considerably increasing signal strength, without causing this form of distortion. Thus, it will be seen that from the point of view of good quality the lowest value of leak should be used with which it is possible to obtain good quality, always remembering that the lower the leak the less the signal strength.

In a receiver which is mainly designed for distance getting without too much regard being paid to quality, a high value of leak, 5 megohms or more, should be used. In experimental receivers designed for the reception of American broadcasting stations, and of amateur Morse transmissions, therefore, a high value of leak should be used. It would seem, therefore, that there should be a great field for a reliable variable grid leak having a range of from a quarter to ten megohms, or thereabouts. Unfortunately, however, even the best of these components become very unsatisfactory and erratic after a comparatively short period of use, and it is far better to keep a large number of fixed leaks of different values on hand to be used on different occasions, or, alternatively, a number of leaks may be arranged at the back of the panel in conjunction with a stud switch, so that any value may be brought into circuit as desired, or the switching might be arranged to put two or more leaks into series or parallel with each other in order to obtain several values with a minimum number of leaks.

On the whole, therefore, the usual value of two megohms specified for the average receiver represents a fairly good compromise between signal strength and good quality.

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The Schnell Circuit.

Being desirous of constructing a really sensitive single-valve receiver to cover the normal B.B.C. wavelengths and also the Daventry and Paris wavelengths, I have been experimenting with the Reinartz circuit, but have read in a foreign periodical that the Schnell circuit is a great improvement on the Reinartz both for sensitivity and selectivity. I shall be glad if you can give me particulars concerning this circuit. K. S. T.

The Schnell circuit, which is a modification of the well-known Hartley circuit, has achieved great popularity among American amateurs for short-wave reception, it being sensitive, selective, and easy to tune. It is not greatly used in that country for broadcast reception since regenerative receivers have, except for short-wave work, given place to instruments embodying two or three H.F. stages. The receiver is, however, equally efficient on all wavelengths, and is claimed by many experienced amateurs in this country to be greatly superior to the Reinartz. Moreover, its popularity is enhanced owing to the fact that it is equally adaptable to a frame or an open aerial. We reproduce the circuit in Fig. 2 showing the connections both for an open aerial and for a frame.

Referring to Fig. 2 (*a*), it will be seen that the circuit is exceedingly simple, only one coil being used unless a coupled aerial circuit is employed. The coil shown in thick lines consists preferably of a special centre-tapped coil such as the well-known "Dimic" coil, the value being determined by the wavelength to be received. A centre tapped plug-in coil can be used if desired. If a coupled aerial circuit is used it can consist of an ordinary plug-in coil having a suitable number of turns to give the usual "aperiodic" coupling according to the wavelength being received. The H.F. choke can consist of almost any of the commercial chokes that are upon the market, which will give perfect satisfaction between wavelengths of 200 to 4,000 metres or so, thus amply covering all the broadcasting stations, including Daventry.

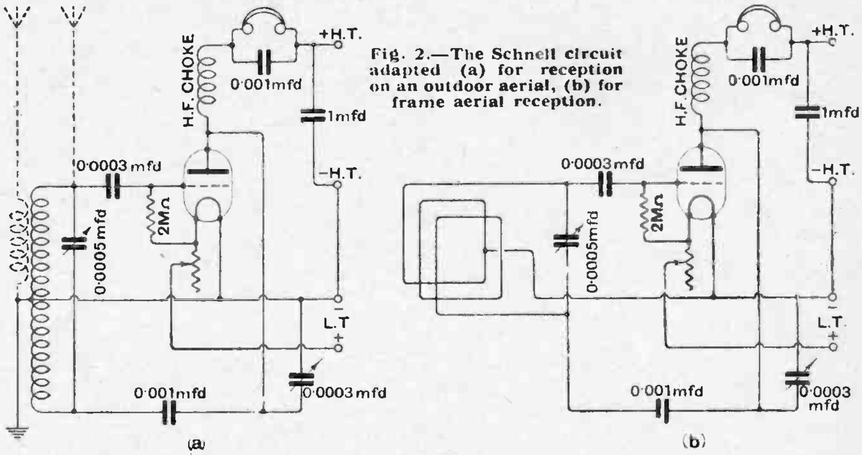

Fig. 2.—The Schnell circuit adapted (a) for reception on an outdoor aerial, (b) for frame aerial reception.

The receiver can be used with equal satisfaction on the short wavelengths using a "Dimic" coil, since these coils are now made in all ranges, from ten metres upwards. Another type of H.F. choke will, however, have to be used, and this should be constructed in accordance with the instructions given on page 906 of our issue dated December 23rd, 1925. On wavelengths below 100 metres an "aperiodic" aerial coil of only two or three turns would suffice, or, alternatively, it might be found better to use capacitative coupling on either short or long wavelengths. This was fully explained in a reply to G.P.K. in the "Readers' Problems" section of this journal for April 7th and again in even greater detail in a reply to T.S.J. in our April 21st issue. Before constructing a receiver embodying this circuit you are strongly advised to study the article on the Hartley circuit on page 117 of our January 27th issue, since much useful information is given which applies equally to the Schnell circuit.

By adopting the circuit given in Fig. 2 (*b*) it is also possible to use this circuit in conjunction with a frame aerial. On the broadcast bands of wavelengths, the frame should consist of 12 turns of a fairly thick gauge of wire spaced $\frac{3}{16}$in. apart, a tapping being taken at the centre. Instead of using a frame with a larger number of turns for the Daventry wavelength, it is possible to "load" the frame by means of plug-in coils. It is essential, however, to use two coils, one in each "outer" of the frame, in order that the filament tapping may still be kept in the electrical centre. Earthing this centre tapping will considerably improve signal strength, or, alternatively, a few extra turns may be wound on the frame for connection to an external aerial as is described in the article on page 544 of our April 14th issue.

This circuit is extremely flexible and reliable, and is to be recommended.